Home Country Effects of Outward Foreign Direct Investment

Theoretical Approach and Empirical Evidence

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LIST OF ABBREVIATIONS

BRIC	Grouping acronym for Brazil, Russia, India and China
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FDI	Foreign Direct Investment
GDP	Gross Domestic Product
ICT	Information and Communication Technologies
IDP	Investment Development Path
IMF	International Monetary Fund
M&A	Mergers and Acquisitions
MNC	Multinational Corporation
NIC	Newly Industrializing Country
NIS	National Innovation System
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
SCE	State-controlled entities
SWF	Sovereign Wealth Fund
UNCTAD	United Nations Conference on Trade and Development

1. INTRODUCTION

1.1. Background and Motivation of the Thesis

Knowledge accumulation and technological progress have long been recognized as engines of economic growth and development (Barro and Sala-i-Martin 2004, Romer 1990, Solow 1956). However, a look on the international distribution of knowledge generation shows that the majority of knowledge investment such as research and development (R&D) expenditures and the bulk of innovations are generated by a handful of industrialized countries. In 2010, almost 70% of worldwide patents have been applied for by industrialized countries (World Development Indicators). Accordingly, economic growth and development in countries and regions of the world, which are less knowledge intensive, are highly dependent on the international transfer, spillover and dissemination of knowledge across borders (Singh 2007). In this context, trade and licensing have been identified as crucial channels to transfer knowledge across spatial distances (Coe and Helpman 1995, Coe et al. 1997). However, from the economic literature on the nature and benefits of knowledge it is known, that knowledge is often highly complex, which hampers its transfer over spatial distances (Gertler 2003). Tacit knowledge, for example, is often sticky and bound to a particular person or organization and is therefore difficult to shift across borders (Polanyi 1967). Such forms of knowledge are among the reasons why knowledge transfer and diffusion are often limited geographically (Audretsch and Feldman 1996, Branstetter 2001, Jaffe et al. 1993, Keller 2002, Maurseth and Verspagen 2002). The geographical limitation of knowledge diffusion gave rise to the emergence of industry clusters, centers of excellence and business agglomerations with a high density of research institutes and knowledge intensive firms (Glaeser et al. 1992).

Given their ability to transfer knowledge across borders, in particular tacit knowledge and strategic assets, academic research has in large numbers highlighted the role of the Multinational Corporation (MNC) as a channel for the international diffusion of knowledge (Bresman et al. 1999, Findlay 1978, Fosfuri et al. 2001, Glass and Saggi 2002, Markusen and Venables 1999, van Pottelsberghe de la Potterie and Lichtenberg 2001). One of the central research questions with regards to MNCs has been their motivation to internationalize and to engage in outward foreign direct investment (FDI) activity (Dunning 1977, Dunning and Lundan 2008, Hymer 1976, Narula and Dunning 2000,

Markusen 1995).[1] Pioneering works explain the motivation of firms to engage in FDI based on their firm-specific ownership advantages and the chance to exploit them abroad (e.g. managerial and technological know-how) (Dunning 1977, 1981, Hymer 1976, Markusen 1995). It is assumed that, by investing abroad, MNCs transfer their strategic assets and knowledge capital across international borders, thereby helping to overcome the geographic limitation of knowledge diffusion and contributing to the knowledge accumulation of their host economies (Hymer 1976). As a result, a very large empirical literature has emerged, which examines the spillover effects and the general impact of inward FDI on the host economy, in particular with regards to productivity and economic growth (Berthélemy and Démurger 2000, Borensztein et al. 1998).[2]

Newer research has shifted the focus and has considered MNCs and their FDI not just as a means to "exploit" home country knowledge, but has increasingly focused on outward FDI as an instrument to "explore" and to tap into foreign sources of knowledge (Fosfuri and Motta 1999, Moon and Roehl 2001 among others). In this context, it is assumed that outward FDI may give access to modern technological products and processes as well as organizational, managerial and marketing skills of host country firms and other knowledge sources. Outward FDI may be of particular importance if localized, tacit knowledge as addressed above is involved. Based on these expectations, an emerging strand of international management literature has started to analyze how host country knowledge is absorbed and may be reversely transferred within the MNC organization (Ambos et al. 2006, Frost and Zhou 2005, Rabbiosi and Santangelo 2013, Yamin 1999).

There is good reason to belief that such a "reverse knowledge transfer" following outward FDI may also generate spillovers and benefits to other parts (firms, research institutes etc.) of the investing MNC's home economy.[3] An eligible question is therefore how outward FDI fosters knowledge accumulation and economic growth in the MNC's home economy. However, the theoretical understanding and the empirical evidence on how MNCs and outward FDI contribute to home economy development are still poor and few in numbers (Criscuolo 2009, Globerman et al. 2010). The lack of research can on the one hand be attributed to the fact that, in the past, academic research has been tied up in attempting to

[1] The terms „MNC" and "(outward) FDI" will be used fairly interchangeably in the following.

[2] Empirical evidence on how and to which extent MNCs contribute to host country knowledge accumulation and economic growth is still very inconclusive (see Görg and Greenaway 2004 for a review of empirical studies).

[3] In the following it is assumed that the home country of a MNC is the country in which it is headquartered.

address the massive public concerns with regards to outward FDI (Kokko 2006). Over the years, the increase in outward FDI has been accompanied by fears of hollowing out home country employment, investment and competitiveness and losing valuable knowledge to host economies (Blomström and Kokko 1998, Lipsey 2004). Thus, whereas research has analyzed in depth the partial effects of outward FDI, for example on the labor market or domestic investment, it failed to provide a comprehensive picture and sound theoretical footing of the overall home country effects of outward FDI, in particular with regards to outward FDI-driven reverse knowledge transfer. On the other hand, the lack of research can be explained by the predominance of analyses on inward FDI. While the global FDI landscape was in early phases mainly coined by FDI flows between developed countries, the inward FDI literature emerged with the increase of investments from developed to developing countries to examine how these investments would go along with knowledge transfer to the developing host countries. The academic literature has therefore primarily focused on the role of inward FDI in international knowledge diffusion and has accordingly disproportionately concentrated on the effects of inward FDI in the host economies as opposed to the effects of outward FDI in the home economy. So, while the economic impact of inward FDI has been widely discussed and acknowledged (Borensztein et al. 1998, Berthélemy and Démurger 2000, Görg and Greenaway 2004), the economic impact of outward FDI is still poorly understood. Yet, it may be assumed that domestic MNCs and their outward FDI activity may generate an even higher potential for knowledge spillovers for the home economy than investments by incoming foreign MNCs. One reason might be that domestic MNCs are more embedded and have more linkages to other actors in their home economies (suppliers, universities etc.) than incoming foreign MNCs and may therefore generate greater knowledge spillover opportunities (Castellani and Zanfei 2006). Local embeddedness may lead for example to increased labor mobility between MNCs and domestic firms and higher subcontracting of domestic suppliers. Another reason could be that domestic MNCs may have a greater interest to share their knowledge and help to upgrade the domestic industries to secure and strengthen for example the competencies of the domestic supplier base. Incoming MNCs more often have established suppliers in their home economies and may be less willing to diffuse their knowledge advantages to domestic actors (Lichtenberg and van Pottelsberghe de la Potterie 2001).

The analysis of the home country effects of outward FDI may be of particular interest for emerging countries (Kokko 2006). Their key to economic growth and access to advanced

knowledge has for a long time been thought to be embedded in inward FDI and the presence of foreign MNCs. Several emerging countries, such as China, have for more than two decades actively fostered international knowledge transfer through inward FDI and the attraction of foreign MNCs, for example via the establishment of free trade areas and special economic zones or joint ventures with large MNCs. Some of these economies now have taken the next step to tap into foreign pools of knowledge by starting to implement an outward oriented FDI strategy (Buckley et al. 2008). According to the Investment Development Path (IDP) concept, the increase of outward FDI activity is closely related to the level of economic development of countries (Dunning 1981, 1986, Dunning and Narula 1996). It is assumed that countries follow five stages regarding their FDI position: from net recipients to net sources of FDI and finally to a balanced FDI position. Thus, in the early stages of economic development outward FDI flows should be rather moderate given that the majority of domestic firms do not possess sufficient ownership advantages to overcome initial hurdles of investing abroad (Dunning 1986). With increasing levels of development and the maturity of firm-specific assets emerging economies are about to take on a more proactive role in FDI activity not only to exploit their assets, but also to tap actively into the growing stock of worldwide knowledge (Kokko 2006, UNCTAD 2006). These developments can currently be observed in several emerging countries. Rather than to solely depend on knowledge transfers from inward FDI or exports, laggard firms start to actively seek and access advanced knowledge through strategic acquisitions of knowledge intensive firms or the establishment of subsidiaries closer to advanced firms or industry clusters abroad. Some scholars assume that they might do so even without possessing firm-specific advantages (Fosfuri and Motta 1999, Moon and Roehl 2001). Given the potential knowledge transfer and developmental function of outward FDI, its home country effects could therefore not only be of interest for managers at the firm level, but also for policymakers at the macro level.

In light of these assumptions, the theoretical and empirical literature seems to lag behind the relevance of the topic. In fact, academic studies have come up with a fairly limited understanding of the overall patterns of the home economy effects of outward FDI, in particular with regards to reverse knowledge transfer processes and its effect on home country economic growth (Criscuolo 2009, Globerman et al. 2010). The International Business Literature provides a large amount of studies which, however, mainly focus on the firm-level effects of internationalization as well as on single case and country analyses. These studies provide valuable but rather fractional insights into the topic. Narula (2011)

even speaks of a “quilt” of different concepts and principles. So far, these concepts barely provide a framework to analyze of what to expect from outward FDI from an aggregate home country perspective. Furthermore, the scarce empirical analyses on aggregate home country effects yet do not yield a clear picture of whether and how economic activity at home is influenced by outward FDI (Herzer 2008, 2010). The few empirical analyses in the field have so far mainly focused on the firm and industry effects of outward FDI of developed country MNCs (see e.g. Castellani 2002). In this context, findings are still inconclusive how internationalization and outward FDI feeds back to different aspects and parts of the home country such as employment, exports and domestic investment. By contrast, several studies support the assumption that MNCs generate knowledge spillovers to other home country firms, thereby influencing their knowledge base and productivity. What has scarcely been addressed by theoretical and empirical academic research is the net impact of all these partial effects. That is, how they affect development and economic growth of the MNCs’ home countries. Furthermore, there is a scattered understanding of the capabilities and benefits of the home economy that is needed to access, reversely transfer and make use of the knowledge of their domestic MNCs. What is still missing are a sound theoretical framework and an empirical assessment that takes into account reverse knowledge transfer processes to get a better understanding of the home country effects of outward FDI. The thesis sets out to fill these research gaps.

1.2. Research Questions

The aim of this thesis is to advance the understanding of the home country effects of outward FDI, particularly with regards to reverse knowledge transfer. In consideration of the research gaps identified in the last section, the main research questions which shall be addressed are as follows:

(1) What are the channels of reverse knowledge transfer from the host economy to the home economy of a MNC?

(2) Under which conditions does outward FDI help to transfer foreign knowledge back to the home economy?

(3) To what extent does the home economy benefit from domestic MNCs and their outward FDI activity? How does outward FDI impact home country economic growth?

(4) How does the host country pool of knowledge influence the home country effects of outward FDI?

(5) What are the benefits and limitations of using outward FDI as a development strategy in different development contexts? What are the policy implications?

We will attempt to address these questions, both from a theoretical and empirical point of view. By doing so, the analysis will mainly focus on developed and newly industrializing economies (NICs)[4] which according to the IDP concept addressed above are supposed to have an already higher level of outward FDI activity than countries at rather early stages of their development.

1.3. Theoretical Footing and Contribution of the Thesis

To answer the research questions introduced above, an inter-disciplinary approach is used in so far as it is attempted to receive as much insights as possible from a broad range of branches of research covering the process of knowledge-sourcing FDI, reverse knowledge transfer within and outside the MNC organization and growth effects on the home economy. In order to establish hypotheses for both the theoretical model and the empirical assessment, the analysis draws from the various concepts and ideas of the International Business Literature and research on the internationalization of production and FDI (Castellani and Zanfei 2006, Dunning 1977, 1981, Dunning and Lundan 2008, Fosfuri and Motta 1999, Hymer 1976, Markusen 1995, Moon and Roehl 2001), reverse knowledge transfer (Ambos et al. 2006, Frost and Zhou 2005, Rabbiosi and Santangelo 2013, Yamin 1999) as well as from the growing literature on R&D internationalization (Coe and Helpman 1995, Lichtenberg and van Pottelsberghe de la Potterie 1998, 2001) and economic geography and spatial limitation of knowledge generation and diffusion (Audretsch and Feldman 1996, Branstetter 2001, Jaffe et al. 1993, Keller 2002, Krugman 1991, Maurseth and Verspagen 2002). The theoretical model, that will be set up to describe the linkage between outward FDI and home country economic growth, is based upon the

[4] The term “newly industrializing country” originally emerged with the rise of the four Asian Tigers (South Korea, Taiwan, Singapore and Hong Kong), which became known for their high growth rates and rapid industrialization starting in the 1960s and nowadays belong to the group of high income countries. Up to today, there is no universal definition of what characterizes NICs. Yet, a common feature is that they have outpaced their developing country counterparts in terms of economic growth and industrialization. In the following, the terms newly industrializing countries and emerging economies/countries/markets are used synonymously. When using the term “developing countries” the thesis refers to the broader definition of the World Bank which denotes all low- and middle-income countries (measured by gross national income per capita) as developing countries.

work on endogenous growth of Berthélemy and Démurger (2000). Herzer (2010) and Lichtenberg and van Pottelsberghe de la Potterie (1998, 2001) are the starting points for the empirical contributions of this thesis.

The findings of the thesis fit broadly into the stream of economic growth and R&D internationalization literature. The linkage between outward FDI and economic growth is a rather new research field. So far, the FDI and growth literature have been theoretically only linked with regards to inward FDI (Borensztein et al. 1998, Berthélemy and Démurger 2000). Although at least the empirical literature has recently started to examine the relationship between outward FDI and economic development, research is still very sparse (Herzer 2010). It has so far not taken into account knowledge-sourcing FDI and reverse knowledge transfer.

The thesis therefore contributes to this emerging field of research in various ways. First, to the knowledge of the author, the thesis presents the first approach to formalize the linkage between outward FDI and home country economic growth and describe how advanced foreign knowledge acquired by domestic MNCs may spill over to other home country firms. Second, it adds to the discussion by giving a comprehensive overview of the potential reverse knowledge transfer channels and its determinants. A third novelty of the thesis is the data and method used in analyzing the effects of outward FDI on the home economy. It is among the first empirical analyses to include outward FDI stock data in a cross-country analysis. Moreover, it is the first empirical approach which takes into account reverse knowledge transfer and the host country knowledge pool when analyzing the economic growth effects of outward FDI in the home economy.

1.4. Outline of Thesis

The remainder of the thesis is divided into six chapters. The contents and findings of each chapter are briefly described in the following sections.

Chapter 2 provides a comprehensive literature survey on the linkage between knowledge, innovation and economic development and gives initial insights into the role of outward FDI in linking them internationally. Descriptive statistics of the international distribution of innovative activities show, that new knowledge generation is highly concentrated geographically. While developing countries have increased their innovative capacities in recent decades, the bulk of new knowledge is still generated in more developed countries. The literature review points to the growing importance of MNCs and knowledge-sourcing

outward FDI to overcome the existing knowledge gaps and to tap foreign knowledge sources. In this context, it is shown that two developments have given impetus to the topic of knowledge-sourcing FDI; that is the increase of the internationalization of R&D and the growing importance of MNCs from the NICs.

To capture the overall effects of outward FDI on the home economy, it is in first place crucial to understand how and to which extent the investing MNCs are profiting themselves from their outward investment. **Chapter** 3 therefore conducts an intensive literature summary of the main theoretical and empirical findings which shed light on the firm effects of outward FDI as well as on reverse knowledge transfer channels and determinants. The review shows that there exist several important channels for reverse knowledge transfer from the host country to the investing MNC and within the MNC organization back to its (headquarter) units in the home economy, that is, demonstration effects, labor mobility and vertical and external network linkages. The overall findings of the summary provide considerable support to the hypothesis that outward FDI has a positive impact on the knowledge base and productivity path of the outward investing firm. The potential for reverse knowledge spillovers, however, seem to strongly depend on various factors such as the absorptive capacities of MNCs, their host country embeddedness or the technological advancement of host economies.

In **Chapter** 4, the scope of the analysis is expanded to the home country of the MNCs. It will be analyzed through which channels the domestic economy is impacted by outward FDI and which conditions might influence the knowledge spillover potential. The literature summary shows that outward FDI may generate various effects for the home economy. Despite concerns of employment losses and hollowing out of domestic production and investment, outward FDI can lead to an upgrading of jobs and increase of productivity. Several studies have shown that domestic MNCs may bring in new knowledge and technology, from which other home country firms may profit through similar channels as the ones identified in Chapter 3. Likewise, the potential for reverse knowledge transfer and spillovers are shown to be subject to several conditions such as the ability of the home economy to make use of the MNC knowledge or the home country embeddedness of MNCs. The literature review discloses that the aggregate effects of outward FDI and reverse knowledge transfer on the home economy have barely been addressed in the theoretical and empirical literature. Chapter 5 and 6 address this shortcoming.

In **Chapter** 5, the findings of the literature reviews and discussions of Chapter 2, 3 and 4 coalesce in the set-up of an endogenous growth model which formalizes the relationship between outward FDI and home country economic growth. The model is based on the framework provided by Berthélemy and Démurger (2000). The main novelty of the model is the introduction of the differentiation of non-multinational (low-tech) and internationally operating (high-tech) firms (MNCs). This special feature allows for the analysis of the impact of internationally operating firms on the home country's rate of long-term economic growth. The findings highlight outward FDI as an instrument for the transfer of foreign technology and accelerator of technology diffusion and economic growth in the home economy. Moreover, the results indicate that the developmental role of outward FDI is subject to the ability of the home economy to absorb and make use of the advanced knowledge that the MNCs reversely transfer back to their home economies as well as to the technological gap between MNCs and home country firms.

Chapter 6 confronts the theoretical predications developed in Chapter 5 with empirical evidence. Based on the findings, a set of hypotheses are developed which are tested subsequently in three distinct empirical models. The results show that across all model specifications, outward FDI has a significantly positive and robust impact on economic growth per capita. Several checks support the robustness of the findings. Furthermore, it is shown that countries in the sample whose outward FDI is directed towards countries with a larger knowledge pool in turn profit from higher rates of economic growth compared to countries that invest in less knowledge intensive economies. Accordingly, countries in the sample seem to reap more foreign knowledge spillovers and thus will experience higher growth rates if they invest more in countries with a relatively high domestic knowledge stock. In addition, the results indicate that higher growth rates are more likely for less developed countries with a lower level of initial GDP (this finding is irrespective of a country's outward FDI activity). Finally, the decisive role of absorptive capacity can also partly be supported.

Based on the theoretical and empirical findings, Chapter **7** draws the main conclusions of the thesis. While the discussion approves the potential growth effects of outward FDI, it highlights the necessity of sound home country conditions and a growth friendly environment for MNCs to develop in first place. It also discusses the role of a gradual investment path that corresponds to the home country capabilities and accounts for the knowledge gap between host and home economies and between MNCs and other home

country firms, respectively. The chapter closes with some thoughts on the role of government policy with regards to outward FDI.

2. KNOWLEDGE, INNOVATION AND THE ROLE OF OUTWARD FDI

Knowledge and innovation have long been recognized as important sources of economic prosperity and development (Stiglitz 1999).[5] In economic history, major knowledge leaps and innovations, such as the invention of steam engines, have frequently been followed by prolonged periods of economic growth. Not only has the generation of new knowledge accelerated in recent decades, also the accessibility to knowledge in general has improved significantly, especially due to the spread of information and communication technologies. Knowledge seems to be widely accessible now, sometimes even in the most remote areas of the world. Still, as the following sections will show, knowledge and in particular new knowledge generation are highly localized and distributed quite unevenly across countries and regions. Inward FDI and trade have been extensively discusses as channels to transfer knowledge across these spatial distances (Alfaro et al. 2004, Berthélemy and Démurger 2000, Blomström and Kokko 1998, Blomström et al. 1999, Borensztein et al. 1998, Görg and Greenaway 2004, Helpman 2006, de Mello 1997). A relatively new approach to study international knowledge transfer is the channel of (knowledge-sourcing) outward FDI. It is based on the notion that FDI not only – as discussed in the inward FDI literature[6] – transfers knowledge to the host economies, but may also enable countries to tap into the host countries' pools of knowledge. The "acquired" knowledge may then be reversely transferred back to the home economy ("reverse knowledge transfer").[7] Outward FDI-based reverse knowledge transfer has barely been examined in the academic literature (among the few studies are Ambos et al. 2006, Blomström and Kokko 1998, Criscuolo 2009, Frost and Zhou 2005, Rabbiosi and Santangelo 2013). The following chapters will provide a comprehensive literature review of the main concepts of knowledge and innovation and will discuss the role of outward FDI in reversely transferring knowledge back to the FDI source country.

[5] In 1998, the World Bank devoted an entire issue of the World Development Report to the topic and highlighted the importance of knowledge for development and sustained economic growth. More recently, the World Bank has given great attention to the concept of the "knowledge economy", a term which originated in the 1960s and describes an economy, in which know-how and expertise are as decisive for economic success as other resources such as capital.

[6] In the following, "inward FDI literature" refers to the theoretical and empirical studies which have been conducted to analyze knowledge transfer from MNCs to the host economy.

[7] In the following, the terms FDI "home country/economy" and "source country/economy" are used synonymously.

2.1. Key Concepts of Knowledge, Innovation and Economic Development

The following sections give a short introduction to the main concepts and key definitions of knowledge and innovation, followed by a discussion of the role of knowledge and innovation in international economic theory. The final section sheds light on empirical findings on the current geographical distribution of knowledge.

2.1.1. Economic Nature of Knowledge and Innovation

The core questions which arise when considering economic concepts of knowledge are: Who or what holds the knowledge and to whom else is it available? And how can it be documented or transferred across spatial distances? Various academic disciplines in humanities and social sciences have come up with different approaches to answer these questions and to characterize knowledge (among others Kogut and Zander 1992, Polanyi 1958, Romer 1986, Romer 1990, Stiglitz 1999). The vast amount of concepts in economic literature itself gives an indication of the manifold nature of knowledge. Given the scope of the thesis, the following discussion is confined to the economic perspective on knowledge.

In economic literature, the term "knowledge" typically comprises knowledge on technologies, processes and skills such as management techniques or organizational know-how. Knowledge is often categorized by its *origin* and by its *form* (Braunerhjelm 2008, Gertler 2003). With regards to the *knowledge origin*, a clear-cut distinction can be made between scientific, technological and entrepreneurial knowledge (Braunerhjelm 2008). Distinguishing knowledge according to its *form* is decisive to understand the transferability and spillover potential of knowledge, both features which are important to explain the existence of international knowledge diffusion. The following classifications of different forms of knowledge can be found in the economic literature.

(1) *Codified vs. tacit knowledge*

Within the framework of knowledge forms, the distinction between codified and tacit knowledge is the most frequently discussed.[8] Codified knowledge (also known as explicit knowledge) can easily be articulated, written down and stored, for example in rules, formulas, statements or patents. In contrast, tacit knowledge is so complex and interdependent that it is hard to be documented or described comprehensively, sometimes

[8] The concept of tacit knowledge roots back to the works of Polanyi (1958, 1967).

not even by the knowledge holder himself. According to Gertler (2003), knowledge is tacit either because the knowledge holder is not aware of the knowledge he holds or he is not able to communicate, explain or express it. For example, a formula may provide a solution to a specific problem, but does not capture the whole intellectual process, e.g. the studying or learning procedure, that lead to the solution (Kogut and Zander 1992). Tacit knowledge is usually the product of learning-by-doing, routines or interactions and resides with individuals as a skill or experience. In an organizational setting, tacit knowledge is often part of a firm's intangible assets and firm-specific advantages, like entrepreneurial, organizational or managerial skills. Such knowledge or intellectual assets provide decisive competitive advantages and are the main basis of competitive differentiation between firms, particularly in developed countries (Teece 1998).

Tacit and codified knowledge differ significantly with regard to their **transferability**. Empirical evidence shows, that the higher the degree to which knowledge is codifiable and teachable[9], the easier it may be transferred within or outside a firm (Zander and Kogut 1995).[10] Such explicit knowledge is also transferable by impersonal means and readily available channels such as data networks or e-mail and thus does usually not require local proximity to the knowledge source (Teece 1998). By contrast, the transfer of tacit knowledge usually necessitates face-to-face contact and frequent interaction between knowledge source and recipient. The difficulty to **exchange** tacit knowledge over long distances is a reason why firms which want to tap new forms of products or processes locate nearby firms or institutions holding tacit knowledge. Accordingly, tacit knowledge is acknowledged as a major determinant of the localization of knowledge creating and innovative activities. According to Malmberg and Maskell (2006, p.4),

> "(T)*he more tacit the knowledge involved, the greater the dependence of spatial proximity between those taking part in its creation or exchange; the more codified the knowledge, the easier to communicate across spatial distance."*

[9] According to Zander and Kogut (1995), teachability describes "the extent to which workers can be trained in schools or on the job" (Zander and Kogut 1995, p.79).

[10] In this context, Zander and Kogut (1995) address the dilemma for the knowledge holding firm: The more codifiable and thus transferable knowledge is within the firm, the more likely it is also to be copied, imitated and adopted from outsiders and competitors.

(2) *Embodied vs. disembodied knowledge*

A second, closely linked typology concerns the embodiment of knowledge (Romer 1986). Knowledge can either be independent (disembodied knowledge) or tied to an object, organizational structures or person (embodied knowledge). As tacit knowledge is often generated by a learning-by-doing process, or based on personal experiences, its use is linked to specific persons or organizations and thus embodied (Gertler 2003). By contrast, explicit knowledge is usually disembodied as it is not necessarily bound to one person or organization.

(3) *Public vs. private; excludable vs. non-excludable; rival vs. non-rival knowledge*

Finally, knowledge can be distinguished according to its public or private nature and closely linked to that also according to its excludability and rivalry (Romer 1986, Stiglitz 1999). Knowledge is private, if it is rival in consumption[11] and excludable from the use of others[12]. Due to their rival and excludable nature products can be "privately provided and traded in competitive markets" (Romer 1990, p.74). By contrast, public goods such as basic scientific research are often non-rival and non-excludable and access to new knowledge is likelier to be freely available. Given that most rival goods are also excludable, the concepts of rivalry and excludability are closely related (Romer 1990). Figure 1 exemplarily groups different types of goods according to their degree of rivalry and according to the degree to which these goods can be excluded from the use of others.

However, the knowledge features of goods and services are not static. Knowledge which is non-rival in nature such as design, which could be easily copied by others as soon as it is generated, can be turned into a private, (partially) excludable good by legal means and therewith be excluded from the use of others.[13] Excludability gives inventors the possibility to appropriate the return of the invention they invested in. Such non-rival, yet

[11] According to Romer (1990), purely rival goods can only be used by one firm or person at a time, e.g. the use of a special machine by one firm precludes other firms to use it. By contrast, non-rival goods can be used by two or more economic agents (persons or firms) simultaneously and in different places.

[12] According to Romer (1990, p.74) a "good is excludable if the owner can prevent others from using it". Excludability can derive from technological as well as legal attributes. If a good is non-excludable, it is not possible to legally or technically prevent others from using it.

[13] A blueprint or new design, for example, can be turned into excludable knowledge by legal means such as intellectual property rights which allow the inventor to patent his ideas and prohibit copying. Or, an employee with a special skill may become excludable if he is obligated to only work for one company. Similarly, a new idea can be turned into excludable knowledge by using technical means such as encrypting a code.

excludable goods are the main feature of Romer's endogenous growth model, which will be discussed in detail in Chapter 5.

Figure 1: Rivalry and excludability

High ⇧ Degree of excludability ⇩ Low	Rival Goods	Non-rival Goods
	e.g. trained work force	e.g. firm-specific research, patents
	e.g. natural resources, public infrastructure	e.g. national defense, basic research

Remark: Based on Romer (1993, p.72).

Incomplete excludability and appropriability of knowledge form the basis for **knowledge spillovers**. Branstetter (2006, p.328) defines knowledge spillovers as a "process by which one inventor learns from the research outcomes of others' research projects and is able to enhance her own research productivity with this knowledge without compensating the other inventors". In a more detailed distinction, the seminal work of Griliches (1979) distinguishes between two types of knowledge spillovers: "rent spillovers" and "true knowledge spillovers". Rent spillovers refer to the situation in which knowledge is tradable, but knowledge acquiring firms pay less for knowledge (in traded goods) than its quality is worth because the seller cannot internalize the whole value of its invention because of imperfect price discrimination which may be due for example to information asymmetries. True spillovers occur if knowledge is transferred without compensation, e.g. due to the mobility of researchers working in R&D, reverse engineering or the exchange of knowledge at conferences.

Knowledge spillovers will be an important feature of the endogenous growth model presented in Chapter 5, as will be **innovations**. Innovation and knowledge are closely related given that innovative outputs build on existent knowledge and are the result of a (intentional or unintentional) knowledge creation process (Arrow 1962a).[14] A certain level of individual, firm or country knowledge is an important precondition for the ability to engage in innovative activities or to adopt new knowledge developed elsewhere. OECD (2010) provides a helpful definition of the forms of innovation by distinguishing

[14] Another relation concerns knowledge and information. The terms are not synonymous, but are closely intermeshed: The ability to generate new knowledge depends on the accumulation and interpretation of information and thus from an economic perspective knowledge may be considered as the productive use of information. In turn, a certain level of knowledge is needed to collect, to apply and to make use of relevant information.

innovation according to (1) its type: technological (product[15] or process[16]) or non-technological (organization[17] and marketing[18]); (2) the mode of innovation: novel innovator (strategic and intermittent), technology modifier, or technology adopters[19]; and (3) its socioeconomic impact: incremental, disruptive or radical. Closely linked to the last distinction on the socioeconomic impact of innovation, the thesis takes a rather broad view by considering innovations not merely as something that is globally unprecedented (new to the world market). Following the standard innovation literature (Marin and Bell 2010, Lundvall 2011), the term innovation will in the following also encompass incremental, disruptive or radical changes that are new to the local context, e.g. new to the firm, new to the local industry or new to the region or country. Hence, in a local context, innovation can also be an adoption and modification of knowledge to the local conditions, which has already been implemented somewhere else in the world. This perspective makes it easier to discuss innovations in a developing country context, where innovations are very often adoptions or improvements of knowledge developed in industrialized countries (Fagerberg et al. 2010).[20]

From a macro perspective, economic theory shows that a country's ability to innovate is considerably influenced by its **national innovation systems (NIS)**.[21] The national innovation system includes national innovation nodes such as universities and other research institutions, which conduct basic research and train scientists and engineers; domestic firms, which invest in R&D and commercialize innovations; any public programs to foster technology adoption, and finally, the national set of laws and regulations that

[15] Product innovation refers to "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended us" (OECD 2010, p.20). Such improvements can also be rather minor, such as a refinement in the functionality and user friendliness of a product.

[16] Process innovation refers to "the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software" (OECD 2010, p.20).

[17] Organizational innovation refers to "the implementation of a new organizational method in the firm's business practices, workplace organization or external relations" (OECD 2010, p.20).

[18] Marketing innovation refers to "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing" (OECD 2010, p.20).

[19] More recently, economic literature has come up with several concepts to define innovation according to specific drivers (cost-driven, demand-driven, and employee-driven) (Lundvall 2011).

[20] It has to be noted, that, in recent years, developing countries have developed major innovations themselves (also called frugal innovations), such as the mobile payment system M-Pesa in Kenya (Denzer 2013).

[21] Early ideas of a national system of innovation can be rooted back to the works of Friedrich List (1841) and the national system of political economy. The concept of national innovation system (NIS) has its origin in the works of Freeman (1987) and has since then been significantly advanced by Lundvall (1992) and Nelson (1993). See OECD (1997) for an extensive survey on the topic.

guarantee intellectual property rights and affect the innovative behavior of the agents (Mowery and Oxley 1995). Networks of public and private institutions may help to initiate, import, modify and diffuse innovations and technological advances (Freeman 1987). Furthermore, both the quality of the education system that lays the ground for innovative people as well as a functioning financial system that funds innovative activities are important aspects of the national innovation system (UNCTAD 2005).[22] The potential and capacities of national innovation systems vary with the level of general economic development. In a more developed country context, innovation systems are more likely to determine a countries' ability to push back the technological frontier and become technical leader in certain fields. Given that newly industrializing economies usually import and adopt already existing knowledge, it is more adequate to speak of a "national learning system" in an emerging economy context (Viotti 2002). As will be discussed in the next chapters, such learning systems determine the ability of national innovation nodes to absorb, diffuse, improve or adapt already existing knowledge, which is reversely transferred from abroad through home country MNCs. Accordingly, national innovation systems can be an important policy instrument to influence the returns from outward FDI.

2.1.2. Role of Knowledge and Innovation in International Economic Theory

One of the first economic concepts of knowledge and innovation is Schumpeter's well-known thought on "creative destruction" (Schumpeter 1911). In Schumpeter's view, innovation[23] is the main driver of economic change and economic development can be understood as an evolutionary process of continuous innovation and creative destruction. The majority of the economic models which have followed Schumpeter continue to consider innovation and knowledge as drivers of economic growth. However, their economic modeling of knowledge and innovation differs quite significantly. Early neoclassical growth models, like the Solow Growth Model, acknowledge that economic growth is influenced by technological process (as a result of knowledge accumulation) (Solow 1956, 1957). However, in the Solow Model, technological change is modeled as an unexplained residual which enters the production function exogenously. The "new" or endogenous growth theory, pioneered by Romer (1990), overcomes this shortcoming by specifically modeling knowledge accumulation and the innovation process. These are the results from the deliberate economic decisions of firms which (at least temporarily) gain

[22] An in-depth discussion of the role of human capital and economic development will be provided in Section 3.2.1.

[23] Schumpeter originally used the term "new combinations".

monopoly power, allowing them to recoup the costs which were incurred to innovate, for example F&E expenditures or R&D personnel (Romer 1990). The existence of the (temporary) innovation monopoly is in this context crucial since economic agents will only invest in innovation if they expect the related costs to be amortized and this may only happen if they at least may temporarily "protect" their new knowledge, for example through patents. The increase in the stock of knowledge and the translation into new goods are the basis of the endogenous growth theory. As will be discussed in Chapter 5, knowledge is commonly treated as an input into the production process next to other production factors such as physical capital or labor. However, knowledge seems to be inherently different from traditional factors of production such as capital or labor (Audretsch 1998). While physical factors are characterized by diminishing returns to scale, the process of knowledge accumulation does not suffer from diminishing returns – it does so at least in theory. It still remains to be seen whether this assumption sustains in practice in the future.

Knowledge production in the home economy does not only spur domestic economic growth but can – given its tradable character and spillover potential – have a significant influence on other economies as well. Thus, international economic theory has also given great attention to the topic of international knowledge transfer. Various theoretical and empirical models in international economics have tried to capture the impact of (international) knowledge transfer and spillovers on the economic development and catch-up processes of economies. First generation catch-up models, which root back to the works of Gerschenkron (1962) and Nelson and Phelps (1966), imply that adopting and imitating inventions made is generally cheaper for backward economies than innovating themselves.[24] Given the limited innovation capabilities and resources of developing countries, copying and adopting foreign, already existing knowledge to their environments may provide a better "catch-up" strategy than investing in own innovation.[25] The notion

[24] There are several important works on the lag in the transmission and diffusion of knowledge between countries. Posner (1961) introduced the technology gap theory which assumes that there is a delay in the transfer and dissemination of technology between countries as well as a lag in the demand adjustments of consumers. Based on the works of Posner, Vernon (1966, 1979) introduced the product cycle theory of trade and investment. It predicts that the location of production depends on the stage of the product cycle. At the early stages of market maturity, products are usually produced in the innovator's country of origin (mainly developed countries) and exported, while in the later stages of the cycle the innovator is imitated by other countries. Consequently, production moves to countries with the lowest costs of production (mainly developing countries) and are eventually imported by the innovating country.

[25] Given the scope of the thesis, the topic of intellectual property rights (IPR) cannot be addressed in more detail. However, as will be seen in the endogenous growth model in Chapter 5, the possibility to secure ideas and new knowledge is crucial for a functioning innovation system.

behind these catch-up models is that - due to its backwardness and catch-up potential – an economically less developed country initially grows faster than the leader, subsequently converging to the leader's income levels ("advantage of backwardness") (Solow 1956).[26] There exist several examples of remarkable economic catch-up processes in modern economic history. Japan, for example, managed to close the knowledge gap to industrialized countries by the 1980s. The so called "Asian Tigers" Hong Kong, Singapore, South Korea and Taiwan pursued an unprecedented catch-up strategy starting in the 1960s (Coe et al. 1997, Stiglitz 1999). These countries benefitted heavily from international knowledge diffusion through the transfer of foreign technologies based on exports as well as imitation and advancements of foreign knowledge (Pack and Saggi 1997).[27]

The topic of economic growth related to international knowledge transfer and knowledge spillovers gained further momentum with the endogenous growth theory (Romer 1990), which was already briefly touched upon above. What makes the endogenous growth models so interesting for the consideration of international knowledge transfer and spillovers is that they assume that firm R&D is based not only on private investment but also on the stock of general domestic and foreign "state-of-the-art" knowledge available which – in theory - can be accessed by all innovators worldwide, given that, as discussed above, new knowledge is often only partly excludable from the use of others. Thus, each innovation not only leads to a new product which may be turned into profits by the innovator, but also increases the stock of international knowledge. Those knowledge spillovers are drivers of endogenous growth, not only nationally but also internationally. Based on the findings of the endogenous growth literature, a new strand of research analyzing the impact of outward orientation and international R&D spillovers on economic development emerged in the mid-nineties (Coe and Helpman 1995, Coe et al. 1997). The international R&D spillover models of Coe and Helpman (1995) and Coe et al. (1997), for example, are based on the assumption that developing economies benefit in terms of higher productivity levels, if they are able to absorb foreign R&D spillovers from economically more advanced countries.[28] The basic properties of the endogenous growth models and the

[26] Empirically, this assumption could not be supported. See Section 5.1 for an in-depth discussion.

[27] It has to be noted, that there are also „losers" among the economies in this continuous competitive catch-up race. There are several examples of economies which have lost comparative advantages relative to other economies in recent decades and were overhauled by other economies. See Preuße (1991) on the Dynamic Continuum of Comparative Advantages.

[28] There exists a vast amount of literature concerning inter- and intra-industry spillovers providing empirical evidence that spillovers mainly occur between similar organizations or within the same industry (Glaeser et al. 1992, Lane and Lubatkin 1998).

international R&D spillover models will be applied both in the theoretical model in Chapter 5 and its empirical realization in Chapter 6 to account for the reverse transfer of host country knowledge to the home economy via outward FDI.

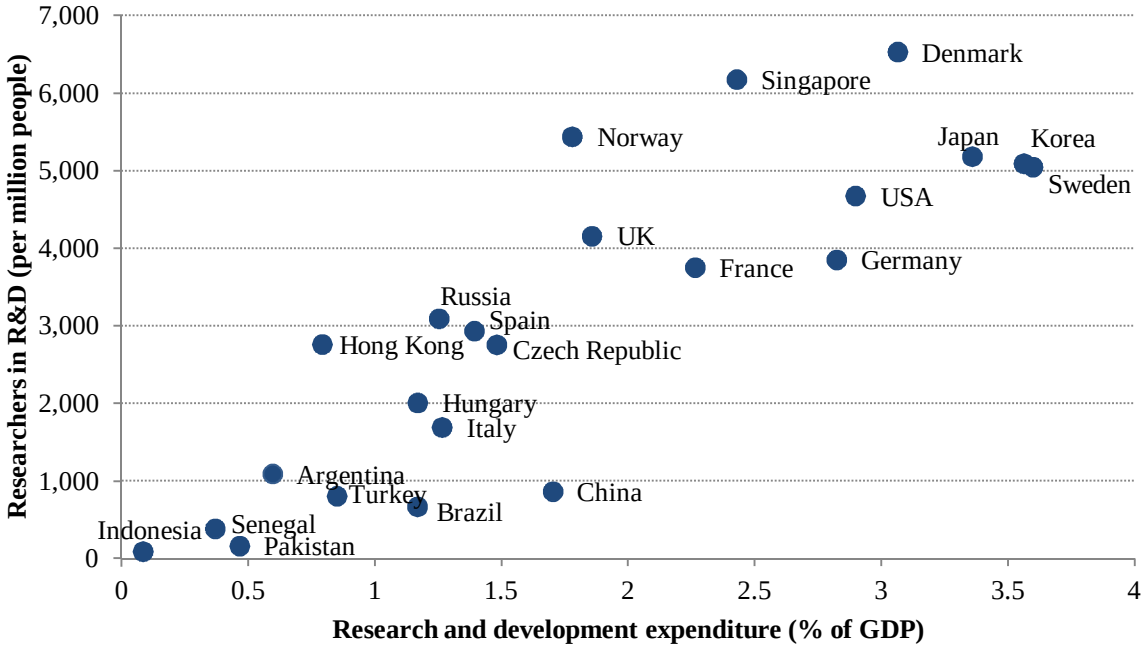
2.1.3. Geography of Knowledge Generation and Diffusion

In order to empirically assess the uneven spatial distribution of knowledge across countries, one should distinguish between different approaches to measure knowledge. National knowledge generation and innovative activities can be measured either by its "inputs" or by its "outputs". On the input side, R&D expenditure (usually measured as a percentage of GDP) is one of the most widely used indicator. Although it is only one component of knowledge generation, it is considered as a statistical indicator which is readily available for a wide cross-section of countries, thus facilitating the comparison of knowledge generation internationally (UNCTAD 2005).[29] Another prominent indicator of input-based assessment of global knowledge generation activities are the number of researchers in R&D. Based on these two input factors, Figure 2 provides a good indication of geographical distribution of new knowledge generation for a sample of randomly selected countries. Generally, there seems to be a positive linear trend between the number of people working in research and R&D expenditure. Moreover, both R&D expenditure and the number of researchers are highly geographically concentrated and vary substantially across countries. Interestingly, it seems that industrialized countries tend to invest more in R&D and have on average a higher number of people working in research. The distribution shows that, although R&D expenditure in developing countries is on the rise, in particular in emerging countries like China, new knowledge is to a large extent generated by a handful of developed economies.[30]

[29] R&D activities comprise basic and applied research as well as development. Whereas basic research aims to advance scientific knowledge without any concrete commercial and application purpose, applied research is directed towards meeting specific needs and commercial benefits. Development refers to the systematic use of knowledge gained from basic or applied research to produce materials or methods (e.g. design of prototypes) (UNCTAD 2005).

[30] According to Keller (2004), it is rather difficult to use R&D data to measure innovative activity in less developed countries as the standard OECD definition mainly captures resources spent in pure innovative activities and not imitation and technology adoption. As discussed above, imitation and adoption are, however, probably the most important components of innovative activity in developing countries. The data might therefore to some extent underestimate real innovative activity in developing countries.

Figure 2: Global investment in R&D for selected countries, 2009



Remarks: Own illustration based on World Development Indicators (World Bank).

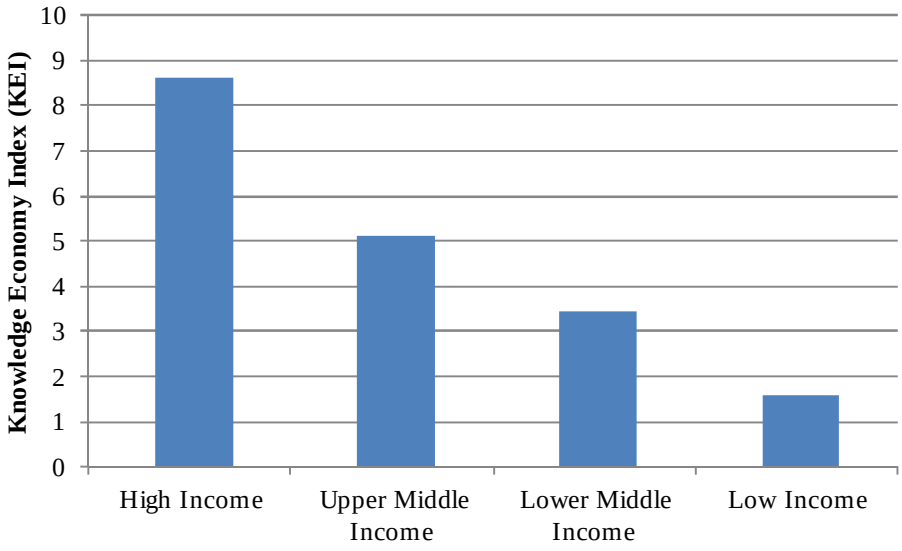
The unequal distribution of knowledge activity between developing and developed countries is also known as the **knowledge gap** (World Bank 1998). Furthermore, Figure 2 reveals a gap within the randomly selected group of developing economies itself. Asian economies (above all South Korea and Singapore) seem to be at the forefront of the spectrum, whereas Sub-Sahara African economies range far behind at the lower end. Despite their immense economic performance in the last decade, the BRIC economies (Brazil, Russia, India and China) still trail behind their more developed counterparts.

In contrast to the input-based measurement of knowledge generation, output-based approaches measure the products of knowledge generation, e.g. the number of patent applications. The output-based measurement of knowledge shows similar patterns with regards to the geography of knowledge generation. In 2010, high income countries accounted for more than 70% of global patent applications (World Bank, World Development Indicators). Nevertheless, patent activity in developing countries, especially in Asia has gained ground and has risen significantly in recent years. Whereas developing and middle income countries accounted for less than 5% of global patent applications in 1985, their share has reached close to 30% in 2010 (World Bank, World Development Indicators).

Not only the generation of knowledge, but also the ability to absorb and make use of knowledge varies extensively across countries. The World Bank's Knowledge Economy

Index (KEI) measures the degree of a country's ability to generate, adopt and diffuse knowledge. The index also takes into account whether the environment (economic incentives and institutional regime) is conducive for knowledge to be used effectively for economic development. Figure 3 gives further indication of the existing gap in knowledge generation and usage ability between high income and low income countries. High income countries score on average higher that less developed countries indicating that they have on average an enhanced capability to generate, adopt and diffuse knowledge compared to less developed countries.

Figure 3: Knowledge Economy Index, 2012



Remarks: Own illustration based on World Bank's Knowledge Economy Index. The KEI is calculated based on the average score of a country on four sub-indices, which are expected to represent the four pillars of the knowledge economy, that is the Economic Incentive and Institutional Regime (EIR), Education and Human Resources, Innovation System as well as Information and Communications Technologies (ICT) Infrastructure. The scoring ranges from 0 to 10: the higher the score, the better a country's ability to generate, adopt and diffuse knowledge.

In recent decades, globalization and technological progress which came along with the spread of new information and communication technologies (ICT) and reduced transport costs have facilitated the transfer of knowledge between spatial distances (Keller 2002). Nevertheless, as addressed above, knowledge spillovers are often local in nature and the transfer of knowledge often requires proximity to knowledge sources such as competitors, customers or suppliers which makes geography an important determinant of knowledge diffusion. As Glaeser et al. (1992, p.1127) pithily put it, "(A)fter all, intellectual breakthroughs must cross hallways and streets more easily than oceans and continents". A rich strand of economic literature has linked the extent of knowledge spillovers to the

geography of innovative activity, showing that knowledge diffusion is attenuated by geographical distance between knowledge source and recipient (Audretsch and Feldman 1996, Branstetter 2001, Jaffe et al. 1993, Maurseth and Verspagen 2002). Thus, although the spread of ICT and the reduction of information costs have facilitated the transfer of knowledge across distances, the geographical limitation of knowledge diffusion is seen as one of the main reasons for the localization of knowledge and the emergence of so called industry or business clusters, centers of excellence or agglomerations which often can be found in economically strong regions or cities (Glaeser et al. 1992).[31] Knowledge clusters often emerge because innovations depend on collective actions of economic agents and mutual synergies. The intensity of geographic clustering also differs across different industries. Audretsch and Feldman (1996) show, that innovative activity tends to concentrate geographically in industries, where important inputs for knowledge creation such as for instance skilled labor, industry or university R&D are essential and often scarce, for example in the high-tech industry. In addition, geographic clustering of innovative activity occurs mainly in sectors where tacit knowledge plays an important role (Audretsch 1998). Prominent examples for economic clusters and innovation hubs are the computer industry which is clustered geographically in Silicon Valley, USA or the IT industry in Bangalore, India.

Summing up this first section, it can be said that while knowledge is considered as one of the main drivers of economic development, the differences in creating and absorbing knowledge are still large across a broad spectrum of economies which are developed to different degrees. The question, which shall be addressed in the next section, is how outward FDI may act as a channel for reverse knowledge transfer between spatial distances to bridge these knowledge gaps.

2.2. Outward FDI as a Channel of Reverse Knowledge Transfer

With the growing evidence of the existence and relevance of international knowledge spillovers and diffusion, it has become increasingly important to understand the mechanisms and channels behind these processes. Naturally, the international spread of technology and knowledge must be transmitted through some kind of interaction between economic agents in the countries involved. The field of international economics stresses

[31] The "New Economic Geography Theory", coined by the work of Krugman (1991), gives reasoning for the geographic localization of production sites and asserts that due to economies of scale economic activities tend to concentrate in a few countries, regions or cities.

several channels of economic interaction for the international diffusion of knowledge and technology: international trade[32] (Coe and Helpman 1995, Coe et al. 1997 among others), international labor migration (Arrow 1962a, Fosfuri et al. 2001, Glass and Saggi 2002, Kaufmann 1997 among others), licensing (e.g. use of trademarks, copyrights, or patents) (Markusen 1995 among others), joint ventures or alliances between firms and the international movement of capital through FDI and the activities of MNCs (Findlay 1978, Fosfuri et al. 2001, van Pottelsberghe de la Potterie and Lichtenberg 2001 among others). The focus of the thesis is on the latter, in particular outward FDI.

FDI may transfer technology and enhances knowledge spillovers in two directions: first to the host economy via inward FDI and second to the home economy via outward FDI. The first direction is the spread of knowledge from inward FDI to the host country. According to the theoretical literature, inward FDI enables the host countries to access advanced technology and knowledge since investing foreign MNCs are considered as on average technologically more advanced than domestic firms, in some cases they are even market leaders in their field (Findlay 1978). Over the last decades, a large number of studies have analyzed different aspects of MNCs and their technology spillovers to the host country through the firm-specific knowledge that accompanies their investment (Berthélemy and Démurger 2000, Hymer 1976). Much empirical work has therefore been done to capture the effects of inward FDI on the host economy, for example with regards to host country productivity, wages levels and economic growth (see among others Borensztein et al. 1998, Berthélemy and Démurger 2000).[33] In contrast, less research has been done on the second direction, which is of main interest of this thesis: knowledge spillovers and technological diffusion via outward FDI. It is based on the assumption that a country's growth rate is not only dependent on the domestic stock of know-how, but also on the stock of knowledge it holds abroad, for example knowledge which is acquired via outward FDI. The idea has been nurtured by the phenomenon that MNCs increasingly invest in countries and sectors with a high density of firms operating at the technological front although they might not even possess firm-specific advantages (Fosfuri and Motta 1999, Moon and Roehl 2001). Given the importance of knowledge spillovers and their

[32] Imports are a channel of knowledge spillover when firms benefit from reversely engineering the technological innovations of imported goods. The literature also suggests that firms profit from foreign knowledge via "learning-by-exporting", e.g. when firms learn to improve the quality of their products through competition with more advanced foreign firms in global export markets or through the contact to foreign customers who demand higher quality and standards (Bernard and Jensen 1999).

[33] So far, the evidence whether inward FDI has a positive effect on the host economy is mixed (see Görg and Greenaway 2004 for an extensive discussion).

geographical limitation, technologically less advanced firms will have an incentive to seek spillovers by locating close to a particular knowledge source, e.g. the headquarters, production facilities or design facilities of their more advanced competitors in order to appropriate their technology and knowledge. The following sections will look at the role of MNCs and the different types of outward FDI in international knowledge diffusion.

2.2.1. Multinational Corporations and their FDI Motives

In the following, the terms FDI and MNC will be used in line with the definitions given in the IMF's Balance of Payments International Investment Position Manual (IMF 2008) and the OECD's Benchmark Definition of Foreign Direct Investment (OECD 2008). Both standards share the same conceptual framework and their operational guidelines set the world standards for direct investment statistics. They are the basis for FDI data collection in most economies. According to IMF and OECD definition, direct investment is the category of cross-border investment[34] made to acquire lasting interest in enterprises operating outside of the investor's country of origin and exercise control over it.[35] This also includes Greenfield FDI.[36] In doing so, the investor's purpose is to gain an effective voice in the management of the enterprise.[37] According to IMF and OECD, a minimum of 10% of equity ownership (ordinary shares or voting power) allows a shareholder to convey effective control over the acquired company's business operations.

Firm-specific ownership advantages (e.g. managerial and technological know-how) and the chance to exploit them abroad in countries providing location advantages have for a long time been considered as the main motivation of firms to engage in FDI (Dunning 1977, 1981, Hymer 1976, Markusen 1995).[38] Today, there is general acknowledgement among

[34] The forms of investment classified as FDI are equity capital, reinvested earnings and other capital associated with various inter-company debt transactions such as the provision of long-term and short-term inter-company loans (between parent and affiliate companies) (OECD 2008).

[35] What distinguishes FDI from portfolio investment is the motivation and risks underlying the transactions. While portfolio capital crosses international borders in search of high yield and thereby also bears higher risk, FDI is motivated by direct entrepreneurial activities and the acquisition of control.

[36] Greenfield FDI is a form of foreign investments where the parent company creates a new venture from scratch, for example a new physical facility or service company.

[37] The entity or group of associated entities that makes the investment is referred to as the direct investor. The enterprise, in which the direct investment is made – is termed a direct investment enterprise. Direct investment enterprises comprise those entities that are subsidiaries (a non-resident investors owns more than 50%), associates (an investor owns 50% or less) and branches (wholly or jointly owned unincorporated enterprises) either directly or indirectly owned by the investor.

[38] Dunning's well-known and widely used eclectic or OLI-paradigm is a framework that explains the existence of MNCs by providing three preconditions for a firm to engage in FDI: ownership (O), locational (L) and internalization (I) advantages (Dunning 1977, 1981). Vernon (1966, 1979) introduced the product cycle theory of trade and investment which predicts that the location of production depends on the stage of

academics that there exist four main FDI motives (Dunning and Lundan 2008). These motives are not mutually exclusive as MNCs may pursue multiple objectives.

(1) The aim of *resource-seeking FDI* is to acquire or to secure the access to and supply of particular resources (e.g. raw materials, skilled or unskilled labor) of higher quality or supply at lower real costs compared to the home economy.

(2) The incentive for *market-seeking FDI* is to exploit growing markets, access distribution networks, to facilitate exports from home economy, or to enhance exports from host country to other large and rapidly growing markets.

(3) The objective of *efficiency-seeking FDI* is to take advantage of different availability and relative costs of factor endowments in the host market compared to the home economy.

(4) Finally, the purpose of *strategic asset-seeking FDI* (also known as *knowledge-sourcing FDI*) is to sustain or advance global competitiveness by either acquiring strategic assets such as R&D capacity and output, design facilities and brand names or by locating in close proximity to particular knowledge sources in anticipation of knowledge spillovers.

The four motives may further be differentiated according to their asset-exploitation (home base-exploitation) and asset-augmenting (home base-augmenting) nature. In the FDI literature, motives (1) to (3) are often associated with *asset-exploitation* activities (Narula and Dunning 2000). Investing firms aim to generate economic profit by exploiting their existing ownership advantage and firm-specific assets (mostly capabilities developed in their home economy). To do so, assets are transferred from the parent company to foreign subsidiaries (and in some cases adapted to the local context). By contrast, knowledge-sourcing FDI (motive 4) is *asset-augmenting*, as the MNC seeks to add to its existing assets and augment its knowledge base by tapping into foreign knowledge resources and capturing the externalities created by the host country clusters.[39] This involves knowledge flows in the opposite direction, namely from the subsidiary to the home country.

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the product cycle. At the early stages, products are usually produced in the innovator's country of origin, while in the later stages production is shifted to countries with lower input costs, e.g. labor costs.

[39] Bjorvatn and Eckel (2006) find that the existence of such local spillovers may influence the FDI motives of firms in two ways depending on their technological level: Whereas laggard firms may undertake FDI to upgrade their technologies, advanced firms may strategically invest in the home markets of their followers to limit the extent of spillovers and prevent and forestall technology sourcing FDI by laggard firms in their own home market.

2.2.2. Rise of R&D Internationalization and Outward FDI from Emerging Countries

Two recent developments in outward FDI activities worldwide have triggered research interest in the topic of knowledge-sourcing FDI: A first impetus has been given by the pickup of the **internationalization of R&D** in recent decades. In early studies on the internationalization of firms, the firms' home market had been considered as the preferred location for R&D activities (Griliches 1979). With the integration of the world economy, however, firms have increasingly located their R&D activities abroad.[40] In an international survey conducted by UNCTAD, it is show that the average firm spent 28% of its R&D budget abroad (UNCTAD 2005).[41] Originally, the internationalization of R&D has been thought to be driven by pure asset-exploitation motives and the necessity to adapt assets developed at home to local conditions and demands in foreign host markets, especially in markets where MNCs already had established manufacturing sites and had sales activities (Belderbos et al. 2008b). In recent decades, however, the establishment of foreign R&D centers has also been increasingly motivated by asset-augmenting motives and the attempt to assess foreign knowledge sources and profit from knowledge spillovers which are generated by other firms and institutions located in that country (UNCTAD 2005). Belderbos et al. (2008a) show that the larger the knowledge pools of host countries (measured by patents applied for by residents) the likelier are both leader and laggard MNCs to locate R&D units in these countries. For a long time, MNCs from developed countries were the only players in the field of the internationalization of R&D. However, in recent years emerging economies like China or Brazil have not only become a popular host country for R&D investment, but also active source countries of foreign R&D investments. MNCs from mostly emerging countries have begun to set up R&D activities abroad – in both other developing and emerging countries and developed economies (UNCTAD 2005).

This evolution is closely linked to the second phenomenon which boosted the discussions on knowledge-sourcing FDI: the **increase of outward FDI from developing countries** and the rise of "Emerging Markets Multinationals" (Sauvant 2008).[42] Such "unconventional FDI" (Moon and Roehl 2001) is of course not solely driven by

[40] See Dunning and Lundan (2009) for an overview of the historical phases of R&D internationalization.

[41] Data on the internationalization of R&D is fragmented and rather difficult to gather due to the sensitive issue of data disclosure. For an extensive discussion on the available evidence see UNCTAD (2005).

[42] Although the majority of these MNCs originate from emerging economies, the terms "developing" and "emerging" market multinationals are typically used synonymously.

knowledge-seeking motives but can also be attributed to other determinants as listed above. According to UNCTAD (2005), the major motive of MNCs from developing countries is in fact market-seeking. South-South FDI for example is driven by firms which seek to access new but similar markets in neighboring or other developing countries. However, empirical evidence shows that an increasing share of outward FDI from developing countries is in fact knowledge-sourcing, especially when it is invested in more developed countries (Rasiah et al. 2010). Here, investments are often made in search for advanced foreign technologies, distribution channels and brands (see Buckley et al. 2008 for China).

There exists substantial empirical evidence which shows that technology-sourcing FDI, in particular of Asian MNCs, is not a totally new phenomenon. For instance, the surge of Japanese FDI in the United States after the Plaza Accords in 1985 triggered extensive empirical research on the topic which shows that Japanese FDI was to a large extent driven by asset-seeking motives (Blonigen 1997, Branstetter 2000, Kogut and Chang 1991). Sachwald (2001) comprises several studies which consider technology-sourcing FDI as the prime motive of Korean MNCs to invest in OECD countries. Similarly, Makino et al. (2002) stress the importance of strategic asset-seeking motivations by MNCs from Taiwan. Recent empirical analyses on Chinese outward FDI in Germany (Schüler-Zhou and Schüller 2013) and in the United Kingdom (Buckley et al. 2007) support the growing relevance of knowledge-seeking motivations of Chinese firms in Europe. Recent prominent examples are the acquisitions of Western firms by developing country MNCs such as the takeover of American IBM personal computer business by the Chinese technology company Lenovo in 2005 or the Indian automaker Tata’s acquisition of the British company Jaguar in 2008.

The extent of outward FDI from developing countries has challenged traditional FDI theories which used to link outward FDI to the level of economic development and the existence of firm-specific ownership advantages (Fosfuri and Motta 1999). The IDP concept, for example, suggests that a country’s international investment position is determined by its level of economic development (Dunning 1981, 1986, Dunning and Narula 1996). Along the IDP, economies go through five stages regarding its outward FDI position: from a net recipient to a net source of FDI and finally to a balanced FDI position. The higher a country’s economic development the higher its net outward FDI flows. It is assumed that firms only invest abroad if they possess the financial resources and have developed serious ownership advantages in certain fields which they could exploit abroad

and which are needed to overcome the liability of foreignness in host markets (costs related to unfamiliarity with the local environment or costs directly related to the spatial distance to the headquarters) (Markusen 1995). According to the predictions of the IDP, developing countries' outward FDI activity should therefore be relatively moderate given their rather low level of development and the lack of extensive ownership advantage. Scholars like Barnard (2010) argue that developing country MNCs may nevertheless possess certain firm-specific advantages to overcome their liabilities of foreignness. Such advantages become clearer in a less developed context. Emerging market MNCs are probably more likely to operate successfully in less developed environments where for example weak regulatory conditions prevail since they are more familiar with those circumstances (Buckley et al. 2008). Furthermore, knowledge-sourcing FDI may be in itself a mean to overcome the liability of foreignness. Firm-specific assets are created through the interactions and knowledge exposure in the host economy. This also led to the revision of the IDP (Dunning 1986).

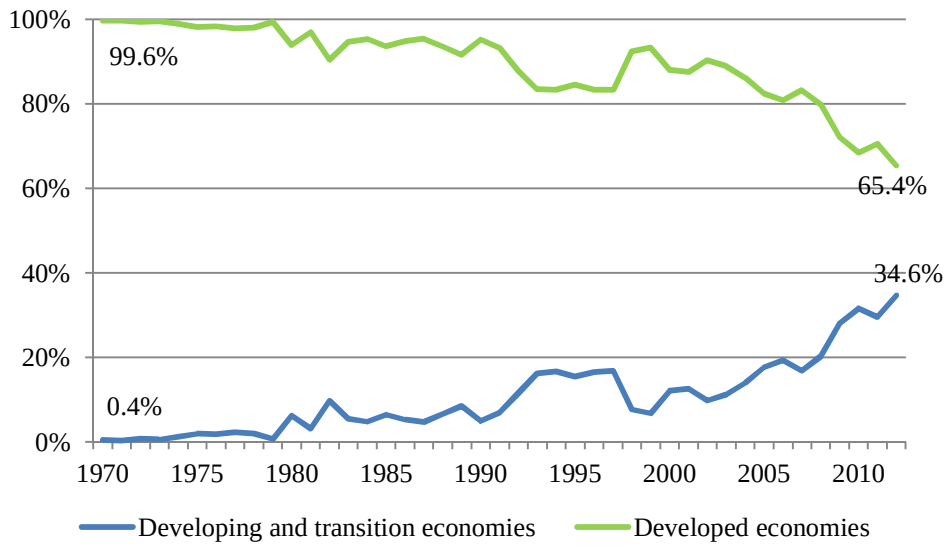
A look at empirical data shows that outward FDI from developing countries has increased significantly in recent decades. While developed countries continue to be the leading source of outward FDI, outward FDI flows from developing countries have experienced tremendous growth reaching a new record high of US Dollar 426 billion in 2012.[43] The share of developing and transition countries FDI outflows has increased continuously from 0.4% in 1970 to 12.1% in 2000 and mounted to an unprecedented 34,6% of the world total FDI outflows in 2012 (Figure 4).[44]

Outward FDI data from developing countries should, however, be treated with caution. A large amount of developing country FDI originates in offshore financial centers like the British Virgin Islands or Cayman Islands (UNCTAD 2006). Yet, even if the data from offshore financial centers is discounted, outward FDI from developing countries shows a clear upward trend (UNCTAD 2013).

[43] See Rasiah et al. (2010) for an extensive discussion on the "three waves" of outward FDI from developing countries.

[44] The recent accelerated rise of the share of developing countries' FDI may partly be attributed to the slump in FDI outflows from developed countries in the aftermath of the financial and economic crisis. Developed economies are therefore likely to regain shares in the next years.

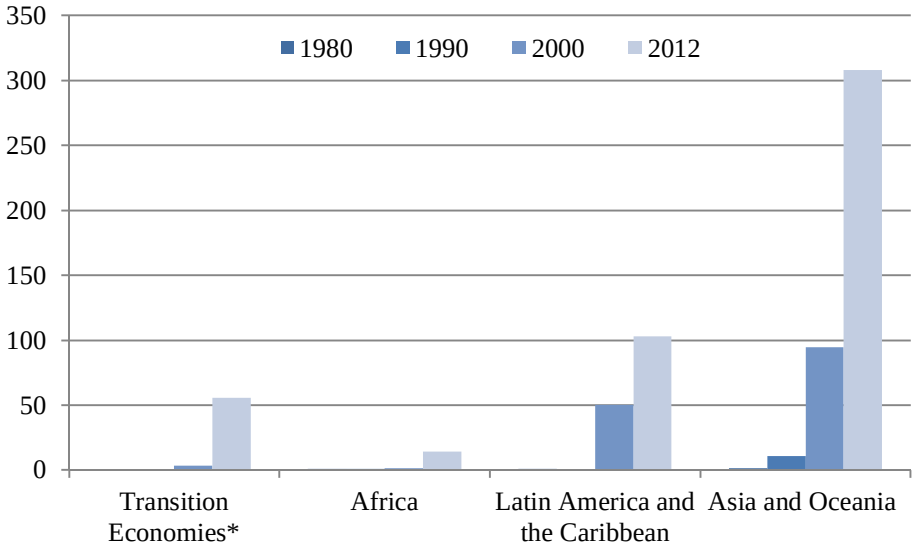
Figure 4: Share of developed and developing/transition economies in FDI outflows, 1970-2012



Remark: UNCTAD FDI Statistics.

From a regional perspective, Asia has experienced the largest growth of outward FDI in recent years and is by far the largest source of developing countries' FDI accounting for three quarters of outward FDI flows from developing countries in 2012 (see Figure 5) (UNCTAD 2013).

Figure 5: FDI outflows by region, 1980-2012 (in US Dollar billion)

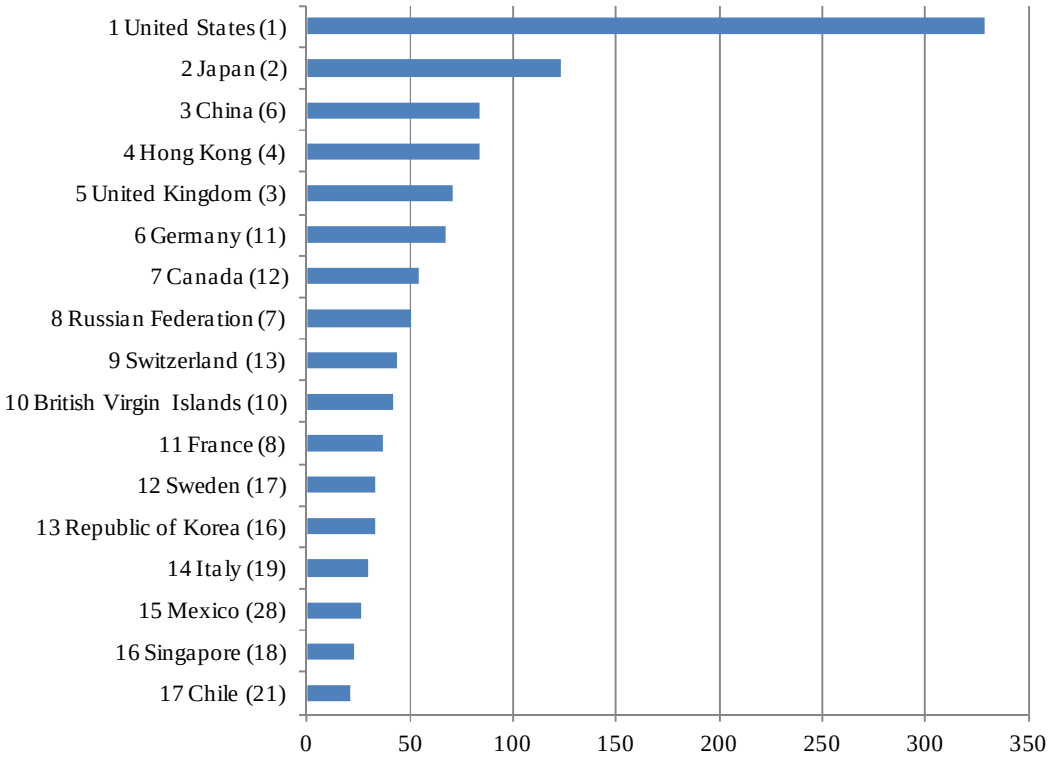


Remarks: UNCTAD FDI Statistics; (*) no data available for transition economies for the years 1980 and 1990.

The strong growth of Asian outward FDI in the last two decades was mainly driven by increased outward FDI activity by few emerging and industrialized countries in the East and South East Asian region, mainly Singapore, China, Hong Kong and South Korea (UNCTAD 2013). Outflows from Latin America show a steady rise, while outward FDI flows from Africa are still on a comparatively low level (UNCTAD 2013). Here again, the main bulk of outward investment stems from few emerging economies (South Africa, Nigeria and Angola in recent years).

The global ranking of the leading FDI investor economies shown in Figure 6 illustrates the growing importance of emerging market MNCs from a country perspective.

Figure 6: Top investor economies, 2012 (in US Dollar billion)



Remarks: UNCTAD World Investment Report 2013, 2012 ranking is shown in parentheses.

In early periods, the main drivers of outward FDI from developing countries were the newly industrializing countries in Asia (Taiwan, South Korea, Singapore, and Hong Kong). Since then, several other developing countries have entered the stage. In 2012, eight emerging economies ranked among the largest 17 investors worldwide. Among them, China was the largest source (US Dollar 84 billion) ranking third in absolute investment volume in the ranks of global top investor economies, followed by Hong Kong. One should note, that FDI flows between NICs are often highly interlinked, such as China's and Hong

Kong's FDI activities. In 2012, China invested around US Dollar 51 billion in Hong Kong (more than half of China's total outward investment) (UNCTAD 2014). In 2013, Hong Kong was in turn the largest FDI investors in China, with around US Dollar 78 billion of total investments (MOFCOM 2014). A large share of Chinese outward FDI goes to Hong Kong and then from Hong Kong back to China. This linkage is also considered as "round-tripping FDI" which means that domestic capital is transferred outside the country and then reinvested as foreign capital, for example to escape regulation or to profit from government benefits such as lower taxes provided to foreign companies in China (Lunding 2006).

The emerging BRICS countries (Brazil, Russia, India, China, and South Africa) accounted for around 10% of the world total in 2012 (UNCTAD 2013). Along with the predictions of the IDP, these economies have developed from mere recipients of FDI to increasingly important sources of FDI, while inward FDI flows still prevail. Moreover, while they initially directed their investments to other developing countries, more than 40% of their FDI stock was located in developed countries in 2012. This may also be considered as an indication that BRICS' FDI is increasingly driven by market and knowledge-seeking motives (UNCTAD 2013).[45]

In many emerging countries, the increase in outward FDI has been backed by substantial state support programs and special policies to push forward the internationalization and expansion of domestic firms. A prominent example is China's "Go Out Policy" (also known as "Going Global Strategy") which was initiated in 1999 to support the international competitiveness of Chinese MNCs. Chinese outward FDI has been encouraged through the provision of information about potential host economies as well as direct incentives such as financial support, foreign exchange assistance or through the reduction of administrative obstacles to international investment (Buckley et al. 2007, UNCTAD 2006). In doing so, the Chinese government acted strategically and tried to steer firms' investment decision by circulating a strategy paper which provided detailed information about favored host economies, strategic sectors and favored types of FDI, such as R&D investment or mergers and acquisition (M&A), which were of strategic

[45] A brief remark should be made with regards to the heavy headwind MNCs from developing countries often face when investing in more developed countries. Many developed countries have taken a protectionist stance toward inward investments from developing countries, especially with regards to cross-border M&A of domestic companies (UNCTAD 2006). In the past, several M&A deals have been called off due to regulatory and political reasons (UNCTAD 2013). Prominent examples are the failed acquisition of the British firm P&O by Dubai Ports World or the buyout attempt of the U.S. based oil company Unocal by the Chinese oil company CNOOC (Dunning and Lundan 2009). Controversies were highest when state-owned firms from emerging markets were involved in the takeover due to security concerns.

importance for the Chinese competitiveness. Today, the promotion of the internationalization of Chinese firms is an integral part of China's industrial policy (Buckley et al. 2008). Singapore, Taiwan and South Korea are other examples of countries which actively tried to accelerate outward FDI by strategic government policies. Those national strategies often involve state-controlled entities (SCE), like state-owned enterprises or sovereign wealth funds (SWF) which are used to support strategic industrial development objectives abroad. State involvement is particularly pronounced in the natural resource sector (UNCTAD 2005) and often goes along with knowledge-sourcing motives. In 2012, 70% of developing country SWF investments were targeted at developed countries (UNCTAD 2013).

In light of this empirical evidence, there is an ongoing debate whether conventional theory is able to account for developing countries MNCs or whether a new theory is needed to explain the existence of MNCs from emerging countries. As discussed above, traditional theory considers the internationalization of firms as a result of firm-specific ownership advantages of investing firms and the ability to internalize and exploit them above (Dunning 1977, 1981, Hymer 1976, Markusen 1995). When it comes to investment in other developing countries, it is often assumed that emerging MNCs possess such ownership advantages over MNCs from developed countries due to their experiences in operating in often similar home markets (better market knowledge due to cultural, technological and physical proximity etc.) (see Buckley et al. 2008 for Asian MNCs). When it comes to investments of developing country MNCs in developed countries, conventional theory begins to totter. The firm-specific advantages of MNCs from developing countries are usually not comparable to that of their developed country counterparts. However, as empirics show, emerging country MNCs nevertheless increasingly invest in more developed markets where they have to compete with MNCs from developed countries. Conventional theory seems to lack explanation. Moon and Roehl (2001) therefore propose a new approach to extent the existing theory. Their concept replaces the conventional ownership advantages with imbalances between a firm's advantages (technology, capital etc.) and disadvantages (small home markets, lack of technology, political instability etc.). The authors assume that one of the motives why firms from less developed economies engage abroad without possessing firm-specific ownership advantages is to balance their strategic assets effectively and to access assets which are necessary to reduce their imbalance. Their concept remains consistent with traditional explanations of FDI activity as it does not replace the explanation of traditional

FDI behavior of firms. It rather shows that the two types of FDI, conventional and unconventional FDI, seem to coexist (Moon and Roehl 2001).[46] Accordingly, traditional theory still has explanatory power but has to be extended by taking into account the special characteristics and motivations of outward FDI from developing countries. These may include special advantages (e.g. government support, local embeddedness) but also the lack of advantages (ownership disadvantages) which motivates them to invest in more developed countries (Buckley et al. 2008, Moon and Roehl 2001).

It can be concluded that the practice of knowledge-sourcing FDI has intensified over the last two decades (Lichtenberg and van Pottelsberghe de la Potterie 2001). This development is backed by several trends. The decrease of information costs has facilitated the transfer of knowledge between entities, although some knowledge is still sticky and bound to locations. The internationalization of R&D points to the growing importance of accessing this knowledge via knowledge-sourcing FDI. Moreover, the increase of outward FDI from emerging countries has changed the global FDI landscape in recent decades. As proposed by the IDP, after decades of receiving inward FDI, several emerging countries increasingly take on a more outward oriented investment position and their share in total FDI has increased rapidly in recent years. They even seem to make outward investments at quite early stages of their development, sometimes even if they do not possess comparable ownership advantages and in some cases in search of advanced knowledge and strategic assets to address deficiencies in the home country knowledge basis (Moon and Roehl 2001). This “early” rise of outward FDI is often driven by the declared strategy of governments to encourage outward FDI, e.g. via state-owned enterprises or monetary incentives. Thus, when looking at the home country effects of outward FDI and related reverse knowledge transfer processes, it seems advisable to not only take into account MNCs from developed countries but also the special context of MNCs from NICs which, however, should also be abstracted from the broader group of developing countries.

2.2.3. Framework for the Reverse Knowledge Transfer Process

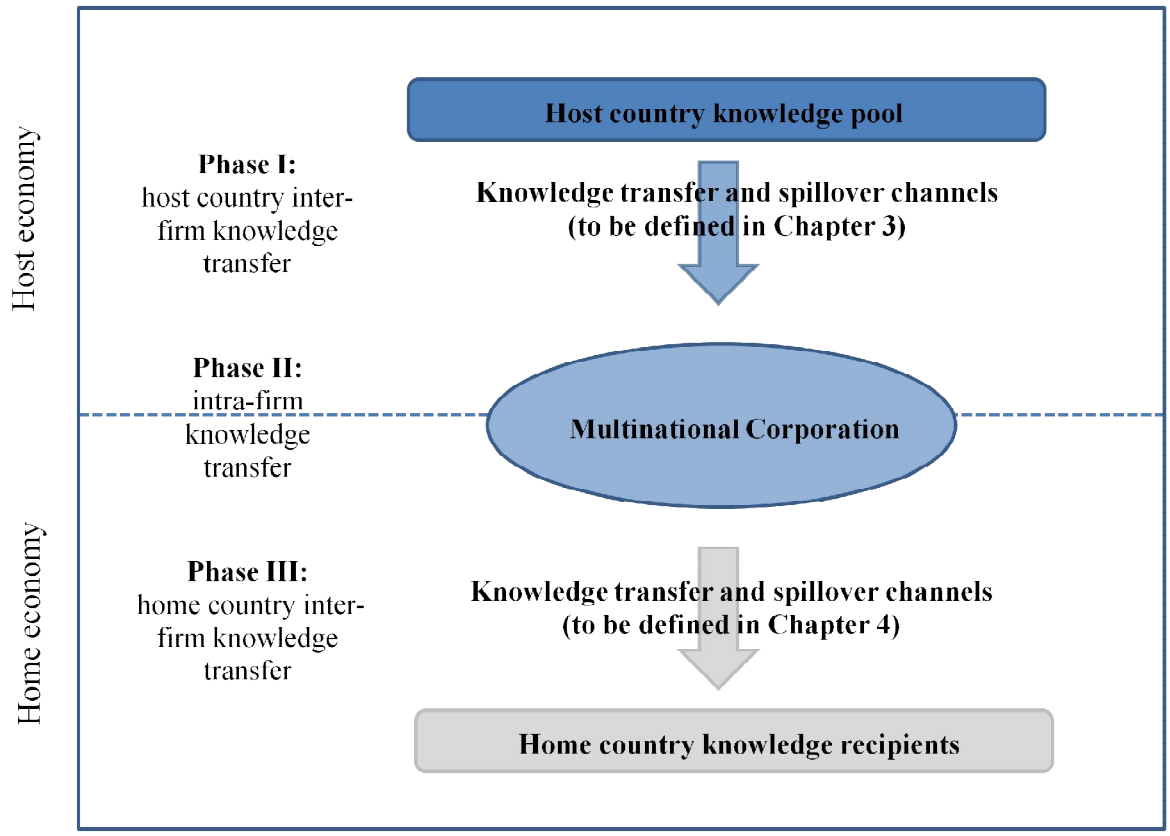
Outward FDI in general and knowledge-sourcing FDI in particular have increased in recent decades, from both developed and NICs. Its growing importance raises the question how outward FDI could affect the investing firms and their home economies. So far, outward FDI flows were often linked with the fear of job erosion in the home country or the

[46] Their theoretical approach may not only be applied to explain emerging country MNCs but also strategic investments of developed countries MNCs (Moon and Roehl 2001).

worsening of the balance of payments (Lipsey 2004). The fact that outward FDI can be knowledge-sourcing in nature and that foreign knowledge can be "reversely" transferred back to the home economy allows for a new way to study the home country effects of outward FDI. The approach is based on the assumption that not only the investing MNC benefits from the absorption of advanced foreign knowledge, but also its home economy due to the potential spillovers to domestic firms (Globerman et al. 2000).

Figure 7 illustrates a framework for the process of reverse knowledge transfer. In this setting, the process starts with the direct absorption of host country specific knowledge through the subsidiary (host country inter-firm reverse knowledge transfer) (phase I). The acquired knowledge is then absorbed and depleted by the parent company in the home economy (intra-firm reverse knowledge transfer) (phase II). In a final step, the foreign knowledge spills over or is transferred to home country firms or other knowledge recipients and is indirectly absorbed by the domestic economy (home country inter-firm reverse knowledge transfer) (phase III). The framework shall give us an orientation for the discussions on the knowledge transfer channels in the following chapters.

Figure 7: Process of international reverse knowledge transfer



Remark: Own illustration.

The framework leads to several assumptions with regards to the effects of reverse knowledge transfer on the home economies. Reverse knowledge transfer could for example contribute to the increase of the number of varieties and improve the quality of products available in the home economy. The augmented home country knowledge base in turn should accelerate the process of technology diffusion and increase the rate of economic growth. However, one has to bear in mind that the described sequence of events represents a best-case scenario. In reality, MNCs and economic agents in their home economies are confronted with numerous obstacles. The question is, e.g. whether capabilities of MNCs, especially those from developing countries, are appropriate to absorb foreign knowledge. There might also be barriers to the intra-firm transfer of knowledge across countries. Furthermore, the absorption of knowledge by home country firms is conditioned on substantial local capabilities. Finally, it is questionable whether backward countries can catch-up with industrialized ones if the technological distance between them is too large (Findlay 1978). In this context, it should be discussed whether it seems advisable for investing countries to follow a more incremental investment path, starting in countries with low technological distance to build up and strengthen ownership advantages (or correct imbalances as Moon and Roehl 2001 would propose) and then increasingly expand to technologically more advanced economies. Based on the findings of the theoretical and empirical assessments of this thesis, this question shall be discussed in Chapter 7.

2.3. Summary

This chapter provided groundwork on the link between knowledge, innovation and economic development and gave initial insights into the potential role of outward FDI as a channel of reverse knowledge transfer. The main conclusions are briefly summarized in the following.

The review pointed to the significance of knowledge and innovation in economic theory. Innovation plays an important developmental role for the economy that is producing the knowledge, but also for other economies which might profit from international knowledge spillovers. In this context, an understanding of the nature of knowledge was crucial to explain the international concentration and diffusion of knowledge as well as the transferability of knowledge, both features which are important to explain the existence of international knowledge spillovers. Whereas codified knowledge may be easily transferred across borders, the transfer of tacit knowledge needs spatial proximity between economic

agents. Non-excludability of knowledge on the other hand explains the existence of knowledge spillovers, which are in turn important drivers of growth in many models of economic growth.

Closely linked to the stickiness of tacit knowledge was the empirical evidence on the international distribution of knowledge generation which showed that knowledge is highly concentrated geographically. Although developing countries have also increased their innovative capacities in recent decades, the bulk of new knowledge is still generated in more developed countries. Thus, knowledge gaps are prevailing not only between developed and developing countries, but also within the group of high-income countries and within the group of low-income countries.

Based on the empirical evidence, the role of the MNC as a channel to overcome these existing knowledge gaps was discussed. It was shown that, so far, academic research has mainly addressed FDI as a mean to transfer knowledge from the source to the host country. Accordingly, the effects of inward FDI on the host economy have been extensively covered by the literature. In contrast, research has given less attention to FDI as a mean to reversely transfer knowledge from the host to the home economy. Thus, the home country effects of outward FDI have been given by far less attention than the host country effects of inward FDI. However, outward FDI and in particular knowledge-sourcing FDI could have positive impacts on the home economy given that outward FDI gives domestic MNCs access to foreign knowledge sources and the chance to reversely transfer knowledge back to the home economy. The question on how outward FDI effects home country development is becoming an even more important issue as knowledge-sourcing FDI has gained momentum in recent years. There are several potential explanations for the growing importance. The decrease of information costs due to the spread of ICT has facilitated the transfer of knowledge across distances. Moreover, the internationalization of R&D, which has become an important strategic tool of MNCs worldwide, is based on a clear knowledge-sourcing motive. Finally, the growing presence of MNCs from emerging countries, also in more developed countries, is often associated with strategic-asset seeking FDI.

Despite the growing relevance of outward FDI in general and knowledge-sourcing FDI in particular, the consequences of this increment, that is, the home country effects of outward FDI have scarcely been addressed by the theoretical and empirical research. What is still missing is a sound theoretical framework to conceptualize and discuss the home country

growth dynamics of outward FDI. Moreover, empirical analyses are still too few to draw any conclusions. These research gaps shall be addressed by this thesis in order to contribute to a better understanding of the home country effects of outward FDI.

To set up the theoretical model in Chapter 5, the spillover and knowledge transfer channels and determinants of reverse knowledge transfer need to be identified in first place. The next two chapters will therefore screen the theoretical and empirical evidence on the different reverse knowledge transfer and spillover channels as well as their determinants. Moreover, a summary of the empirical evidence on the home country effects of outward FDI is provided. This will be done, both from a firm-level (Chapter 3) and home country (macro-level) perspective (Chapter 4).

3. DIRECT OUTWARD FDI EFFECTS ON INVESTING FIRMS: THEORY AND EMPIRICAL EVIDENCE

In order to generate positive knowledge spillovers to the home economy, outward FDI has to be beneficial to the investing MNC itself in the first place. Or, to be more precisely, the outward investment should benefit both the MNC's subsidiary in the host economy and the MNC's parent unit or other parts of the MNC organization in the home economy. This chapter will therefore review the main theoretical and empirical findings which shed light on the direct, "private" effects of outward FDI. The review covers phases I (inter-firm reverse technology transfer) and phase II (intra-firm reverse technology transfer) of the reverse knowledge transfer framework presented in the previous chapter.

The main questions that will be addressed in the following sections are: Through which channels is host country knowledge reversely transferred from the host economy to MNCs' subsidiaries and back to the parent company in their home economies (Section 3.1)? What are the determinants for reverse knowledge flows and spillovers (Section 3.2)? What are the theoretical and empirical findings on the impact of outward FDI on the investing firm (Section 3.3)? A subject that shall be addressed along these questions is how MNCs from less developed countries do fit into this. How and to which extent do they differ from conventional MNCs from more developed economies? In which cases do they potentially profit from their activities in host economies and in which cases are they disadvantaged? A brief summary of the main insights of this chapter will be provided in Section 3.4.

3.1. Reverse Knowledge Transfer Channels

Academic research on reverse knowledge transfer and spillovers from the host economy to the investing firm is still limited (Criscuolo 2009). There exists, however, a large theoretical and empirical literature on the channels of knowledge transfer stemming from inward FDI in host economies, from which valuable insights may be derived (Blomström and Kokko 1998). The decisive difference in the following discussions lies in the direction of knowledge transfer: It is assumed that knowledge is transferred from the host country to the MNCs and not, as discussed in the inward FDI literature, from the MNCs to the host economy. Thus, the focus is shifted from the host country as a receiver to a source of knowledge and from the MNCs as a source to the receiver of knowledge. Another focus of the following sections will be on the intra-firm knowledge transfer channels and the

reverse flows of knowledge from the subsidiaries back to the parent firm in the home economy. It is known from the international management literature, that transferring complex and advanced technological knowledge within an organization, particularly between the subsidiary and its headquarter, is a challenging task (Ambos et al. 2006, Frost and Zhou 2005). Hence, the intra-firm reverse knowledge transfer demands a short review of the main findings in this field.

Four main transfer and spillover channels of reverse knowledge diffusion, which are assumed to affect the investing firms' productivity and innovativeness, have been identified in the literature, namely demonstration effects, labor mobility, vertical linkages and network linkages (Criscuolo 2004). These conduits have a circumscribed geographical dimension. This means that firms may often only profit from these channels if they geographically locate near the knowledge pools in the host economy. The following sections will provide a discussion of these channels, both in terms of the theoretical arguments that have been proposed and the empirical evidence that has been provided by the academic literature.

3.1.1. Demonstration Effects

In the literature on inward FDI spillovers, the demonstration effect refers to a display of superior products and techniques by foreign MNCs and an imitation of these products and techniques by domestic firms in the host economy, which often operate on a lower technological level than foreign MNCs (Blomström and Kokko 1998). Without directly interacting with the MNCs, domestic firms may observe and adopt the MNCs' advanced technologies due to the mere proximity to the MNCs. The idea behind the demonstration channel can easily be reversed and applied to the case of outward FDI: Here, it is not the MNCs but firms[47] and research institutions in the host economy, which possess tangible and intangible capabilities such as new technologies, products or techniques which are purposefully or inadvertently "demonstrated" to the MNCs. Thus, if MNCs establish subsidiaries close to knowledge sources in the host country, they may have the chance to profit from their demonstrated set of knowledge.

The demonstration channel may benefit the investing MNCs in various ways. First, the geographical proximity allows MNCs to observe, analyze and learn about host country

[47] Host country firms may cover a broad spectrum of firm types: They may consist of non-multinational, domestic companies, host country MNCs or even MNCs from third countries. They may be direct competitors, suppliers or customers etc.

firms' advanced capabilities (learning from watching).[48] MNCs may directly apply the host country knowledge to their own operations by imitating the processes and techniques or by reversely engineering the products (learning by doing). Second, the proximity to advanced R&D projects of host country firms or research institutes may indirectly encourage MNCs to adopt new technologies or even stimulate the MNCs' own innovative activity (Blomström and Kokko 1998). This can be explained by the fact that MNCs are able to reduce their R&D costs if they observe that specific techniques and products are feasible, which shortens the "trial-and-error" process of their own research activity and improves the efficiency in the R&D process (Cheung and Lin 2004, p.26). The third and final reason is closely linked to the second. If MNCs observe that specific products and techniques (output of host country firms' past R&D projects) have already been tested successfully in the advanced host market, the uncertainty and risk of advancing products and techniques along these existent lines may be reduced significantly (Cheung and Lin 2004).

Demonstration effects are often related to horizontal knowledge spillovers. In this regard, some valuable thoughts can be drawn from Malmberg and Maskell (2006), who discuss the advantages of spatial proximity of firms competing in the same industry. They argue that proximity may lead to horizontal knowledge spillovers as "(c)losely located firms undertaking similar activities find themselves in a situation where every difference in the solutions chosen, however small, can be observed and compared" (Malmberg and Maskell 2006, p.6). Observability, on the one hand, refers to the spontaneous and automatic observation of the undertakings of co-located firms and their potential alternative production and processes without systematically monitoring them (Malmberg and Maskell 2006). Comparability, on the other hand, is related to the assumption that sharing common conditions, opportunities and threats by operating in the same location may more likely reveal potential deficits in the production process and business practices (Malmberg and Maskell 2006). Due to spatial proximity, firms may easily and quickly learn about promising avenues of research, identified by competing firms or imitate their successful products or methods.

The interaction of MNCs and host country firms might result in a virtuous circle and demonstration effects could be reinforced even more so by the increased competition

[48] Host country firms are not the only potential knowledge sources in the host economy. They may also comprise public and private research institutes or other sources of knowledge. Due to simplification, the term "host country firms" is used to refer to the knowledge source.

between host country firms and MNCs.[49] As MNCs are able to increase their capabilities via demonstrations effects from host country firms, the latter could be urged to increase their productivity or innovative activity in order to maintain their superiority in their home market. The increased effort of host country firms, again, adds to the potential for demonstration spillovers and offers a further incentive for MNCs to assimilate their products and processes. At the same time, however, the reverse could eventuate. As a result of the increased competition of MNCs, host country firms might increase their efforts to prevent demonstration spillovers to MNCs. This would reduce the potential for knowledge spillovers.

The empirical evidence on demonstration effects is limited, even in the inward FDI literature. Here, a simple example provided by Alfaro and Rodríguez-Clare (2004) shows how demonstration effects emanating from a single firm may improve the productivity of other firms. They refer to an innovation which was introduced by MNCs in the maquila industry in Honduras in form of a free breakfast that was provided to employees half an hour before the official start of the morning shift. This did not only provide an incentive for employees to be at work on time, but also helped to improve their productivity. Due to the demonstrated success, the idea was adopted by domestic Honduran firms in the same sector, which in turn had a positive effect on their productivity. Another empirical example is provided by Cheung and Lin (2004). They find that inward FDI in China of foreign MNCs leads to positive spillover effects on the number of Chinese patent applications at the provincial level. Since the effect is strongest for minor innovations such as external design patent (involving a new design for shape, pattern, or combination, or of color, or of aesthetic properties), the authors assume that the spillovers are most likely to be evoked by demonstration effects. This example also shows that the scope of spillovers from the demonstration effect will very much depend on the complexity of products and processes. Simple manufactures and production procedures are more easily imitable than more complex ones. Moreover, the extent of spillovers through the demonstration effect is likely to increase with the similarity of the goods produced by MNCs and host country firms. This is because the pressure for firms to adopt advanced techniques and products increases with the number of competitors in the host market (Barrios and Strobl 2002). In order to successfully compete in the host economy, MNCs will have to successfully adopt technologies and allocate their resources more efficiently. However, this argument

[49] These considerations are drawn from a discussion on inward FDI triggered virtuous cycles in the host economies as discussed in Criscuolo (2004).

becomes obsolete for spillovers of more general knowledge such as management or marketing practices. In this case, demonstration effects may occur without direct product linkages (Crespo and Fontoura 2007).

3.1.2. Labor Mobility

Knowledge spillovers from the host economy to the MNC can furthermore occur through the channel of labor mobility. The analysis of labor flows as a source of knowledge spillovers dates back to the early work of Arrow (1962a) which states, that "mobility of personnel among firms provides a way of spreading information" (Arrow 1962a, p.615). Several models have followed to study labor mobility as a channel of knowledge spillovers from a theoretical point of view, among others Fosfuri et al. (2001), Glass and Saggi (2002) and Kaufmann (1997). Many academics stress that labor mobility is of particular importance for the transfer of tacit knowledge (Almeida and Kogut 1999, Song et al. 2003). As already addressed in Chapter 2, tacitness makes knowledge especially difficult to transfer across organizations and borders, even within organizations. Since tacit knowledge is often embodied in employees, job rotation and the active movement of employees between and within firms can have a substantial impact on the spread of knowledge and capabilities beyond organizational boundaries (Teece 1982).

In the following, two channels of labor-related reverse knowledge transfer will be discussed: inter-firm labor mobility which refers to the mobility of employees between host economy firms and MNCs' subsidiaries[50] and intra-firm exchange, which relates to job rotation within the MNC organization. The latter is an important channel to transfer host country knowledge back to the home economy.[51]

3.1.2.1. Inter-firm Labor Mobility

The basic assumption behind the inter-firm labor mobility channel is that MNCs can access advanced knowledge in the host economy if they employ staff who was previously employed, trained or educated by (advanced) host country firms or institutes. This may happen through strategic recruitment and headhunt of personnel from host country firms or direct acquisition of firms employing highly-skilled labor. A recent example for the latter is the takeover of Europe's second largest steel producer Corus by the Indian company Tata Steel. The acquisition did not only bring Tata Steel more than 80 new patents, it also

[50] This channel is expected to occur in phase I in the reverse knowledge transfer framework.

[51] This channel is expected to occur in phase II in the reverse knowledge transfer framework.

came along with almost 1,000 trained researchers (UNESCO 2010). Other well-known examples come from the automotive industry. A much-noticed job rotation was the recruitment of the former chef designer of VW by the Korean automotive company Hyundai Kia automotive group in 2006 which has proved to be a success for the brand Kia. In 2010, the Chinese car maker Geely took over Volvo Cars from the US automaker Ford. This allowed Geely to access Volvo's vast experience and technological know-how embodied in its employees.

Job rotation is a significant driver of international knowledge diffusion. There is for example evidence that the inter-firm mobility of managers has contributed to the spread of specific management techniques from Japan to the United States and Europe (Blomström and Kokko 1998). Well-known examples are the Japanese management practice "kaizen" with the focus on the continuous improvement of processes throughout an organization or the "lean manufacturing" philosophy originating from the Japanese car manufacturer Toyota.

According to Song et al. (2001), learning-by-hiring is an essential tool to expand a firm's knowledge beyond its technological boundaries. Given their prior experience, their knowledge and social networks, hired personnel can serve as "gatekeepers and boundary spanners who influence the source, flow, and direction of knowledge for subsequent knowledge-building activities" (Song et al. 2001, p.66). Through collaborative research, social interaction or mentoring, the hired employees should inevitably share their advanced knowledge with fellow employees. This may have an impact on the costs and time, which are usually needed to identify, understand, and adapt new technologies (Song et al. 2001). Besides, host country employees may possess specific knowledge about local business actors such as customers or suppliers (Andersson et al. 2005). It can be assumed that the more developed the host economy, usually the better the education system and consequently also the skill level of host country employees (Barnard 2010).

Many researchers claim that it is difficult to find empirical evidence on knowledge spillover effects from labor mobility given the difficulties in collecting data to trace personnel and knowledge flows. Nevertheless, there are several studies that provide hints on the mechanisms and externalities caused by labor movements. The majority of these studies use patent data to track knowledge flows.[52] For instance, **Almeida and Kogut (1999**) track the career paths of patent holders as well as their patent citation records. They

[52] See Section 3.3.1 for an in-depth discussion on patent data.

find evidence that the inter-firm job movement of engineers has a significant impact on the exchange of ideas and enhances the transfer of knowledge within regions with a high concentration of technological knowledge such as the Silicon Valley. In a similar approach, **Song et al. (2003)** distinguish between domestically and foreign owned firms and study the patent activities of engineers who moved from U.S. firms to subsidiaries of non-U.S. MNCs. They show that hiring engineers from U.S. firms is a strategic mean of MNCs to source technologically distant knowledge. Moreover, the authors find that the potential for inter-firm technology transfer increases when (1) the hiring firm is less path dependent and lacks well-defined technological trajectories[53], (2) the technological expertise embodied by the hired engineer is distant from that of the hiring firm, and (3) this expertise is used outside the existing core technological areas. The findings of Song et al. (2003) could give an indication that external knowledge-sourcing through recruitment of personnel in advanced host economies is of particular importance for MNCs from developing and emerging markets. Their technological trajectory usually is still emerging and is on that account less path-dependent and still more open to new knowledge. **Singh (2007)** emphasizes the importance of labor mobility as a channel of knowledge transfer for both developed and developing economies. By observing the job movements of patent holders and their patent citations in 30 economies between 1986 and 1995, Singh shows that the number of job movements from host country firms to MNCs even exceeds the number of job moves in the opposite direction.

A second branch of literature uses case studies to analyze knowledge spillovers from labor mobility. In a case study on the Korean manufacturer Samsung's entry in the U.S. semiconductor industry, **Kim (1997)** highlights the importance of recruiting U.S.-trained scientists and engineers as a means of Samsung to acquire advanced foreign knowledge. The author provides evidence that their employment does not only lead to a one-time transfer of knowledge, but also forms the base for future knowledge building.

A third strand of literature, which analyzes the externalities transmitted through labor movements, is based on survey data. On the basis of interviews with Japanese industry observers, government officials, and managers, **Branstetter (2006)** finds that a popular method of Japanese subsidiaries in the United States to source advanced knowledge from leading U.S. firms and universities is to hire their engineers, technology managers, and

[53] In this context, a low path dependency means that firms without a large stock of existing capabilities are likely to be more open to new knowledge brought by newly hired engineers than firms which already have established successful routines and products and are therefore less constrained to access other firms' expertise to improve their own performance (Song et al. 2003).

research scientists. Similarly, based on in-depth interviews with R&D managers and scientists in Europe, **Criscuolo (2004)** observes that running R&D units close to foreign centers of excellence enables the recruitment of local scientists and engineers to learn about advanced technologies. Based on a survey among subsidiaries of emerging MNCs in the United States, **Barnard (2010)** notices, that drawing from a skilled workforce in the host economy enables the investing MNCs to develop capabilities, which are valuable beyond their immediate location. **Hsu et al. (2008)** cite from an interview with a CEO of a Taiwanese semiconductor company operating subsidiaries in the United States who states on the role of host country recruits:

> "*The upgrading of product levels could not have been possible without their inputs. To remain on the technology frontier, we had to recruit engineers from Silicon Valley every year. I went to Silicon Valley to find the right people every year. They are like the roots of a tree, absorbing nutrients from outside. You've got the right people, you've got the right technology."* Hsu et al. (2008, p.109)

Whereas most of these studies, regardless of their empirical approach, draw a positive picture on spillovers from labor mobility, there are also limits to the positive effects of labor mobility. **Ettlie (1985)** finds empirical evidence that new employees stimulate innovations only up to a certain threshold, as too many new personnel may disrupt and destabilize the innovation process in the hiring firm. A rather surprising empirical observation has been made by **Maliranta et al. (2009)**. Based on a sample of Finnish firms, they find that hiring workers, who had previously been employed in R&D departments of other firms, does not significantly trigger spillovers to the hiring firms' R&D unit. However, there is a strong positive spillover effect on productivity and profitability if the recruits previously engaged in R&D of other firms are employed in non-R&D activities of the hiring firm. The authors argue that this rather unexpected result reflects the fact that the employees transmit knowledge, which can be readily copied and implemented without much additional R&D effort (without "funneling" it through the receiving firms' lab). Another limit to potential spillovers of labor mobility is labor mobility itself; that is the risk that host country employees leave the firm, for example after the takeover by a foreign MNC. As argued by Hsu et al. (2008, p.111) such negative effects "are not uncommon when the investing firm are relatively late entrants to the technology frontier and the acquired firms are relatively well established." The loss of employees may also be attributed to cultural differences between the acquiring and the

acquired firms. Prominent examples of employee losses are according to Hsu et al. (2008) several takeovers of U.S. firms by the Taiwanese computer firm Acer, which were followed by employees gradually leaving the company.

3.1.2.2. Intra-firm Labor Mobility

So far, this section has focused on the impact of external labor recruitment in the host economy on the hiring MNC. Yet, another important dimension of reverse knowledge transfer is the diffusion of advanced foreign knowledge within the overall organization. In this regard, foreign assignments of home country employees play a crucial role in the transferring of knowledge across borders and units. The driving forces of the intra-firm labor mobility effect are expatriates, who are sent on temporary assignments in MNC subsidiaries and access advanced foreign knowledge they bring back as repatriates once returning to their parent unit (learning by sending/rotating). Reverse knowledge transfer via intra-firm labor mobility takes, however, only full effect if repatriates are able to share their knowledge after their return and if the receiving unit is able and willing to absorb it. As Oddou et al. (2009) point out, the majority of parent MNCs fail to actively harvest the valuable knowledge of repatriates since knowledge flows are often mistaken as being only one-way, from parent to subsidiary.

There is scattered empirical evidence on the firm effects of foreign assignments and intra-firm job rotation. The majority of studies find that intra-firm job rotation has a positive impact on the sending unit's knowledge base. One of the few empirical assessments has been conducted by **Subramaniam and Venkatraman (2001).** Analyzing MNC survey data from multiple industries and countries, they show that international assignments can help MNCs to create superior capabilities for transnational new product development and can contribute significantly to MNCs' innovative ability. Further evidence on positive spillover effects can be found in **Branstetter (2006)** who reveals that Japanese firms with subsidiaries in the United States frequently send engineers from the Japanese parent company on short-term assignments to their subsidiaries in the United States to promote knowledge diffusion. This was also a common practice in Japanese pharmaceutical firms as recorded by **Penner-Hahn and Shaver (2005)**. **Poon et al. (2006**) analyze the patent activity of Taiwanese MNCs which operate subsidiaries in the United States and actively promote bidirectional knowledge exchange via intra-firm labor mobility. Using survey data, the authors find evidence that by frequently sending parent engineers to the United States as well as U.S. subsidiary engineers to the parent firm in Taiwan, patent output

could be increased. **Kim (1997)** finds similar evidence for Korean engineers employed by Samsung, who were sent to the United States to build up tacit knowledge and identify strategic technology suppliers. Kim also observes that the establishment of mixed teams composed of Koreans and Americans who frequently interacted through trainings, joint research and consulting, resulted in comprehensive knowledge diffusion between outposts in Silicon Valley and the Korean headquarter in a short period of time. The crucial role of bi-directional, cross-border job rotation within organizations is also documented in **Piscitello and Rabbiosi (2006),** who empirically study the supportive conditions for reverse knowledge transfer within Italian MNCs. Questionnaire results show that reverse knowledge transfer processes are not formalized in most cases, but rather driven by interpersonal ties between employees of multiple units.

It can be concluded that the labor mobility effect is dependent on both host country and home country employees. Whereas the former are essential to bring in foreign knowledge in the first place, the latter are important for the diffusion of foreign knowledge in the overall organization, in particular as a channel for reverse technology transfer back to the parent MNC.

3.1.3. Vertical Spillover Channels

Knowledge spillovers from the host economy to the MNCs may furthermore occur through vertical channels, for instance backward (from buyer to supplier) and forward (from supplier to buyer) linkages.[54] The underlying assumption is that MNCs are typically specialized in different stages of the production process along a vertical axis of a value chain that links them automatically to other agents through a buyer-supplier relationship. In order to guarantee a smooth and frictionless supply of inputs and outputs along the production process, such relations frequently demand coordination between buyers and suppliers as well as mutual adjustment of their design, standards and production processes. Given that such adjustments are often enabled by a continued exchange of information or even of personnel who possess explicit engineering or management knowledge, vertical linkages often go along with knowledge transfer.

Due to the lack of direct competition among suppliers and customers, vertical FDI spillovers are even more likely than horizontal spillovers (Javorcik 2004). While host country firms have an incentive to prevent information leakage that would enhance the

[54] These channels are expected to occur in phase I in the reverse knowledge transfer framework.

performance of MNC competitors or followers, they are less likely to inhibit spillovers to upstream or downstream firms. This is because they are more likely to benefit from knowledge sharing with suppliers or customers, e.g. in form of better product quality or faster delivery times (Javorcik 2004). Empirical support to this proposition can be found in Kugler (2006). Based on data from the Colombian Manufacturing Census, the study shows that there are substantial vertical spillovers in supplier/buyer relationships, but no knowledge exchange to competitors in the host economy. Of course, this assumption of vertical knowledge spillovers only holds up as long as multinational suppliers and buyers are no serious threat to the competitiveness of host country firms.

The following sections provide a brief overview of theoretical and empirical findings on how vertical linkages in form of backward and forward linkages in the host economy affect knowledge spillovers to investing MNCs.

3.1.3.1. Backward Linkages

Knowledge may be channeled through backward linkages between MNCs as suppliers of intermediate goods and advanced host country firms as customers. MNCs may improve their products by selling intermediate goods to host country customers in various ways. Advanced host country costumers may pose higher requirements regarding quality standards, production processes or delivery time (Criscuolo 2004, Humphrey and Schmitz 2002). The sheer pressure of higher standards and on-time delivery imposed by customers in the host country alone may dispose multinational suppliers to upgrade their products and production processes (Javorcik 2004). Furthermore, host country customers may have an incentive to help to improve the quality of their suppliers' products, for example by providing technical assistance and labor training or by exchanging technical information (Lall 1980).[55] Additional supportive measures may include help with the organization of the production processes, quality controls or with the acquisition of additional customers (Javorcik 2004). This way, multinational suppliers learn about new designs and products or advanced organizational and management methods and get a better understanding of the customers' needs. They may gain access to new varieties and develop new intermediate

[55] An example for backward knowledge transfer from MNCs to host country firms, which is worth mentioning, is the Japanese Keiretsu System, which is an informal business group network. Branstetter (2000) finds empirical evidence that Keiretsu linkages of Japanese firms create strong vertical knowledge spillovers and increase the factor productivity growth of keiretsu network members. Knowledge transfer is for example driven by labor mobility as downstream firms frequently depute engineers and managers to their suppliers in order to provide assistance in coordination and dissemination of innovations, management techniques and accounting practices.

goods as a response to customer firms' demands and needs. This may increase their portfolio of intermediate goods. With the transfer of these new varieties back to their home economies, MNCs automatically contribute to the increase of the pool of intermediate goods available in the home economy. This will be one of the crucial assumptions for the endogenous growth model presented in Chapter 5.

Given the lack of literature on backward linkages from host economy firms to MNCs, theoretical frameworks on backward spillover effects can be drawn from the literature on inward FDI, in particular the work of Rodríguez-Clare (1996).[56] In the model, the presence of a MNC leads to an extension of the number of varieties of intermediate goods produced by host country suppliers, which in turn allows the host economy to gain a competitive advantage in the production of more sophisticated final goods, thereby increasing its overall productivity. According to Rodríguez-Clare (1996), the spillover effect depends on the technological gap between the host and the home countries. If the host country supply of intermediate goods is too poor, MNCs will import their intermediate goods, which eventually will lead to a reduction in input variety and specialization of host country suppliers. In contrast, the more developed the host economy, the likelier are spillovers from MNCs to host country firms via backward linkages. From this theoretical work on inward FDI, assumptions may be drawn for the reverse case of backward spillovers to MNCs in the host economy: If MNCs fail to provide adequate intermediate goods given that the technological gap is too large, host country customers will purchase from technologically more advanced host country suppliers. Hence, the more advanced multinational suppliers are, the likelier they sell their products and consequently the likelier are spillovers from host country customers to MNC suppliers.

What do the empirics say? To date, there is hardly any empirical evidence on spillovers from backward linkages on MNCs in the host economy. Based on survey data of Italian MNCs in the manufacturing industry, Piscitello and Rabbiosi (2006) find evidence that host country customers provide unique and specialized knowledge by sharing demands and needs with the subsidiaries' engineers and technicians through activities such as co-design. Moreover, the findings indicate that suggestions by host country customers stimulate marketing and product development departments of MNCs and lead to incremental product innovation and continuous customization efforts. Similar evidence is found for emerging countries MNCs that invest in developed economies. Based on survey data of MNCs from

[56] Additional theoretical discussions can be found in Markusen and Venables (1999) and Lin and Saggi (2005).

Taiwan, Singapore and South Korea, that all operate affiliates in the United States, Hsu et al. (2008) observes that the direct interaction of the affiliates with sophisticated U.S. customers helps MNCs to access their customer needs better. This significantly contributes to the introduction of new products and the accumulation of technological competencies. A study by Kotabe et al. (2003) stresses the importance of link duration between suppliers and their customers for knowledge transfer. Based on a survey of U.S. and Japanese supplier firms in the automotive industry, they find that the experience that suppliers and buyers share in dealing with each other (measured in duration and continuity of work relationship) increases the likelihood of technology transfer and improves supplier performance. Beyond, the authors distinguish between ordinary and higher-level technology transfer and find that duration has a positive effect on the effectiveness of higher-level transfer, but does not significantly influence ordinary technology exchange.

For MNCs from developing countries, vertical linkages might provide both a big opportunity and a great challenge at the same time. One the one hand, they might learn extensively from customers in more advanced economies. On the other hand, the question is whether they manage the demands of more technically advanced and developed host economies.

3.1.3.2. Forward Linkages

MNCs may also profit from knowledge spillovers through the upstream interaction with host country suppliers. Forward linkages may benefit the MNCs in several ways. First, the proximity to advanced host country suppliers enables MNCs to source higher quality intermediate products helping them to upgrade their final products or increase their production efficiency (Barnard 2010). Second, by reversely engineering these products, MNCs may also learn about new designs and technologies. Third, since the host country suppliers usually interact with several firms in the same industry, MNCs are likely to gain access to valuable information about the overall industry, especially competitors (Barnard 2010).

Of course, it could be argued that MNCs could import advanced intermediate goods more easily to their home economy, instead of bearing the risks of investing abroad. Nonetheless, it can be assumed that in some cases the benefits outweigh the risk and costs of investing abroad. For example due to the proximity to suppliers, intermediate goods often come along with the provision of complementary services that may not be available in connection with imports (Javorcik 2004). This might in particular apply for the transfer

of tacit knowledge, for instance tacit skills related to the maintenance and repair of purchased machinery.

There are a few works to date which study the impact of forward linkages and reverse knowledge flows to the MNCs' home economy.[57] The ones that have been conducted barely scratch the surface. Interviews by Almeida (1996) of foreign subsidiaries' executives in the United States reveal that foreign MNCs buy into local knowledge by sourcing from U.S. suppliers. In her study on emerging market MNCs in the United States, Barnard (2010) suggests that by being able to draw from a better supplier base in the United States, MNCs from emerging markets can develop valuable capabilities.

It can be concluded that backward and forward linkages are assumed as valuable knowledge sources for MNCs in the host economy. Yet, the empirical literature is still limited, so that any assumptions regarding positive effects from forward linkages can only be very weakly supported.

3.1.4. External Network Linkages

Several branches of research have identified external network linkages as an important channel of reverse knowledge transfer (Acs et al. 1992, Jaffe 1989, Kuemmerle 1999). Through external networks in the host economy, MNCs get "access to resources and capabilities outside the organization, such as capital goods, services, innovations etc." (Andersson et al. 2002, p.980). Such networks might be made up of advanced host country universities, research institutes or even competitors.[58]

In academic literature, a distinction between formal and informal network channels can be found (Grimpe and Hussinger 2008, von Hippel 1987). Formal exchange may entail a legal contract on patents, license or on collaborative research activities (Grimpe and Hussinger 2008). In contrast, the informal channel refers to non-contractual, personal exchange of knowledge between academic agents and industry personnel or between employees of different firms, which develop and produce similar products or use similar processes (Grimpe and Hussinger 2008, von Hippel 1987). Informal trading networks emerging between professional colleagues with the same professional interest and of the same industry provide e.g. technical assistance, consultancy or information on required

[57] Empirical evidence on spillovers from MNCs to the host economy in the inward FDI literature is similarly scarce. One of the few studies was conducted by Javorcik (2004). She uses panel data of Lithuanian firms and finds no robust evidence for productivity spillovers from foreign presence in the upstream industry on domestic firms.

[58] Note that vertical network linkages as discussed in the previous section are not taken into account.

knowledge that might be too specialized and thus not available otherwise (von Hippel 1987). Moreover, scientists and industry personnel frequently may share state-of-the-art knowledge at national and international conferences and conventions (Grimpe and Hussinger 2008, von Hippel 1987). A geographical proximity to peer groups in the host country allows for a frequent informal know-how sharing. Through informal social ties, employees may learn about more advanced technology, methods or management practices. Again, such informal exchange is of particular importance when it comes to the transfer of tacit knowledge (Grimpe and Hussinger 2008). Based on survey data, Cohen et al. (2002) show that informal knowledge sharing between R&D units in the U.S. manufacturing sector and public research is even more important than formal ties. Based on a large sample of German manufacturing firms, Grimpe and Hussinger (2008) show that both the formal and informal channels are mutually reinforcing and lead to higher innovation performance of firms, as informal contacts improve the quality of a formal relationship and vice versa.

One of the most frequently discussed and analyzed external network channel is the knowledge exchange between academia[59] and the private sector (Acs et al. 1992, Cassiman et al. 2008, Cassiman and Veugelers 2006, Cohen et al. 2002, Jaffe 1989). The types of relationships between academia and private sector are manifold and range from citations to university patents, university-industry collaborations (e.g. joint research, sharing of equipment, and research tools), licensing, or university spin-offs to the exchange of firm and university scientists (Cassiman et al. 2008). For firms, academic knowledge may be very valuable and unique. Cassiman et al. (2008, p.612) argue, that "technological knowledge generated by universities can be seen as the result of a dynamic development that is hard for firms to develop internally, since this process relies on vivid discussion of earlier research results including a careful documentation of trial and error". A frequent exchange with academic scientists may therefore help private firms to reduce wasteful experimentation and unnecessary research effort. Grimpe and Hussinger (2008) argue that university involvement is especially important in new technological areas, in which university scientists provide useful information about industrial application opportunities and future research problems. Besides, it could be assumed that it is easier to access academic research than research of private firms since the former has "less incentive to try to keep research secret" (Jaffe 1989, p.957).

[59] In the following, the term academia is used to refer to all kinds of academic institutions such as universities and other (public) research institutes.

Using patent data, Jaffe (1989) was one of the first researchers to empirically measure positive spillovers from university research (basic science) to commercial innovation of private firms in the United States. Since then, several studies have shown that frequent knowledge exchange with academic research may be beneficial for the individual firm's performance and innovation activity (Acs et al. 1992, Cohen et al. 2002, Cassiman and Veugelers 2006). Based on survey data of major U.S. manufacturing firms, Mansfield (1991) finds evidence, that the research input from scientific institutions has been crucial for the development of new products and processes. He shows that some 10% of these would not even have been developed without the knowledge provided by academia.[60]

In this context, outward FDI and the proximity of MNCs to the knowledge source plays a crucial role. Several studies show that knowledge spillovers from academia to private firms very much depend on the geographic proximity between academia and private firms (Jaffe 1989, Acs et al. 1992, Kuemmerle 1999).[61] The underlying assumption is that a proximity to a major public research institute provides spillover opportunities, e.g. through close social ties between local science communities, university scientists and firm employees via conference, seminars or frequent meetings. Geographic proximity to public research institutes matters in particular when informal knowledge transfer is involved (Audretsch and Stephan 1996). Exchange of knowledge often happens spontaneously without being carefully planned. In contrast, geographic proximity is not necessary when knowledge is formally transmitted e.g. via journal publications.

Empirical studies support the view, that firms actively seek knowledge by locating close to academia. Based on international survey data, Kuemmerle (1999) analyzes the motives and location characteristics of 238 R&D investments in different host economies of various MNCs in the pharmaceutical and electronic industries. He finds that if the investment is technology-sourcing, MNCS tend to establish facilities in proximity to host country universities and public or non-profit research institutes.[62] A survey-based study by Piscitello and Rabbiosi (2006) shows that the relationship between Italian subsidiaries and

[60] Mansfield's findings show that the measured benefit has been highest for the pharmaceutical industry, and lowest for the oil sector.

[61] There are also studies which oppose the importance of localized knowledge spillovers from academic research. Zucker and Darby (2001) find little evidence for localized knowledge spillovers in Japanese biotechnology industry. However, the authors attribute their findings to Japan's country specific context with regards to the legal and constitutional settings.

[62] Kuemmerle (1999) takes the sourcing case of the Japanese pharmaceutical firm Eisai as an example. Eisai established a R&D center in the Boston area in 1987 to be nearby Harvard's chemistry department. One the center's chief scientific advisors even was a professor from Harvard's chemistry department.

host country universities and research centers has a positive impact on the parent firm's probability of innovating. Given that scientific research is still mainly concentrated in developed economies (see Chapter 2), MNCs from less developed countries might have an even greater incentive to source knowledge by investing close to academic intuitions in more advanced host countries. So far, however, no empirical evidence can be found on this.

Finally, one has to keep in mind, that only a small number of firms within a limited set of industries are able to directly benefit from the knowledge provided by academia (Cassiman 2008). Given the close collaboration between private firms and public research and relevance of basic science to the biotechnology and pharmaceutical industry, most of the empirical evidence on spillovers generated by academic research has been found in these areas.

3.2. Determinants of Firm-level Knowledge Spillovers

Although outward FDI investment allows MNCs to locate in closer proximity to valuable knowledge sources, it is rather unlikely that they are able to access the full range of knowledge resources of the host economy. Reverse knowledge transfer and spillovers are likely to depend on several factors, which favor or deter reverse knowledge transfer. A deeper understanding of the determinants of knowledge transfer and spillovers is therefore essential for the analysis of the existence, sign and magnitude of outward FDI-driven reverse knowledge transfer and the developmental role of MNCs in general. Without claiming to be exhaustive, the following reviews on theoretical and empirical findings intend to give an impression on the factors and conditions that influence the size and scope of knowledge transfer and related spillovers.

3.2.1. Absorptive Capacity

Academic studies show that the potential for reverse knowledge spillovers via the channels discussed above will strongly depend on a MNC's ability to identify, take up and apply advanced host country knowledge (Castellani and Zanfei 2006, Kuemmerle 1999, Mowery and Oxley 1995). Based on the concept of "absorptive capacity", it is assumed that firms setting out to acquire advanced foreign knowledge need to have developed sufficient internal capabilities in order to make use of the knowledge spillover channels, both in the subsidiary located in the host economy and in the parent unit back in the home country.

The benefits of inter-firm labor mobility for example will depend on the internal capabilities of the subsidiary to identify and make use of the incoming host country employees' knowledge. Similarly, a successful reverse knowledge transfer within the MNC organization via intra-firm labor mobility will depend on the absorptive capacity of the receiving parent unit to integrate the returning employee's knowledge into the existing practices (Oddou et al. 2009).[63] At the same time, knowledge spillovers through the channels discussed above and absorptive capacity may be mutually reinforcing. As stated by Cockburn and Henderson (1998), for example, close links to public science may also help to enhance the absorptive capacity of firms (improve the quality of research conducted within the firm) to better screen and absorb external information.

But what exactly is the idea behind the concept of absorptive capacity and what does the empirical evidence say? The concept of absorptive capacity was coined by the seminal work of Cohen and Levinthal (1990) and today is a common term not only in the international business literature. Cohen and Levinthal (1990, p.128) define absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities". The level of absorptive capacity is assumed to be determined by a firm's prior knowledge, which "at the most elemental level" includes "basic skills or even shared language but may also include knowledge of the most recent scientific or technological developments in a given field" (Cohen and Levinthal 1990, p.128). The concept of absorptive capacity reaches beyond the mere acquisition of external knowledge. It also includes the organization's capability to exploit it (Cohen and Levinthal 1990). Accordingly, comprehensive knowledge absorption also depends on a MNC's ability to internally transfer external knowledge between firm units and across borders.

Zahra and George (2002) have prominently advanced and refined the idea of Cohen and Levinthal by specifying two types of absorptive capacity: potential and realized absorptive capacity. Potential absorptive capacity refers to a firm's receptive abilities such as knowledge acquisition[64] and assimilation capabilities[65], whereas realized absorptive

[63] According to Oddou et al. (2009), there are two clusters of preconditions that facilitate absorption via intra-firm labor mobility: prior related knowledge (general knowledge of related domains, basic skills and problem solving, prior learning experience, and shared language) and internal mechanisms (structure of communication and character and distribution expertise and knowledge within the organization).

[64] Acquisition capacity allows a firm to identify and acquire external knowledge that is critical to its operation (Zahra and George 2002).

[65] The ability to assimilate knowledge means that a firm is able to analyze, process, interpret, and understand the information obtained from external sources (Zahra and George 2002).

capacity comprises knowledge transformation[66] and exploitation capabilities.[67] In the reformulated concept, absorptive capacity is seen as a "set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability" (Zahra and George 2002, p.186).

Research lends support to the preposition that absorptive capacity is of particular importance for knowledge-sourcing FDI activities of MNCs. As argued by Castellani and Zanfei (2006), asset-seeking firms need to be endowed with an adequate amount of internal capabilities not only to profit from localized spillovers in the host economy, but also to transform them into a potential source of knowledge spillovers to its home economy. Similarly, Kuemmerle (1999) states that firms need to have established a network of R&D facilities in the home economy before venturing abroad since the establishment of external R&D units in a foreign environment is a task that requires sophisticated international management skills. Furthermore, it can be said that for knowledge-sourcing MNCs, absorptive capacity has to include a broad array of skills, not only to modify foreign-sourced, advanced technology for domestic applications, but also to deal with the tacit components of the transferred knowledge (Mowery and Oxley 1995). On the other hand, one could also expect, that the higher a firm's absorptive capacity the lower its interest to engage in knowledge-sourcing FDI. Likewise, Song et al. (2003) argue that firms with strong technological capabilities may be less prone to source external knowledge, given that they have already competitively developed capabilities on their own, and have often already chosen a specific technological trajectory and source their knowledge internally. However, a probably more realistic assumption is that external knowledge acquisition and absorptive capacity are complementary and mutually reinforcing. Similarly, Cassiman and Veugelers (2006) assume that the efficiency of firms' internal R&D activity may be leveraged by accessing external knowledge. To increase efficiency a firm has to be open enough to accept new ideas and knowledge and has to leave behind the "not invented here" syndrome (Cassiman and Veugelers 2006, p.68). Based on innovation data of the Belgian manufacturing industry, the authors empirically support the complementary nature of internal and external innovative activities. They conclude that the internal knowledge base increases the marginal return to external knowledge acquisitions and vice versa.

[66] Transformation capabilities enable firms to develop and refine these routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge (Zahra and George 2002).

[67] Exploitation capability refers to an organizational skill to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into the firm's operations (Zahra and George 2002).

The concept of absorptive capacity and its impact on international knowledge transfer and spillovers have been extensively analyzed empirically at the firm-level.[68] The majority of these studies have looked at inward FDI driven knowledge transfer to the host economy (Dahlman and Nelson 1995, Girma and Görg 2005, Kokko et al. 1996).[69] In the last decade, researchers have started to analyze the relation between absorptive capacity and outward FDI (Almeida and Phene 2004, Ambos et al. 2006, Kuemmerle 1999, Penner-Hahn and Shaver 2005). With regards to the absorptive capacity of subsidiaries operating in advanced host economies, Kuemmerle (1999) analyzes survey data of R&D laboratories operated by 32 MNCs in the pharmaceutical and electronics industry and finds that technology-sourcing facilities (R&D centers) are only established close to institutions, which externalize "absorbable" knowledge. With regards to the MNC's parent's absorptive capacity, Ambos et al. (2006) empirically supports the view, that the parents' benefits from reverse knowledge transfer originating in foreign subsidiaries relates positively to its absorptive capacity. Analyzing 294 knowledge transfers of 66 subsidiaries to their respective European headquarters, the authors find that the higher the capacity of the home country unit to absorb advanced foreign knowledge, the higher its benefits from reverse knowledge flows from foreign subsidiaries. Based on a sample of 65 Japanese firms in the pharmaceutical sector, Penner-Hahn and Shaver (2005) find that international R&D activities increase the R&D patent output. However, this finding again is dependent on the firms' absorptive capacity and only holds for those firms, which already have established prior capabilities in the underlying technologies (measured by the stock of already existent drug patents). Further evidence on the importance of absorptive capacity for the innovativeness of MNCs subsidiaries can be found in Almeida and Phene (2004), who analyze subsidiaries of MNCs in the U.S. semiconductor industry. Their regression results

[68] A broad spectrum of indicators to measure absorptive capabilities of firms can be found in the empirical literature. For example, Zahra and George (2002) propose an extensive set of indicators for each of the five absorptive capabilities described in the last paragraph. For acquisition capacity they propose the number of years of experience of the R&D department or the amount of R&D investment as an indicator for acquisition capacity. Assimilation capacity may be proxied by the number of cross-firm patent citations or number of citations made in a firm's publication to research developed in other firms. An indicator for transformation capacities could be the number of new product ideas or new research projects initiated. Finally, Zahra and George (2002) propose the number of patents, new product announcements or length of product development cycle as an indicator for transformation capacity.

[69] For example, Girma and Görg (2005) provide firm-level evidence that absorptive capacity matters for productivity spillovers from MNCs to domestic firms in the United Kingdom. In their empirical testing, they reveal a U-shaped relationship between productivity growth and FDI interacted with absorptive capacity of UK firms and conclude that firms are able to enhance their ability to benefit from inward FDI spillovers by improving their absorptive capacity. This means that for a given level of FDI growth, improvements of firms' absorptive capacity will initially weaken productivity growth due to competition effects but will beyond a critical level eventually boost productivity growth.

indicate that subsidiaries with a higher initial stock of R&D are more capable to utilize knowledge from the host country.

Looking at developing country MNCs, absorptive capacity might play an even more important role. Interesting empirical evidence can be found in Barnard (2008), who explores the success of emerging MNCs in the United States. She finds supportive evidence for her hypothesis, that the higher the development levels of the MNC's home country, the greater its economic success in the United States.[70] However, this relation only holds for firms whose home country has overcome a certain threshold level of development which is given by GDP per capita US Dollar 7,000. For firms from less developed countries (GDP per capita less than US Dollar 7,000) the success is not determined by the development level of their home economies, but rather by the home country level of equality. That is, the more equitable the spread of wealth in the home economy, i.e., the smaller the Gini coefficient, the more successful are firms from less developed countries.

Both, the theoretical and empirical findings indicate that absorptive capacity, regardless of how it is measured, seems to play a decisive role for the reverse knowledge transfer process.

3.2.2. Technological Gap

The size of the technological gap between the investing MNC and host economy firms is expected to be another determinant for the success of outward FDI-driven reverse knowledge transfer. From the discussion on absorptive capacity, it is known that investing firms will need a certain level of capabilities to profit from spillovers. The concept of technological gaps adds a relative perspective to the discussion on absorptive capacity by setting the investing firms capabilities in direct relation to the ones of host country firms (suppliers, customers, competitors).

There are two opposing views in the technological gap discussion. On the one hand, it is assumed that the larger the technological gap between the MNC and host country firms, the less likely knowledge will spill over, since MNC are not able to bridge the lack of capabilities, which are necessary to profit from knowledge spillovers (Barnard 2010). On the other hand, one could also expect that a greater technological gap gives rise to larger spillover potentials in comparison to a small technology gap because it increases the

[70] The economic success of firms is measured using return on assets data (Barnard 2008).

opportunities of MNCs to obtain higher levels of efficiency through the imitation of foreign technology (Findlay 1978). If the technological gap is too small, host country firms will transmit few benefits to the MNC.

With regards to asset-augmenting outward FDI of firms from emerging countries, it is often assumed that firms benefit more the more developed the host economy, in particular in terms of technological or human capital development. This "more is better" assumption is challenged by Barnard (2010). She assumes that the dynamic interaction between the subsidiary and its host economy needs not to necessarily result in learning and technological advancement; it can even be harmful. Based on survey data of emerging MNCs' subsidiaries in the United States, Barnard (2010) finds evidence that subsidiaries of emerging markets MNCs operating affiliates in the United States are most successful for the overall MNC, if they invest in less competitive industries. She concludes that a technology gap which is too big does not benefit the investing MNCs.

Unfortunately, the empirical evidence regarding the impact of the technological gap between host country firms and MNCs on the potential of reverse knowledge transfer is so limited that no conclusions can be drawn. However, interesting assumptions with regards to knowledge gaps between home and host economies may be derived from the endogenous growth model presented in Chapter 5.

3.2.3. Type of Market Entry

The type of market entry is another factor that may affect the potential of reverse knowledge transfer. A firm has generally three choices when investing abroad: an establishment of a new plant or laboratory (also known as greenfield investment), a joint-venture project or a merger and acquisition (M&A) of an already established firm abroad (Kuemmerle 1999). Some studies argue that greenfield investment is the dominant entry strategy for firms that want to protect their intangible assets and therefore follow a home base-exploiting strategy (Kuemmerle 1999). In contrast, one could argue that a MNC with a knowledge-sourcing intention is more likely to engage in and profit from M&A investments, since this is a "shortcut" to access host countries firms' knowledge pool, personnel and its local networks and distribution system (Criscuolo 2004). By contrast, subsidiaries created by greenfield investments may be more disadvantaged due to their start-up position in the new host market. Greenfield subsidiaries may have to bear higher costs related to the creation of new production sites and the establishment of new networks

and distribution systems. Moreover, securing access to new knowledge sources in the host market may take up a lot of time.

Descriptive statistics seem to discount the assumption that knowledge-sourcing MNCs choose M&A as the dominant entry mode. As stated by Criscuolo (2004), knowledge-sourcing investment is most commonly conducted through greenfield FDI, and to a lesser extent through acquisition of existing firms. Similar evidence is found in Kuemmerle (1999). He studies R&D investment of major U.S., European and Japanese MNCs abroad and finds that greenfield investment is the dominant mode of entry for R&D firms (79%), followed by M&A (15%) and joint ventures (6%) for both home base-exploiting and home base-augmenting outward FDI strategies. However, when looking at the impact side of the different entry modes, empirical evidence supports the assumption that cross-border acquisitions tend to be associated with higher returns, at least for the acquired subsidiary. Empirical findings from Yamin (1999) on British owned subsidiaries in the United States show that acquired subsidiaries are more likely to be innovative than greenfield subsidiaries. Moreover, spillovers from vertical linkages are probably more likely if MNCs acquire companies which already have established supplier and customer linkages in the host economy. Based on an analysis of a wide sample of MNCs' subsidiaries located in Greece, Georgopoulos and Preusse (2009) examine the impact of a MNC's choice of foreign market entry (cross-border acquisitions vs. greenfield) on the post-entry performance of subsidiaries. They show that cross-border acquisitions are associated with a better performance of the subsidiary in comparison to greenfield entries. The findings show that acquired affiliates tend to have a larger market share and firm size, higher capital intensity of production as well as more differentiated products. The authors find that this economic success may be attributed to both, the strong position of the to-be-acquired firms prior to the acquisition as well as to the mix of the firm-specific advantages of the MNC with the strengths of the acquired firm that lead to new competitive advantages and an increase of the subsidiary's core abilities.

Of course, one has to keep in mind that one of the desired assets of M&A, human capital, can easily leave the acquired firm if employees dislike the new strategic direction of the MNCs or the change of culture after the acquisition (Kuemmerle 1999). Moreover, organizational differences and difficulties involved in incorporating acquired firms hamper reverse knowledge transfer from the acquired firm to the parent unit (Yamin 1999).

To sum up, it should be noted that the short literature review of the effects of the type of market entry on the reverse knowledge transfer process is not extensive enough to draw trends and general conclusions. Yet, it may be assumed that the underlying motive of the market entrance – be it market seeking, knowledge-sourcing or other factors – is likely to influence the knowledge transfer outcome.

3.2.4. Host Country Embeddedness

An important factor determining the potential for outward FDI-related spillovers is the degree to which the MNC's subsidiary interacts with other agents in the host economy such as suppliers, customers, competitors and research institutions ("host country embeddedness"). Andersson et al. (2002) distinguish between business and technical embeddedness of subsidiaries in the host economies. The former includes mutual adaption of business conducts and a frequent exchange of information about market conditions between the MNC's subsidiary and peer business contacts in the host economy. According to Andersson et al. (2002, p.987), "business embeddedness should mirror a subsidiary's capacity to understand changing business conditions and its ability to adapt to these conditions through business relationships". Technical embeddedness is linked to the dependency between the MNC's subsidiary and host country firms in terms of their product and production development processes (Andersson et al. 2002). If firms are technically embedded, their technological activities are expected to be closely linked to each other.

There are two views in regards to the influence of local embeddedness of subsidiaries on the reverse knowledge transfer process. On the one hand, it can be assumed that if the subsidiary forms an enclave within the host economy with little contacts to domestic firms, the spillover potential is limited. Hence, the more "embedded" the subsidiary in the host economy, e.g. the more it buys inputs from host country suppliers, sells products to host country customers, recruits local workers or operates joint research corporations with other firms or institutions, the larger the knowledge spillover potential (Almeida and Phene 2004, Piscitello and Rabbiosi 2006). On the other hand, a high local embeddedness may also bear some risks to reverse technology transfer. One might argue that the more subsidiaries are locally embedded in the host economy, the smaller the MNCs headquarters' possibility to influence its subsidiaries' activities which may lead to a loss of the reverse transfer of advanced knowledge. Moreover, one could assume that the greater a subsidiary's local embeddedness, the higher the location specificity of the products and

products innovated, e.g. because of specific local customer preferences or markets (Mu et al. 2007). The subsidiaries' products and processes might not be compatible to the rest of the MNC, and reverse knowledge transfer could become redundant.

What can the empirical evidence tell us? In the majority of empirical studies, host country embeddedness has been found to foster subsidiary knowledge creation and innovation and to drive its performance. Based on a sample of MNCs from the U.S. semiconductor industry, Almeida and Phene (2004) show that U.S. subsidiaries with more knowledge linkages to the host country are more innovative, i.e., have a higher patent output. According to Piscitello and Rabbiosi (2006), the benefits of a high embeddedness of subsidiaries in host economies may even spill over to the parent unit in the home economy. Based on survey data, the authors find a significant empirical relationship between the innovativeness of an Italian parent firm and the host country embeddedness of its subsidiaries abroad. Local embeddedness of subsidiaries may also strengthen the subsidiaries role as a knowledge creator within the MNCs. Based on interview data from Swedish subsidiaries in Europe and North America, Andersson et al. (2002) show that a subsidiary's external technical network embeddedness (represented by customers and suppliers) positively affects its expected market performance and strengthens its role as a knowledge creator and as a provider of knowledge for the entire MNC organization (including other subsidiaries and the headquarters). However, in order to be reversely transferable, it is assumed that the knowledge acquiring subsidiary continues to have sufficient linkages to its parent unit in the home economy as well. Marin and Bell (2010) support this assumption in their study on foreign subsidiaries' innovative behavior in Argentina. Based on survey data, they find that firms which are integrated in the local economy enjoy higher innovative output than firms which are less locally embedded, but only if they are at the same time also functionally integrated in their global corporation. One could go one step further and assume that strong host country embeddedness may even impede reverse knowledge transfer. This concern is addressed in a study by Mu et al. (2007). Based on survey data, Mu et al. (2007) – similar to the other authors – highlight the influence of local embeddedness on the learning behavior of foreign subsidiaries in the United States. The researchers find evidence that a high degree of local embeddedness increases the awareness to identify, access and acquire advanced host country knowledge. However, they also find that strong local embeddedness may hamper reverse technology transfer to the parent unit. The technology developed or acquired in the host economy might be too specific to be transferable to another context (e.g. due to specific customer

demands in the host economy) or it might just be incompatible with technologies and systems in the home economy (e.g. due to different standards, norms etc.).

In a nutshell it can be concluded, that host country embeddedness is very likely to positively impact reverse knowledge transfer. However, this is only the case if the knowledge acquired abroad is of value to the whole organization and if the subsidiary is closely integrated in the overall MNC organization. The next section briefly reviews the impact of the subsidiary-headquarter relationship on the process of reverse knowledge transfer.

3.2.5. Subsidiary – Headquarter Relation

The extent of spillovers and reverse knowledge transfer are expected not only to depend on the embeddedness of the subsidiaries in the host economy, but also on the embeddedness of the subsidiary within the overall organization of the MNC. The embeddedness of MNCs is influenced by several factors. Some of the most important factors are reviewed in the next sections.

First, knowledge-sourcing activities by the subsidiaries and the strategic reverse transfer of knowledge to other units of the MNCs, especially the parent unit, are very likely to be influenced by the **subsidiary's mandate** and its strategic role within the MNCs (Ambos et al. 2006, Branstetter 2006, Gupta and Govindarajan 1994). It is obvious, that subsidiaries which have a clear mission to absorb and acquire host country knowledge will ultimately most likely transfer knowledge back to the home economy. Subsidiaries that have a sole production and sales mandate will probably make for less foreign knowledge access. Gupta and Govindarajan (1994) provide a helpful distinction for the different types of subsidiaries mandates. The authors distinguish four types of subsidiary roles according to their reliance on knowledge inflows from the headquarters and their ability to create knowledge outflows to the rest of the corporation: global innovator (high knowledge outflow, low knowledge inflow), integrated player (high outflow, high inflow), implementor (low outflow, high inflow) and local innovator (low outflow, low inflow). According to these classifications, the most effective subsidiary roles with regards to reverse technology transfer to the home economy should be the global innovator and the integrated player. This hypothesis is partly supported by empirical evidence established in a study by Ambos et al. (2006). Based on the classifications proposed by Gupta and Govindarajan, the authors find that subsidiaries which are classified as integrated players provide significantly higher benefits for headquarters. The results show no significant evidence for subsidiaries which are

considered as global innovators. Of course, these findings have to be treated with caution given that they are based on a very much black and white categorization of the roles of subsidiaries. It is probably more likely that subsidiaries act for example simultaneously as innovators and integrated players. Further empirical evidence on the role of the subsidiaries' mandate can be found in Branstetter (2006). Branstetter argues that knowledge spillovers from U.S. firms to Japanese MNCs in the United States depends on the "business purpose" of the Japanese subsidiary for the parent unit. He differentiates between R&D, product development, and the gathering of market intelligence business purposes. The findings show that knowledge spillovers to the Japanese MNCs are strongest if the subsidiary is a R&D or product development facility, that is, if the outward FDI strategy is knowledge-sourcing in nature. Analyzing R&D activities of Japanese manufacturing MNCs in the United States, Iwasa and Odagiri (2004) find that only research-oriented subsidiaries have a positive effect on the patent productivity of parent firms if they locate in the United States. By contrast, R&D subsidiaries with the mandate to support local manufacturing and sales by adapting their superior technology to local conditions have no significant impact on the parent firm. Based on survey data taken from Argentinean manufacturing firms, Marin and Bell (2010) find empirical support that the greater foreign subsidiaries are functionally integrated in their global corporation, the better their performance with regards to innovative activity in their host economy than firms which were less announced to be.

The second factor, which is likely to determine the scope of reverse knowledge transfer and spillovers, is the **autonomy of subsidiaries** within the MNC organization. In regards to autonomy issues, it can be assumed that subsidiaries which are kept autonomously are likely to hinder reverse knowledge transfer as they lack the incentives to pass their acquired foreign knowledge on to the home country unit. Instead they strive to promote their own interests. In contrast, if the subsidiaries' autonomy is limited, this might mitigate their possibilities to learn and absorb knowledge from the host country (Piscitello and Rabbiosi 2006).

The third organizational factor which is likely to influence reverse knowledge transfer processes is the **communication** between the two units. Based on questionnaire data of 42 acquisitions by Swedish MNCs in Europe with the aim to gain access to host country R&D knowledge, Bresman et al. (1999) finds evidence that knowledge transfer from the internationally acquired company to the acquiring company depends positively on frequent communication (face-to-face and other media), visits and meetings. Moreover, the authors

show that the early stages following the acquisition are usually characterized by knowledge flows from the acquirer to the acquired firm. Reverse knowledge flows from the acquired firm to the acquirer needs some time to manifest. Frequent communication has also found to be important in Japanese pharmaceutical MNCs. Interviews conducted by Penner-Hahn and Shaver (2005) of managers from Japanese MNCs reveal that alternating scientific meetings sites were often used to better acquaint the scientists with the activities occurring at each site in order share research findings and diffuse foreign knowledge within the organization.

The fourth and final factor with regards to the headquarter-subsidiary relationship which is likely to influence the reverse knowledge transfer is **cultural distance** between the subsidiary and the parent unit. Large cultural distances are often assumed to have a negative impact on reverse knowledge transfer due to difficulties in communication and understanding between the subsidiary and the parent unit. However, empirical studies are ambivalent (Ambos et al. 2006, Frost and Zhou 2005). Ambos et al. (2006) assume that there are two contravening forces inherent in cultural distance: Cultural distance on the one hand impedes cross-border knowledge transfer given the different nature of knowledge and communication problems. But on the other hand, cultural distance also enhances autonomous knowledge creation making subsidiaries in cultural distant economies important sources of innovation. At the bottom line, the two contrary effects may counteract. Furthermore, Ambos et al. (2006) cannot affirm the assumption that organizational distance in form of structure, processes and values has a significant impact on the benefits of reverse knowledge transfer from the subsidiary to the headquarter. Their survey data shows that the more units are integrated into the overall organization, the higher are the headquarters' benefits.

This section has pointed to the various organizational characteristics that may influence intra-firm reverse knowledge transfer. An important organizational aspect that has been identified is the mandate of the subsidiary within the MNC and its autonomy. It has become clear that subsidiaries with a clear mandate to engage in knowledge-sourcing activities abroad are more likely to actively promote the reverse knowledge transfer process. Furthermore, a frequent communication between subsidiaries and headquarters should help to overcome cultural and spatial distances and it is also likely to positively affect reverse knowledge transfer.

3.2.6. Additional Factors

There are several other factors influencing the success of knowledge acquisition and reverse knowledge transfer to the home economy, which have been discussed in the academic literature and therefore deserve a brief summary. First, the extent of knowledge spillovers via the channels described above very much depend on the **type of knowledge**. As discussed in Chapter 2, the features of different types of knowledge are decisive for its degree of transferability. It is a common view in academic literature that the more complex and tacit the knowledge, the more difficult it is to transfer from host country knowledge sources to the MNC and back to the home economy, even if geographical proximity is given. Accordingly, different types of knowledge may need different types of knowledge transfer channels (Piscitello and Rabbiosi 2006). Particularly the transfer of tacit knowledge; it needs intense interaction between knowledge source and knowledge recipient (Bresman et al. 1999, Subramaniam and Venkatraman 2001). Labor mobility is certainly one of the most important mechanisms to transfer tacit knowledge (Almeida and Kogut 1999, Song et al. 2003).

Second, several researchers have found that the **size of the MNC** is likely to influence the spillover outcomes (Aitken and Harrison 1999, Almeida and Phene 2004, Sinani and Meyer 2004). However, empirical evidence provides a mixed picture. According to empirical findings on Taiwanese firms by Aw and Lee (2008), the larger the size of firms are, the greater the likelihood of a firm to engage in outward FDI and the better their chances to overcome disadvantages of operating abroad. Almeida and Phene (2004) find that the reverse is true. They show that firm size has a significant and negative impact on subsidiary innovation.

Third, the **age of the subsidiary** may influence its ability to absorb foreign knowledge. Positive evidence on the age of subsidiaries is found by Frost (1998) and Rabbiosi and Santangelo (2013). They state that subsidiaries of different ages differ in their ability to source, absorb and transfer back the host country knowledge to the parent unit in their home economy. Given their experience and embeddedness (both internally within the MNC organization and externally in the host economy), parent units benefit more from reverse knowledge transfer stemming from more mature subsidiaries.

Fourth, another factor which may influence spillovers and knowledge transfer relates to home country institutional characteristics. Criscuolo (2004) suggests that the **intellectual property right (IPR) regime** of the host economy could have an influence on spillovers.

If the host country has a strong IPR, this could reduce the possibilities to acquire advanced knowledge due to restricted access to patented technologies etc.

In general, **geographical proximity** plays a decisive role for the success of spillovers. Given that spillovers have a circumscribed geographical dimension, they are likely to decrease with geographical distance (Audretsch 1998, Audretsch and Feldman 1996). The majority of channels discussed in the previous sections are reinforced at or limited to the geographical proximity. For example, demonstration effects and labor mobility are limited in space, and forward and backward linkages are often regionally confined due to transport costs (Crespo and Fontoura 2007).

The list of aspects which influence the outcomes of reverse knowledge transfer could be easily extended. Some of the most important factors have been addressed in the previous sections. Empirics have supported the assumption that the absorptive capacity of the knowledge-sourcing firms and the embeddedness of the subsidiary in the host economy as well as the mandate of the subsidiary within the organization have a decisive impact on how easily host country knowledge may be acquired and reversely transferred to the home economy. The next chapter will go a step further by screening the empirical literature to get an understanding of the effects of outward FDI on the investing firm.

3.3. Empirical Evidence on the Firm Effects of Outward FDI

Given that a firm's decision to engage in outward FDI is based on a for-profit intention, one could expect that the overall impact on the investing firm is on average positive. However, as Kokko (2006) notes, there are examples where firms failed with their foreign ventures and where expected benefits from outward FDI did not materialize. The purpose of the following sections is to summarize the empirical evidence on the effects of outward FDI on the investing firms.

Some general notes on the empirical literature can be put up front. First, the majority of empirical studies in the literature on the performance of firm internationalization relates to MNCs from developed countries (UNCTAD 2006). Unfortunately, firm-level empirical assessments of the effects of outward FDI of MNCs from developing countries are still rather scarce. Second, there are various empirical approaches to assess and measure the impact of outward FDI. For a long time, empirical evidence has been mainly confined to case studies. This was mostly attributed to data limitations. Although micro-level case studies include valuable information, they are related to particular firms and outward FDI

projects and thus hardly give a general direction. More recently, the development of broader databases has enabled researchers to conduct cross-section econometric testing and dynamic analyses with panel data to empirically measure the extent of knowledge spillovers. Firm- and industry level data has helped solidify the findings, even though firm and industry specific differences remain. In order to get a comprehensive picture, the review will be based on the broad range of empirical approaches available. Third and lastly, the measurement of knowledge flows and its impact on the firm is not easy. Especially tacit knowledge, which is not documented or cannot be codified, can hardly be tracked and measured. However, empirical studies have come up with various valuable approaches and proxies to measure the stock and flows of knowledge which will be summarized in the following review.

Overall, the academic literature has gathered evidence on two central impacts of outward FDI on the investing MNCs. First, the effect on the investing firms' knowledge base in terms of changes to knowledge inputs (e.g. R&D expenditure) and knowledge outputs (e.g. patents and patent citations or new products). And second, the effect on productivity. An in-depth discussion of empirical evidence is provided in the following. A summary of the empirical studies is provided in Table 1.

3.3.1. Impact on Knowledge Base

3.3.1.1. R&D Activity

One of the findings on the impact of outward FDI is that firms may increase their R&D activities following their investments abroad (Aw and Lee 2008, Dachs und Ebersberger 2013). Aw and Lee (2008) find that outward FDI positively impacts the **R&D intensity** of investing firms. In an empirical analysis of Taiwanese MNCs' outward FDI activities, they show that Taiwanese firms that undertake investments in the U.S. computer and telecommunication industry are more R&D intensive than their Taiwanese MNC counterparts which exclusively invest in China. The authors suggest that, due to the stiff competition of high quality products in the U.S. market, MNCs which invest in the United States have greater incentives to seek intangible assets created by R&D or the purchasing of foreign technologies. Similar evidence can be found in Dachs und Ebersberger (2013). Based on a large dataset of more than 3,000 firms from seven European countries, the authors show that firms that have relocated part of their production activities abroad invest on average more in R&D and product design than firms that did not offshore. A case-study based work by Pradhan and Singh (2008) reveals that outward FDI of Indian automobile

firms positively affects the firms' **in-house R&D activity**. The findings indicate that a firm's R&D intensity (measured as total R&D expenses as a percentage of sales) is positively and significantly related to the overseas presence irrespective of the development status. However, it is shown that knowledge flows from developed host regions are even greater than those from developing regions. Hence, Indian automotive firms that operate subsidiaries in developed host locations are likely to conduct more R&D than MNCs with subsidiaries in less developed country. The same results apply to when the impact of an increased outward FDI intensity (instead of nominal outward FDI data) on R&D intensity is tested. Therefore, it is not just the sheer presence abroad that encourages R&D intensity, but also the relative extent of their outward FDI engagement.

One has to keep in mind that R&D is an input to the development of a firm's knowledge base and does not automatically lead to a higher knowledge output, for example in form of new services or products. Another strung of literature has therefore analyzed the effects of overseas investment on the development of **new product introductions** (Jaklič and Svetličič 2003 for Slovenian MNCs, Poon et al. 2006 for Asian latecomer MNCs). However, as argued by Cheung and Lin (2004), the disadvantage of using new product sales as an indicator for increased innovation output is that the approach does not account for other innovations, such as process innovations which improve the production technology for existing products. Cheung and Lin (2004) conclude that the number of patent applications is a better measure as it includes both product and process innovations.

3.3.1.2. Patent Output

A popular approach to measure the effects of outward FDI on the investing MNC's knowledge base is to analyze the development of its patent output after the investment took place. For example, **Penner-Hahn and Shaver (2005**) compare the innovative activities of 65 Japanese firms in the pharmaceutical industry between 1980 and 1991 of which 36 undertook international R&D activities at some period during the sample frame. They find that firms with R&D outposts abroad have an overall higher patent output than firms that did not invest abroad. However, they find that the benefit from international R&D activities were only significant for those firms that possess already existing pharmaceutical research capabilities. Thus, the finding support the absorptive capacity concept addressed in Section 3.2.1. A study by **Criscuolo et al. (2010)** similarly analyzes the effects of outward FDI on patent output. Based on survey data of firms from the United Kingdom drawn from the EU-wide Community Innovations Survey, the authors find that globally

engaged firms do generate more innovation outputs in form of patents and self-reported innovations than firms which solely operate in their home markets. This is not only due to the increased assignments of researchers (labor mobility), but also the wider access to global knowledge sources such as vertical linkages (suppliers and customers) and universities. According to Criscuolo, the contribution of the different knowledge sources depends on the type of innovation. External information from universities is particularly crucial for patent development, while flows from vertical linkages are less important. The reverse is true for process and product innovations.

Based on patent output data it can furthermore be shown that foreign acquired knowledge is reversely transferred back to the home economy. Using patent output data[71], **Iwasa and Odagiri (2004)** investigate the contribution of home R&D and overseas R&D of Japanese MNCs in the United States and find evidence that locating research facilities in states with high technological strength positively contribute to both the innovative activity of the subsidiary in the United States and the parent firm back in Japan.

3.3.1.3. Patent Citations

Although an increase in patent output can be read as a sign that the host economy stimulates innovative activity of MNCs, it is per-se no indicator for knowledge spillovers from the host economy to the investing MNCs. A more precise approach to trace knowledge transfer is the analysis of **citations between patents**.[72] In most countries, patent applicants are bound by law to disclose the knowledge and hence patents on which their invention builds (see Branstetter 2006 on U.S. patents). Patent documents thus usually contain references to earlier patent documents as well as information on the originating firm, geographic location of the invention, and the technology of innovation (Almeida and Phene 2004). Such citations are a helpful measure to capture knowledge flows across organizations (Singh 2007). In the words of Jaffe et al. (1993, p.580): "a citation of Patent X by Patent Y means that X represents a piece of previously existing knowledge upon which Y builds". These citations "indicate a link between the technical ideas embodied in the current prior inventions" (Frost 2001, p.109). Thus, when a patent is cited in a patent application, it implies that "the knowledge embodied in the cited patent

[71] Iwasa and Odagiri (2004) measure the innovative activity with the number of patents granted by the USPTO.

[72] The use of patent citation as an indicator for general knowledge spillovers has been pioneered by the works of Jaffe et al. (1993). The authors use the patent citation approach to measure the extent to which knowledge spillovers are geographically localized within the United States.

has been useful in some way for developing the new knowledge described in the citing patent" (Criscuolo 2009, p.874). Patent citations by MNCs to original patents by host country firms can therefore be considered as a more precise indicator for knowledge spillovers from host country knowledge sources to MNCs than the mere patent application.[73]

Geographical proximity attained by outward FDI should facilitate the access to advanced foreign knowledge documented in patents. It can therefore be expected that the amount of citations of host country patents in the patent applications of the investing MNC is likely to be increased following the investment. This assumption has been confronted with empirical evidence. There are several empirical studies in the patent citation literature which focus on spillovers from the host economy to subsidiaries of MNCs. **Almeida (1996)** is one of the first to examine the knowledge spillovers following outward FDI by using patent citations. Analyzing (two-way) citations of patents granted by the U.S. Patent and Trademark Office (USPTO) to subsidiaries of foreign semiconductor MNCs in the United States, Almeida finds evidence that there is a higher probability that foreign subsidiaries cite patents which originated in the United States than originally expected. Thus, the knowledge which foreign subsidiaries use in their innovation activities in the United States is predominantly local. Moreover, the results show that foreign subsidiaries cite U.S. patents to a greater extent than comparable U.S. firms located in the same region.

Based on the works of Jaffe et al. (1993) and Almeida (1996), **Frost (2001)** not only analyzes geographic sources of a larger sample of foreign subsidiaries' patent citations granted by the USPTO in the United States. He also takes into account the conditions under which foreign subsidiaries are likely to draw upon host country knowledge. The findings indicate that both the technological characteristics of the subsidiary and the technological advantages of its home relative to the host economy in a specific field are crucial in determining the geographic sources of patent citations. In detail, Frost finds that innovative subsidiaries tend to draw more upon host country knowledge than less innovative subsidiaries, which are more likely to draw upon ideas and knowledge originating in their parent companies. Moreover, subsidiaries are more likely to draw upon foreign knowledge if the host economy has a technological advantage in a certain field.

[73] For an in-depth discussion on the strength and weaknesses of patents see Guellec and van Pottelsberghe de la Potterie (2001).

Table 1: Summary of empirical studies on the impact of outward FDI on investing firms' knowledge base

Authors	Sample	Period	Findings	Impact	Reverse knowledge channels (if specified)
R&D activity					
Aw and Lee (2008)	75% of all Taiwanese multinationals in the manufacturing sector	2000	Taiwanese firms with outward FDI in the United States are more R&D intensive than their Taiwanese MNC counterparts which exclusively invest in China.	+	Increased competition
Pradhan and Singh (2008)	Indian Tata Group, Amtek Group	n/s	Firms' R&D intensity is positively related to their overseas presence. Knowledge flows from developed host regions are greater than the ones from developing regions.	+	n/s
Dachs und Ebersberger (2013)	3,000 firms from seven European countries	2009	Firms that have relocated part of their production activities abroad invest on average more in R&D and product design than firms which did not offshore; production offshoring is also associated with a higher likelihood of product innovation.	+	n/s
Patent output					
Penner-Hahn and Shaver (2005)	65 Japanese firms in the pharmaceutical industry	1980-1991	Firms with R&D outposts abroad have an overall higher patent output than firms which did not invest abroad. Benefits from international R&D activities were only significant for those firms with already existing pharmaceutical research capabilities.	+	n/s
Criscuolo et al. (2010)	More than 8,000 firms from the United Kingdom	1994–1996 and 1998–2000	Globally engaged firms do generate more innovation outputs in form of patents and self-reported innovation than firms which solely operate in their home markets.	+	Labor mobility, vertical linkages
Iwasa and Odagiri (2004)	137 Japanese MNCs in the United States	1998-2002	Locating research facilities in the United States positively contribute to both the innovative activity of the subsidiary in the United States and the parent firm back in Japan.	+	n/s

Patent Citation					
Almeida (1996)	Subsidiaries of foreign semiconductor MNCs in the United States	1980-1990	There is a high probability that foreign subsidiaries cite patents which originated in the United States. Foreign subsidiaries cite U.S. patents even to a greater extent than comparable U.S. firms located in the same region.	+	n/s
Frost (2001)	Subsidiaries of MNCs in the United States	1980-1990	Innovative subsidiaries tend to draw more upon host country knowledge than less innovative subsidiaries, which are more likely to draw upon ideas and knowledge originating in their parent company. Moreover, subsidiaries are more likely to draw upon foreign knowledge if the host economy has a technological advantage in a certain field.	+	n/s
Almeida and Phene (2004)	Foreign subsidiaries of U.S. semiconductor firms	1981-1991	Subsidiary's linkages to host country knowledge sources have a positive impact on innovation. No evidence is found that the technological richness of the host economy is positively correlated to the patent output of subsidiaries.	+	n/s
Branstetter (2006)	189 Japanese MNCs with investments in the United States	1980-1997	Japanese investments in the United States serve as a channel for knowledge spillovers from U.S. firms to the investing Japanese MNCs and vice versa, with spillovers to Japanese firms being strongest for R&D and product development facilities.	+	n/s
Singh (2007)	Foreign MNCs and host country organizations in 30 countries	1986-1995	Knowledge outflows from the host economy organizations to MNCs are greater than vice versa.	+	Labor mobility

Almeida and Phene (2004) link patent output and citations by foreign subsidiaries of U.S. semiconductor firms. They show that although subsidiaries have on average more linkages to their MNC organization (measured by the amount of patent citation to the MNC patents) these ties are less likely to result in innovations in form of higher patent output. In contrast, although their linkages to the host economy are smaller in scale (measured by the amount of patent citation to host country patents), they provide better inputs to the innovation process. Almeida and Phene explain this finding as follows: Whereas the MNC only provides redundant knowledge to the subsidiaries, ties to the host economy may provide novel knowledge which is more crucial for new patent output. Surprisingly, the authors find no evidence that the technological richness of the host economy is positively correlated to the patent output of subsidiaries.

In his empirical work on Japanese outward FDI in the United States, **Branstetter (2006)** uses patent citation to measure the role of FDI in mediating knowledge flows between the two economies. Branstetter in particular focuses on the impact of Japanese investment on knowledge spillovers from U.S. firms to the investing Japanese firms.[74] Spillovers are measured by the increase in patents citations.[75] Branstetter finds evidence that Japanese investments in the United States serve as a channel for knowledge spillovers from U.S. firms to the investing Japanese MNCs and vice versa, with spillovers to Japanese firms being strongest for R&D and product development facilities. The results indicate that setting up an additional R&D lab in the United States leads to an increase of roughly 2% in annual spillover flows from U.S. firms to Japanese MNCs.

Singh (2007) uses patent citations in a set of advanced economies to measure bidirectional knowledge flows between MNCs subsidiaries and their host economies. The sample consists of 30 technologically advanced countries which in sum account for 99.5% of all patents filed with USPTO. Singh finds evidence for the existence of knowledge flows from MNCs to the host economy and vice versa. He also finds that knowledge outflows from the host economy organizations to MNCs are greater than knowledge inflows from the MNCs to the host economy. In Singh's (2007, p.765) words, "MNCs appear to contribute less to

[74] Branstetter (2006) links firm-level data of a set of Japanese MNCs' subsidiaries to data on the citation patterns contained in their U.S. patents in a panel data set. This approach allows for an examination of the impact of changes in the presence of Japanese subsidiaries in the United States on their patent citation patterns. Moreover, Branstetter controls for patent citations changes in the Japanese parent company.

[75] Branstetter (2006) distinguishes knowledge spillovers from the imitation or adoption of existing technologies. He argues that true knowledge spillovers generate further innovation as one innovator can enhance his own research productivity by learning from the research outcomes of others' research projects, but without compensating the other inventors for the value of this learning.

host country knowledge than they gain from it". Moreover, he finds that the more technologically developed the host economy, the greater the outflows.

There are also limitations to the use of patents citations to trace and measure reverse knowledge transfer. First, it is argued that the amount of patent citations fails to fully reflect the impact of host country knowledge on MNC performances as some of the inventions and knowledge spillovers are tacit rather than codified and can therefore not be patented or entirely captured by patent citation (Globerman et al. 2000, Griffith et al. 2006, Schmidt and Sofka 2009). Positive impacts on the investing MNCs which are derived, for example from imitation or reverse engineering, may not be captured by patent citations. Such spillovers of tacit knowledge are a frequent by-product of strategic asset-seeking FDI (Criscuolo 2009). However, following Almeida and Phene (2004), codified knowledge flows (in form of patents) and tacit knowledge flows are closely linked and complementary. This may again reduce estimation failures. A second drawback of using patent citations as a proxy for knowledge spillovers is that patenting is a strategic choice and firms may decide not to patent their innovation to prevent further spillovers (Almeida and Phene 2004).[76]

Given the limitations of patent data, a second approach to determine the impact of reverse knowledge transfer and spillovers on the investing firms is the use of productivity measures (Griffith et al. 2006). In fact, increased productivity may be considered as a logical consequence of increased innovative activity as more innovations usually feed into higher productivity (Criscuolo et al. 2010). In the following sections, a brief literature review is provided on the empirical findings in regards to outward FDI and productivity trends.

3.3.2. Impact on Productivity

Vahter and Masso (2007) identify three rationales why outward FDI may affect the productivity of the investing firms. First, outward FDI enables the exploitation of economies of scale at the firm-level. This applies in particular to horizontal/market-seeking FDI, which may significantly reduce fixed production costs and thereby increase economies of scale. Similarly, if R&D expenditures are considered as fixed costs, the returns on R&D expenditures can be increased as R&D output can be used as a joint input to the MNC's plants at home and in subsidiaries abroad (Criscuolo 2004). Second, firm-

[76] An extensive discussion of the advantages and disadvantages of patent citations as a mean to trace knowledge flows is provided by Globerman et al. (2000).

level productivity may be positively affected by the change in factor input composition in production following outward FDI (Vahter and Masso 2007). Vertical outward FDI (similarly efficiency-seeking FDI), for example, may increase the MNC's productivity through a significant cost reduction, as important stages of production can be internalized through the acquisition of key customers or suppliers, and the exploitation of host country comparative advantages, for example relative costs of factor endowments (Criscuolo 2004). Vertical investments are often associated with the relocation of low value-added and labor-intensive production steps to less developed countries. More recently, however, the foreign acquisition of scarce resources (resource-seeking FDI), with the aim to safeguard against price volatility and to secure a continuous supply of scarce raw materials, has gained importance (UNCTAD 2005).[77] Such investments may significantly reduce costs in the medium and long run. Third and finally, firm-level productivity may be increased if outward FDI opens new channels of international sourcing of technological and managerial knowledge through the conduits discussed in Chapter 3.1 (Vahter and Masso 2007). Advanced foreign knowledge such as new production techniques may increase production and process efficiency that could result in higher productivity. Such productivity effects could most probably occur with strategic asset-seeking FDI, but could also come as byproduct with other types of outward investment.

Academia has come up with several empirical approaches to capture and measure the productivity effects of outward FDI. A summary of the empirical evidence is provided in Table 2. The first branch of empirical literature has approached the topic by using econometric analyses, in which labor productivity or total factor productivity of the investing firm is regressed on a number of covariates that are assumed to have an effect on productivity, including the degree of internationalization. In many studies the empirical analysis is grounded on a modified form of the Cobb-Douglas production function, which is extended to comprise both a firm's domestic and foreign R&D stock. One of the earliest analyses in this field stems from **Mansfield and Romeo (1984)** who use data of 15 chemical and petroleum MNCs, which operated R&D laboratories abroad in the time period 1960-1976. Based on ordinary least square regressions, the findings reveal that the impact of foreign R&D activity on total factor productivity is not only positive, but also greater than that of domestic R&D. Similarly, based on firm-level panel data for domestic

[77] Natural resource-seeking FDI could in particular be observed for Chinese MNCs in recent years (Zhao et al. 2010). Partly driven by state incentives, Chinese firms try to secure their supply of raw materials which they rely on heavily in their ongoing industrialization.

and foreign-owned firms in France, **Blanchard et al. (2009)** find evidence that MNCs' affiliates in France in the intensive knowledge services improve their total factor productivity from the linkages with their domestic rivals. Yet, relative to French domestic firms they gain less from knowledge spillovers. **Falzoni and Grasseni (2005)** highlight the role of absorptive capacity and find evidence that the impact of outward FDI on the performance of Italian MNCs positively depends on their initial productivity and on the development level of the host economy. Based on quantile regressions, they show that Italian firms with an initial higher level of productivity tend to benefit from investments in developed countries in form of higher total factor and labor productivity. However, investments in less developed countries do not benefit the MNCs regardless of their initial productivity. Similarly, based on firm- and industry-level survey data for Swedish MNCs, **Braconier et al. (2001)** find no evidence for outward FDI-driven spillovers affecting labor productivity in Swedish MNCs. The authors argue that the lack of evidence may be explained by the fact that such spillovers are less enjoyed by technological leader firms with high R&D expenditures such as Swedish MNCs, but rather by laggard firms with catch-up potential. **Todo and Shimizutani (2008)** refine the analysis and take into account the diverging investment motives and its different effects on productivity outcomes. Based on firm-level data for Japanese MNCs in manufacturing industries, the authors show that overseas innovative R&D activities, aiming at the utilization and acquisition of foreign knowledge (basic research, applied research, and development for the world market), increase the parent firms' productivity growth, while adaptive overseas R&D, aiming at the adaption of products and technologies to local conditions in foreign locations (development for the domestic market and design), does not. The authors conclude that the findings support their assumption that innovative overseas R&D activities in high technology industries contribute to productivity growth of parent firms due to reverse technology transfer.

It should be considered, that the majority of the empirical analyses presented in the last section bear a risk of selection bias and endogeneity. Since investing abroad involves high initial fixed costs, it is reasonable to assume that only those firms which (ex-ante) already operate on a higher productivity level per se are able to invest abroad, i.e., that more productive firms self-select into becoming MNCs (Barba Navaretti and Castellani 2003).[78]

[78] Based on the predictions of the model of Helpman et al. (2004), it can be assumed that least productive firms will sell their products only to the domestic market, relatively more productive firms will export and most productive firms will be able to invest abroad. Empirical evidence by Aw and Lee (2008) supports these assumptions. Based on firm level data of Taiwanese electronics firms, they show that the least productive

Now, when analyzing the impact of outward FDI on a firm's productivity path, one has to control for the fact that the creation of a new subsidiary is endogenous, i.e., "depends on the productivity trajectory itself" (Castellani 2002, p.362). It may not become clear whether MNCs perform better than other firms in their home economy because they invested abroad or because they would have performed better anyway (Barba Navaretti and Castellani 2003). As argued in Obashi et al. (2009), it might be difficult to distinguish the differences in performances due to outward FDI from other diverse characteristics of MNCs and non-multinational firms which may also influence productivity. Given that causality may run in both directions, empirical results could be misinterpreted as positive productivity gains may be caused by the fact that MNCs tend to operate with higher productivity per se rather than by genuine productivity spillovers.

A second branch of literature has therefore come up with the approach to compare the ex-post productivity of investing MNCs with that of non-investing, non-multinational firms with similar (ex-ante) characteristics (matching techniques). To demonstrate the differences in productivity trajectories of MNCs and domestic, non-multinational firms a similar productivity growth path scenario is assumed as suggested in Barba Navaretti and Castellani (2003). In this scenario, there are two types of firms in the home economy: domestic, non-multinational firms, that do not operate a foreign subsidiary in the period observed, and domestic firms, that switch from being national into being multinational (MNCs). As can be seen in Figure 8, it is assumed that firms that transform into a MNC follow a higher productivity path than domestic, non-multinational firms per se. Thus, MNCs are expected to be ex-ante different from the domestic, non-multinational firms since they need to possess some intangible assets, giving them the competitive edge over national firms to overcome the disadvantages of investing abroad (Barba Navaretti and Castellani 2003). It is expected that after the outward investment has taken place, the productivity path of the MNC becomes even steeper, as their productivity improves as a result of investing abroad. If the MNC had not internationalized, the hypothetical productivity path would lie below the MNCs path (dotted line in Figure 8).

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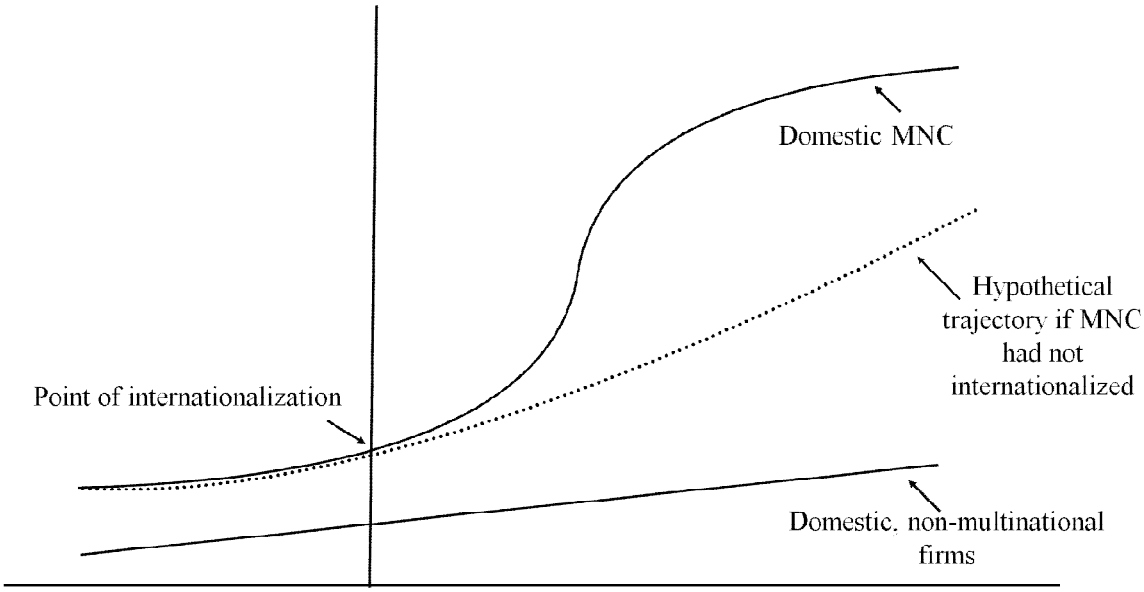
firms stay at home and export to foreign markets instead, while the most productive firms undertake investments abroad. According to Aw and Lee (2008), the choice of production site reflects the underlying pattern of firm productivity and not the other way around. Similar evidence is found in Vahter and Masso (2007) for Estonian firms. They support the assumption that firms with higher productivity naturally "self-select" themselves to engage in outward FDI.

In a further step, it could be now hypothesized, that the knowledge which MNCs acquire abroad spills over to domestic, non-multinational firms in the home economy and the productivity level changes in turn as well. This case will be addressed in Chapter 4.

Figure 8: Productivity trajectories I



Remarks: Own illustration based on Barba Navaretti and Castellani (2003).

The theoretical assumptions of the illustration above are supported by the empirical findings of **Barba Navaretti and Castellani (2003)**. They examine the effects of outward FDI on the home activities of firms by developing a counterfactual sample of Italian firms between 1993 and 1998. The authors match and compare the performance of firms that established their first foreign subsidiary in the period analyzed, with the performance of firms with similar characteristics that had not invested abroad during the same period (control group). Their performance is expected to mirror the dotted line in Figure 8. Productivity performance is proxied by total factor productivity, employment and output growth. The authors find that the rate of total factor productivity and output growth is ex-ante significantly higher for investing firms and it accelerates after the investment has taken place. Placed in the model context this means that MNCs operate on a higher productivity level than domestic non-multinational firms ex-ante and their productivity path becomes even steeper in the period observed after the internationalization.

The empirical findings by Barba Navaretti and Castellani (2003) are supported by several other studies. **Barba Navaretti and Venables (2004)** follow their methodological

approach and apply it on a larger sample of Italian firms in the Italian economy between 1993 and 1998. They distinguish different types of firms to separate the effects of self-selection from causality. They find that Italian MNCs are on average 17% more productive than Italian firms that do not operate subsidiaries abroad. Furthermore, firms that invest abroad for the first time yield higher total factor productivity than firms that remain at home, even before the investment has taken place. Their performance further improves in the aftermath of the outward investment. In a similar approach, **Griffith et al. (2006**) explicitly analyze the productivity spillovers from technology-sourcing FDI of MNCs from the United Kingdom in the United States. Based on firm-level panel data they find that the increase in the U.S. R&D stock in manufacturing in the 1990s was associated with a 5% higher level of total factor productivity for British firms in 2000. Their estimates show that British firms locating part of their R&D activity in the United States enjoy substantially higher spillover effects than firms which only perform R&D in the United Kingdom. This evidence indicates that the productivity increases are significantly larger for British MNCs with a strong presence in the United States. Likewise, an empirical analysis by **Copenhagen Economics (2007)** on the home country effects of Irish outward FDI shows that Irish firms that are engaged in outward FDI activity are up to 50% more productive than Irish firms without investments abroad.

Finally, one could expect that the extent of productivity effects of outward FDI will depend on the degree of host country technological development. **Castellani (2002)** finds empirical evidence for this by showing that productivity outcomes vary with the host country stage of development. He distinguishes between Italian investments in the United States and in other economies of the European Union assuming that the United States operate on a higher technological level than Italy. Based on firm-level data of 2,185 Italian manufacturing firms from 1992 to 1996, he finds that the positive impact of outward FDI on firm productivity trajectory is greater when subsidiaries are established in the United States. Castellani claims that the results substantiate the assumption that the potential for knowledge spillovers and reverse technology transfer increases, the more technologically advanced the host economy and the higher its consumer and organizational standards.

Overall, the findings support the view that outward FDI increases the productivity of firms. Moreover, the empirical evidence seems to support the notion that the host country knowledge level is a decisive factor leading to positive returns on outward investment. Accordingly, outward investments in more (technologically) developed countries are likelier to have a positive impact on the investing firm’s productivity.

Table 2: Summary of empirical studies on the impact of outward FDI on investing firms' productivity

Authors	Sample	Period	Findings	Impact	Reverse knowledge channels (if specified)
Regression analysis					
Mansfield and Romeo (1984)	15 U.S. MNCs in the chemical and petroleum industry	1960-1976	Impact of foreign R&D activity on total factor productivity is not only positive, but also greater than that of domestic R&D.	+	n/s
Blanchard et al. (2009)	90,614 domestic and foreign-owned firms in France belonging to 33 manufacturing and service sectors	1990-2003	Foreign subsidiaries in the French medium and high technology manufacturing sector increase their total factor productivity due to horizontal spillovers from their domestic rivals. However, relative to French domestic firms they gain less from knowledge spillovers.	+	n/s
Falzoni and Grasseni (2005)	Italian MNCs	1994-1998	Impact of international expansion on parents' performance depends on affiliates' geographical locations: Firms do not benefit from FDI in less developed countries, but seem to be positively affected by foreign expansion in developed countries.	+/-	n/s
Braconier et al. (2001)	84 Swedish MNCs	1978, 1986, 1990 and 1994	Outward FDI with no effect on labor productivity, whereas own R&D spending and capital-labor ratio has.	-	n/s
Todo and Shimizutani (2008)	Japanese MNCs	1996-2002	Overseas innovative R&D activities increase the parent firms' productivity growth, adaptive overseas R&D not.	+/-	n/s
Comparison approach					
Barba Navaretti and Castellani (2003)	212 Italian firms	1993-1998	Rate of total factor productivity and output growth is significantly higher for investing firms ex-ante and it accelerates after the foreign investment has taken place. Employment growth is not affected by outward FDI.	+	n/s

Barba Navaretti and Venables (2004)	1,587 Italian firms	1993-1998	Italian MNCs are on average 17% more productive than Italian firms without subsidiaries abroad. Firms that invest abroad for the first time perform better than firms which remain national, even before the investment, but their performance becomes even better in the aftermath of the investment.	+	n/s
Griffith et al. (2006)	188 manufacturing firms listed on the London Stock Exchange	1990-2000	Firms with a stronger inventor presence in the United States benefit disproportionately from U.S. R&D spillovers. Overall, there appears to be strong evidence that the productivity growth of UK firms is significantly higher if they had an inventive presence in the United States prior to 1990 and operate in an industry with strong U.S. R&D growth.	+	n/s
Copenhagen Economics (2007)	20,000 multinational and non-multinational Irish firms	2004-2005	Firms involved in outward FDI improved labor productivity more than non-investing firms.	+	n/s
Castellani (2002)	2,185 Italian manufacturing firms	1992-1996	Outward FDI has a positive effect on the investing firm's total factor productivity. In particular firms, which invest in countries where knowledge spillovers are expected to be relatively higher, profit from outward FDI.	+	n/s

3.3.3. Additional Impacts

Many other approaches and indicators have been proposed to measure the impact of outward FDI on the investing firm. To round up the review, the most important discussions will be reviewed in the following section.

There has been a widespread concern that outward FDI reduces **employment** in the home country units of MNCs, in particular if labor intensive parts of the production process are relocated to countries with lower labor costs. Many studies have therefore analyzed the impact of overseas investment on the employment situation in the home country parent unit. To a large extent, the empirical findings oppose the assumption that outward FDI reduces employment at home; neither as a result of investments in developed nor developing countries (see e.g. Bara Navaretti and Castellani (2003) and Castellani et al. (2008) for Italian firms, Hijzen et al. (2011) for French MNCs, Lipsey et al. (2000) for Japanese firms and Liu and Nunnenkamp (2011) for Taiwanese firms). Copenhagen Economics (2007) even finds evidence that Irish firms with outward engagement generate more employment in comparison to firms which have not invested abroad. Similar results are found by Lipsey et al. (2000) for employment in Japanese MNCs.

Several other studies have investigated the impact of outward FDI on the investing firms' **skill intensity**, i.e., the ratio of skilled to unskilled workers. If production facilities are shifted to countries with lower labor costs, the demand for low value-added jobs is expected to decrease in the home economy. In turn, MNCs are likely to create more high value-adding jobs. If the home country has a sufficient level of human capital, this should trigger a skill upgrading in the MNC labor force and raise the average skill level of the domestic units. This again is likely to result in higher labor productivity. Measurements with regards to the impact of outward FDI on Irish MNCs' skill composition conducted by Copenhagen Economics (2007) shows a strongly positive relationship between outward FDI of manufacturing MNCs and their share of high skilled employees in their home country operations in contrast to Irish firms, which did not invest abroad. Similar evidence on an increase of the average value-added per employee in Slovenian MNCs is found in Jaklič and Svetličič (2003). Head and Ries (2002) find that the upgrade of home country skill intensity depends on the income level of the host countries. Whereas investment in low-income economies increases skill intensity at home, the positive effect decreases the higher the income level of the host economies.

Several studies address the influence of outward FDI on **production output**. Drawing on firm-specific data from a survey on Taiwanese manufacturing firms, Liu and Nunnenkamp (2011) reveal that Taiwanese outward FDI in advanced host economies, which is supposed to be at least partly motivated by the access to host country knowledge, has a positive impact on home country production output of the investing firms. Similar evidence of home country production increases of Slovenian MNCs is found in Jaklič and Svetličič (2003).

3.4. Summary

By reviewing the existing academic literature on outward FDI based knowledge transfer and spillovers to the investing company the previous section has documented the theoretical and empirical contributions that have investigated the related channels, determinants and effects of FDI-driven reverse knowledge transfer. The review does not provide a conclusive and general proposition on how outward FDI investment impacts the investing firms. It rather gives a good indication of the growing importance of reverse knowledge transfer and its effects on MNCs as well as valuable insights on potential transfer mechanisms and determinants.

To sum up, some interesting findings should be highlighted: The literature overview has shown that there exist several important channels for reverse knowledge transfer from the host country to the investing MNC and within the MNC organization. First, MNCs are able to expand their knowledge base by imitating products and processes which are demonstrated by advanced firms or other knowledge sources in the host economy. Second, MNCs can acquire advanced foreign knowledge by hiring experienced employees who were previously trained or had worked for advanced host country firms or institutions. Correspondingly, intra-firm job rotation has been identified as an important channel for knowledge diffusion back to the parent unit in the home economy. Third and lastly, vertical and external network linkage to other knowledge sources in the host economy (for example suppliers, customers or academia) is a prominent way to tap advanced foreign knowledge. Such linkages may help MNCs to improve quality and standards and enhance products and processes.

With regards to the effects of outward FDI, both the impact on the MNCs' subsidiaries and the parent unit back in the home economy have been summarized. The review of the empirical literature hints that the findings on the impacts of outward FDI are far from

homogenous due to different samples and data sources as well as methodologies and empirical approaches. The generalizations that were made may therefore not apply to every country, industry or firm. Nevertheless, the majority of studies concur in certain aspects and hence some general conclusions can be drawn from the review. First, the overall findings provide considerable support to the hypothesis, that outward FDI has a positive impact on the knowledge base and productivity path of the investing firm. In cases where the MNC's subsidiary is able to absorb advanced host country knowledge and diffuse it within the entire MNC organizations, productivity and innovativeness is likely to be increased significantly. Secondly, spillovers are most likely to depend on the MNCs' absorptive capacity and the ability of the MNC to actively acquire and make use of the foreign knowledge. Thirdly, host country characteristics seem to play a crucial role as well: The more developed, i.e., the more knowledge intensive and technologically advanced the host country, the higher the potential for spillovers. However, empirical findings indicate that a knowledge gap that is too large might impede knowledge transfer. Thus, locating subsidiaries at the "right place" is crucial for successful sourcing. Fourthly, the more ties subsidiaries have established in their host economy (the larger its host country embeddedness), the greater the potential for knowledge spillovers. Fifthly, the mandate of subsidiary within the overall organization plays a crucial role when it comes to the ability of the subsidiary to source and tap knowledge in the home economy. It is straightforward, that subsidiaries that have a clear mission to source knowledge in the host economies are most likely to push the reverse knowledge transfer process. Lastly, it has been shown that knowledge spillovers depend heavily on the type of knowledge. Tacit knowledge is difficult to transfer, even within organization, and consequently needs special transfer channels such as labor mobility.

So far, the discussions have focused on the micro level and have exclusively addressed the effects of outward FDI and reverse knowledge transfer on the investing firm itself. In the next chapter, the analysis will go beyond the investing MNCs by taking on a more macro-level view on the topic of outward FDI-driven reverse knowledge transfer. The theoretical and empirical contributions that have analyzed potential spillover channels to the MNCs' home country as well as its determinants shall be reviewed and it shall be discussed which possible impacts on the overall home economy can ultimately be expected from outward FDI.

4. INDIRECT OUTWARD FDI EFFECTS ON THE HOME ECONOMY: THEORY AND EMPIRICAL EVIDENCE

As discussed in the previous chapter, outward FDI affects the investing MNCs directly at various levels and through different channels. More indirectly, however, outward FDI should ultimately have an impact on the MNCs' home economies. In the past, outward FDI has often triggered fears of hollowing out home country employment, investment or leading to technology leakage. Newer research, though, points to the positive effects of outward FDI for the home economy, in particular with regards to reverse knowledge transfer and the generation of externalities to other home country firms (Braconier et al. 2001, Globerman et al. 2000, Herzer 2010). As argued by Braconier et al. (2001), the effects of outward FDI are likely to be even larger for the MNCs' home economies than for the MNC itself – provided that the MNCs interact with other agents in their home economies.

The following sections provide a discussion of the potential casual linkages that run from outward FDI to its home economy. All of the channels that will be discussed are related to phase III of the reverse knowledge transfer framework presented in Chapter 2. Closely along the lines of Chapter 3, the main questions addressed in the following are: How and under which conditions does knowledge move from the MNC to its home economy? The Section 4.1 discusses the different channels of reverse knowledge transfer to the MNCs' home economies. In Section 4.2, a closer look is given at the conditions under which reverse knowledge transfer and spillovers occur. Section 4.3 briefly discusses the competition effects of outward FDI and Section 4.4 will shed light on the empirical evidence on the various home country effects of outward FDI. The final Section 4.5 provides a short summary of the main findings.

4.1. Reverse Knowledge Transfer Channels in the Home Economy

Spillover channels have been barely studied in the context of the home country effects of outward FDI. However, it is reasonable to assume that the linkages between MNCs and domestic firms and other agents in their home economies are similar to the ones addressed in the last chapter. Now it is assumed that MNCs, which in Chapter 3 were knowledge receivers in the host economy, become the source of knowledge for other economic agents in their home economies. For developing country MNCs this means that whereas they

might have been technological followers in the host economy, they may now belong to the technologically more advanced firms in their home economies. The following sections will screen the reverse knowledge channels between MNCs and firms[79] and national research institutions in their home economies.

4.1.1. Demonstration Effects

Domestic firms in the home country may benefit from demonstration effects if a MNC acquires advanced knowledge abroad, transfers it back to its headquarters and applies the new products or techniques in its production at home. Demonstration effects in the home economy enable domestic, technologically less advanced firms to adopt and imitate the new products or processes. The introduction of new technologies and procedures by the MNCs in its home market may similarly encourage other home country firms to adopt them, given that the cost in acquiring basic knowledge and the uncertainty about their success has already been reduced significantly.

Given that the demonstration effect is a frequently discussed knowledge transfer channel, it comes as a surprise that barely any empirical evidence can be found in the academic literature, even in the inward FDI related literature (see Section 3.1.1 for a discussion). Blomström and Kokko (1998) assume that one explanation for the lack of empirical evidence is that knowledge diffusion via demonstration effects often occurs unconsciously as firms usually do not document how and where they have first learnt about a new technology or product and how they have subsequently adopted it. Another reason for the weak empirical evidence is seen in the difficulty to disentangle the demonstration effect from the impact of an increased competition on imitation and adoption of new knowledge. From the inward FDI literature (Blomström et al. 1999, Jenkins 1990, Wang and Blomström 1992) it is known that, if technologically advanced MNCs and technologically less advanced local firms produce similar products, on a similar scale, for the same market, the increased competitiveness causes the local, technologically less advanced firms to adopt and imitate the advanced production techniques of the MNCs to ensure their survival. Accordingly, the competition effect will probably also force home country firms to improve their own performance and to use existing technology more efficiently to be able to compete successfully with more productive home country MNCs and guarantee their survival in the market (Blomström and Kokko 1998). The closer the firms' products

[79] Home country firms may comprise non-multinational, domestic firms, as well as other domestic MNCs or MNCs from third countries.

and market orientation, the greater is the need to close potential technological gaps (Jenkins 1990). And the easiest way to adopt the technologies and processes is to imitate what is demonstrated by advanced competitors. Accordingly, spillovers via the demonstration effects could also be a consequence of the increased competitive pressure from more advanced market player (Jenkins 1990). Moreover, the interaction of home country MNCs and domestic firms could result in a virtuous circle as demonstration effects could be reinforced by the increased competition.[80] Given that MNCs want to maintain their technological superiority at home, they might increase their knowledge-sourcing activities by investing abroad. This again increases the potential for demonstration spillovers and offers a further incentive for home country firms to assimilate their products and processes.[81] The competition effect of outward FDI will be addressed in more detail in Section 4.3.

4.1.2. Labor Mobility

A further channel of reverse knowledge diffusion from the MNCs to its home economy is the mobility of labor. As discussed in Section 3.1.2.2, returning employees, who were employed in subsidiaries abroad, may contribute to the knowledge creation and innovation of their parent MNCs. Given that one could expect that labor mobility does not stop with the organizational boundaries of the MNCs but continues in the home economy, labor mobility in the home economy should also add to the knowledge stock outside the MNC in the home economy. The underlying assumption is that MNCs' employees, who have acquired advanced foreign knowledge during assignments abroad, may be hired by domestic firms, some of which may not have had international business experience before. Returning employees may also set up their own businesses after their return, bringing with them all or at least part of the knowledge that they have accumulated abroad. Relevant information can include new technologies and products, production processes, or managerial techniques. Returnees may also bring important tacit skills or external networks which facilitate the continuation of knowledge exchange. Thus, domestic firms not only

[80] These ideas are drawn from the discussion on inward FDI triggered virtuous cycles in the host economies which are discussed in Criscuolo (2004).

[81] In the inward FDI literature this argument is discussed controversially. In a game theoretical model, Wang and Blomström (1992) argue that spillovers lead to higher technology transfers since the MNC wants to sustain its technological advantages and thus imports more modern technologies. Kaufmann (1997) challenges this assumption and claims that since MNCs will have an interest to prevent spillovers to competitors they might undertake active efforts to limit technology transfer, for example by exporting less knowledge to the host economy. Such a strategy would then alter the virtuous circle.

can profit from product or process related information, but also from the employee's country-specific knowledge which can be used to open up new export markets.

The impact of labor mobility on the home economy is difficult to measure and to evaluate. Here, a precise measurement would require tracking the careers of employees to investigate their productivity development and their impact on home country firms, which at best should not have any other linkages to the world economy and its advanced knowledge base. This has made data collection very elaborate. Therefore, it comes as no surprise that there is a definite lack of valuable empirical analyses of labor mobility as a channel of reverse technology transfer. Blomström and Kokko (1998) argue that the empirical evidence on spillovers from labor mobility is too limited to draw general conclusions. Therefore, the topic may be empirically assessed by drawing from empirical evidence on labor mobility spillovers from the general literature on "reverse brain drain". With regards to developing countries, studies on reverse brain drain have shown that returning human capital from developed countries represents a source of advanced knowledge and offers a short cut for developing countries to acquire state-of-the-art knowledge and develop subsequent knowledge-building capabilities in the process of technological catch-up (Dai and Liu 2009, Filatotchev et al. 2011). Based on surveys, Filatotchev et al. (2011) provide evidence that the reverse flows of highly skilled Chinese labor provide a substantially important channel of knowledge transfer for the Chinese economy. According to the authors, Chinese returnee entrepreneurs, who gained business experience or education in OECD countries, not only are more innovative than their local counterparts, but also have an indirect impact on the performance of non-returnee firms.[82] Similarly, Dai and Liu (2009) empirically test whether returnee entrepreneurs (scientists and engineers) are able to develop competitive advantages by applying their intangible assets which they acquired abroad. Using an extensive dataset of Chinese small and medium enterprises, the authors show that this expertise significantly increases their firms' performances. Returnees not only profit from the physical capital (e.g. patents) they transfer back to the home economy, but also from social capital. For example their international business network, which they have established abroad, gives them the opportunity to acquire information or access critical resources such as new technologies once they are back in their home economies. Dai and Liu (2009) conclude that local entrepreneur-owned firms can profit from returnee-entrepreneurs firms through the

[82] Note that Filatotchev et al. (2011) do not distinguish whether the returnees used to work for a Chinese MNCs' subsidiaries or in host country academia or firms.

establishment of close business linkages. This way advanced foreign knowledge may also spill over to domestic firms without international linkages.

Scattered empirical evidence on the effects of labor movement from MNCs on local firms' productivity can also be drawn from the literature on inward FDI. Here, single country studies show that MNC managers are frequently hired away by local firms in less developed countries to profit from their advanced knowledge. For example, Song et al. (2001) provide evidence that almost 50% of all engineers previously employed by MNC left to join local Taiwanese firms in the mid 1980s. Unfortunately, the authors do not control for performance changes in Taiwanese firms following the recruitments of MNCs trained employees. Analyzing labor movements between MNCs and non-multinational firms in Norway, Balsvik (2011) reports that 28% of the employees of non-multinational Norwegian firms had previous experience in MNCs (foreign and domestically owned) in 2000. She shows that the productivity of non-multinational firms is positively correlated with their share of MNCs-experienced workers. Their contribution to firm productivity is 20% higher than the input of workers without MNC experience.

The question that ultimately arises in this context is how domestic, non-multinational firms can win over employees from MNCs? Balsvik (2011) finds that Norwegian non-multinational firms primarily entice MNCs' employees away with monetary incentives such as higher wages. Similarly, in a study on Kenya, Gershenberg (1987) records that the willingness of Kenyan MNCs' managers to move to competing local Kenyan firms depends on the relative wages level. Although the study fails to determine the effects of labor turnover on Kenyan firms, it indicates that one of the decisive factors for inter-firm labor mobility is that domestic firms have to at least provide an adequate wage premium to give MNCs' employees a monetary incentive to switch employers. The extra wage award paid by domestic firms provides clear evidence that non-multinational firms value the embodied knowledge of the MNCs-experienced employees. This argument is theoretically advanced in Fosfuri et al. (2011) who assume that the mobility of trained workers from MNCs to domestic firms depends on the value domestic firms attach to their additional knowledge compared to other workers. A reason for a low appraisal might be the lack of domestic firms' complementary assets to make use of this knowledge. Low monetary incentives would therefore lead to less labor mobility and knowledge diffusion.

Labor mobility is of particular importance for the transfer of tacit knowledge to the home economy which is often (only) embodied in organizational members (Almeida and Kogut

1999, Song et al. 2003). Since MNCs are often reluctant to share their tacit knowledge with competitors in their home economy, domestic firms may gain access by hiring experienced employees who have worked on relevant topics in MNCs and therefore carry "hands-on" experience. Moreover, spillovers may be very industry-specific. Görg and Strobl (2005) find that Ghanaian firms which are run by entrepreneurs (owner or chairman) with previous work and training experience in MNCs in the same industry have a productivity advantage compared to other firms pointing to positive spillovers through labor mobility. However, no significant evidence on firm performance is found when the entrepreneurs worked for MNCs in other industries. This indicates that some of the knowledge which employees acquire on foreign assignments are industry specific and can therefore not be transferred to firms in other industries (Görg and Strobl 2005). Consequently, if the local hiring firm is not a direct competitor, the knowledge embodied in employees needs to be broad enough to be utilizable for local firms. Otherwise, the knowledge will be too specific and restricted to the use of MNCs. Thus, the less specific and the more general the employees' knowledge acquired while working for the MNCs, the higher the potential for spillovers due to labor mobility. It this case, it can be assumed that inter-industry spillovers are more likely to occur with regards to the spread of management skills since they are less firm-specific than technical skills and can therefore be used in other contexts and outside a particular sector or industry. In particular in developing countries, the lack of modern managerial skills and ample training programs for managers could increase the potential for managerial knowledge spillovers from MNCs.

Finally, it is important to point to potential negative impacts arising from labor mobility, namely the danger of "brain-drain" or a labor-related "crowding-out" effect in the home economy.[83] Home country MNCs may entice highly skilled employees away from domestic firms by providing higher wages. Given the small pool of highly qualified personnel especially in less developed countries, this may have negative effects on domestic (non-multinational) firms. However, to the knowledge of the author, there is to date no empirical evidence on such effects.

4.1.3. Vertical Spillover Channels

Knowledge spillovers from the MNCs to its home economy may furthermore occur through vertical channels, i.e., backward linkages (from MNCs to home country suppliers) and forward linkages (from MNCs to home country customers).

[83] See Beine et al. (2001) for an in-depth discussion on the effects of brain-drain.

4.1.3.1. Backward Linkages

Along with the findings in Section 3.1.3.1, it can be assumed that the home economy benefits from the international activities of its MNCs via backward knowledge transfer. Backward linkages of MNCs may benefit the home economy in several ways.

First, MNCs may increase the product quality and efficiency of its home country suppliers. Having to meet international product and quality standards, MNCs may impose higher requirements for product quality and on-time delivery to its home country suppliers in the course of its internationalization process (Humphrey and Schmitz 2002, Criscuolo 2004). If MNCs are willing to provide assistance to upgrade their production management or technology, home country suppliers may be able to learn about more advanced production and management techniques. They may receive support for the improvement of product quality or the introduction of innovations, e.g. through labor training (Lall 1980). Domestic suppliers may even receive organizational and management training. Furthermore, MNCs may provide assistance for the establishment of productive infrastructure as well as help for the sourcing of scarce raw materials (Crespo and Fontoura 2007).

Second, the competition among domestic firms to stay or become a supplier of the MNCs may furthermore increase their efficiency, e.g. if they are urged to use their resources more efficiently or to adopt new technologies or production processes (Crespo and Fontoura 2007, Herzer 2009).

Third, the business linkages to export oriented MNCs may provide home country suppliers with information about foreign market conditions, e.g. with regards to consumers' taste, design, packaging, product quality requirements and regulatory environment (Blomström and Kokko 1998). The knowledge may help suppliers to establish own direct exports to foreign markets. This is what Blomström and Kokko (1998) refer to as market access spillovers.

Fourth, by increasing efficiency and product quality of its home country suppliers, MNCs may extend the benefit to other downstream domestic producers, who produce end-user consumer goods, as cheaper and technologically more advanced intermediate inputs become available (Blalock and Gertler 2008, Kugler 2006). Based on a panel dataset on local- and foreign-owned Indonesian manufactures, Blalock and Gertler (2008) support this assumption by measuring significantly positive productivity increases due to knowledge spillovers not only of Indonesian supplier firms, but also for their downstream customers. Similarly, Kugler (2006) argues that the aggregate impact goes beyond the

vertical spillovers typically identified in the literature. The author suggests that there will also be indirect effects to other domestic producers utilizing the intermediate inputs produced by the contracted upstream suppliers/input providers. In an empirical analysis on the Colombian manufacturing sector, he finds evidence that the local outsourcing of MNCs subsidiaries gives rise to widespread FDI spillovers to downstream producers, however, only between and not within industries.

Fifth, a last benefit for home country suppliers should be mentioned, which, although it does not involve knowledge transfer is worthwhile to add. Home country suppliers may profit from economies of scale if MNCs increase their demand for intermediate inputs produced in the home economy following their investments abroad (Blomström and Kokko 1998). Of course, the assumption only holds as long as MNCs do not crowd out domestic competitors (in which case total demand for intermediates might even decrease) and do not divert demand away from domestic to imported inputs by sourcing their suppliers in their subsidiaries' host economies. Moreover, home country suppliers only profit if the MNCs do not undo and internalize any cost reductions of the supplier firms by negotiating lower prices (Blomström and Kokko 1998).

4.1.3.2. Forward Linkages

Acquired foreign knowledge may diffuse to the wider home economy, if the MNC is a supplier of intermediate goods in its home economy and sells its advanced intermediate goods to domestic downstream firms. The impact on the downstream firms could be manifold. First, domestic final goods can profit from the advanced technologies and higher quality the products entails (Markusen and Venables 1999). They may become more productive as a result of gaining access to new, improved, or less costly intermediate inputs produced by MNCs in the upstream sector (Javorcik 2004). Second, the purchase of MNCs' intermediate goods may be "accompanied by provision of complementary services that may not be available in connection with imports" (Javorcik 2004, p.608). However, it should be considered that the upgrade of product quality may come along with price increases. Domestic firms may then suffer from increased costs (Crespo and Fontoura 2007). To the knowledge of the author, there is no work to date which empirically studies the forward channel of reverse knowledge flows from the MNCs to its home country customers.

Overall, MNCs suppliers may increase the home country pool of knowledge by providing new intermediate goods which were previously not available in its home economy. This

will be one of the essential assumptions of the endogenous growth model which will be presented in Chapter 5.

4.1.4. External Network Linkages

External network linkages of MNCs in their home economy are another important channel to transfer the acquired foreign knowledge outside the MNCs organizational boundaries. The national innovation system in general (see Section 2.1.1) and academia in particular are valuable platforms to diffuse the acquired knowledge outside the MNC organization. Such systems may help to advance and translate the knowledge acquired abroad into commercial innovations (Mowery and Oxley 1995). As already discussed in Section 3.1.4, the close and frequent interaction between (public and private) research institutes and MNCs, for example in form of joint R&D projects, may significantly facilitate knowledge transfer. If MNCs frequently share the advanced knowledge they gained in advanced host economies, the new insights can spread to the wider economy. To do so, MNCs obviously need incentives to divulge this knowledge to research (government subsidies, R&D collaborations or the like).

Some developing countries already actively foster the joint research of academia and business. The Chinese government, for instance, has launched a series of innovation policies to enhance an enterprise-centered national innovation system with the objective to transform China into an innovation-driven nation by 2020 (UNESCO 2010). In this context, the Chinese government is giving high priority to cooperation among industries, universities and research institutes in assimilating imported advanced technologies and innovation (UNESCO 2010). Chinese policymakers are in particular encouraging Chinese firms to set endogenous technology standards in collaboration with universities and research institutes. Furthermore, national platforms (technology development centers and national engineering laboratories) for joint R&D between firms and academia have been established to foster knowledge exchange (UNESCO 2010). This is in particular promoted in key R&D fields and frontier technology such as nano-research or quantum manipulation (UNESCO 2010).

4.2. Determinants of Home Country Knowledge Spillovers

Spillovers and reverse knowledge transfer to the MNCs' home economy are not an automatic consequence of outward FDI. The presence of home grown MNCs may increase

the set of available knowledge to domestic firms, but does not guarantee the actual absorption and adoption of the advanced knowledge. Thus, while it seems natural to argue that outward FDI may affect the home economy through the channels discussed above, reverse knowledge transfer and spillover effects may be subject to certain conditions. The most important ones are discussed in the following chapters.

4.2.1. National Absorptive Capacity

Studies on international knowledge transfer have revealed that an important conditioner of the magnitude of spillovers can be found in the capability of home economies to absorb foreign knowledge (Dahlman and Nelson 1995, Kaufmann 1997, Keller 1996). It can be expected that countries need a minimum level of capabilities in order to successfully profit from outward FDI. In line with the assumption discussed in Section 2.2.1, it can be understood that firms in the home economy will benefit from reverse knowledge transfer according to internal capacities to acquire, absorb and advance knowledge spillovers from MNCs. For example, home country suppliers will need a sufficient amount of technical capability to supply MNCs in first place, before they are even able to benefit from knowledge spillovers. In the case of labor mobility, domestic firms need a sufficient amount of absorptive capacity to be able to transform spillover information from new employees into production (Kaufmann 1997).[84] A low level of absorptive capacity could, however, also be an upside since MNCs may be urged to provide intensive training measures to home country firms, for example to upgrade the skills of domestic workers (reinforce human capital accumulation). In the medium and long-term, this could increase the absorptive capacity of the home economy which in turn enhances the capabilities of the home economy to take full advantage of knowledge spillovers from MNCs.

From an aggregate, country perspective the concept of absorptive capacity refers to the capabilities of countries to learn and implement the advanced knowledge and associated practices of other knowledge intensive countries (Dahlman and Nelson 1995). With regards to developing countries, Narula and Portelli (2007, p.27) describe the concept of national absorptive capacity as “a function of the capability of the country to benefit from technological spillovers from the more industrialized countries and the ability to accumulate and best utilize technology and knowledge”. Whereas the concept of absorptive capacity has been analyzed extensively at the microeconomic, firm level (see

[84] Hale and Long (2006) empirically show that Chinese firms with initial high productivity tend to hire more skilled workers, and can therefore enhance and facilitate technology transfer and FDI spillovers.

Section 3.2.1 for the literature references), there is only few empirical evidence on the macroeconomic level and here again primarily with regards to the effect of inward FDI on the host economy (Criscuolo and Narula 2002). This leaves us with less empirical evidence, but with a hand full of proxies and indicators to measure the absorptive capacity of an economy. In the following, some of the most commonly used indicators will be introduced and discussed in more detailed.

(1) **Human capital** indicators have long been stressed as important proxies for national absorptive capacity and accordingly as an important prerequisite for economic growth in general (Benhabib and Spiegel 1994). In the empirical literature the most commonly used proxies for human capital are educational attainment measures which reflect the highest level of education completed by each adult. OECD (1998) distinguishes between qualification (share of people who have successfully completed various levels – primary, secondary, tertiary – of formal education) and the average years of schooling completed.[85] Other prominent human capital indicators include literacy rates[86], enrollment ratios or the number of university graduates relative to total population. The underlying assumption is that a better educated workforce is linked to higher productivity and better capabilities to take advantage of foreign knowledge advances. According to Dahlman and Nelson (1995), a sound education system is important for absorptive capacity at two levels. At the primary and secondary level, skills are developed to accelerate the diffusion, adoption and adaption of foreign knowledge to the local context. At the university level, personnel are qualified to track technological trends, assess their developmental relevance for the home economy and develop strategies to master and make use of the advanced knowledge.

Keller (1996) emphasizes the complementary between human capital and technological transformation. In his model, the long-run benefit from the move towards outward-orientation depends on the increase of the rate of human capital formation. As a "country moves towards an outward-oriented regime which gives access to new technologies at a higher rate, then a correspondingly higher rate of human capital will be necessary to sustain the process of technological development and higher overall growth" (Keller 1996, p.202). Thus, a higher economic growth rate due to technological catching-up can only be

[85] One has to keep in mind that educational attainment measures neglects the learning and competencies an individual gains after the completion of formal education. Neither do these measures take into account the deterioration of abilities through the lack of use once the formal education has finished. For a more comprehensive critique of the measures it is referred to the OECD (1998) report on human capital.

[86] There are obvious shortcomings to the empirical analysis when using the literacy rate as a proxy for human capital. One reason is that in most developed countries the rate is close to unity which makes empirical comparability across countries difficult (Benhabib and Spiegel 1994).

sustained if domestic skills accumulate at a higher rate than prior to the outward orientation. If an economy fails to increase the level of human capital, its growth rate is very likely to drop back to its former level (Keller 1996). Borensztein et al. (1998) support this view by showing that developing countries which have attained a certain threshold stock of human capital have significantly profited from inward FDI from OECD countries in form of higher GDP growth rates.

(2) A second concept of absorptive capacity at the macroeconomic level relates to the **national innovation system** which plays a very important role in strengthening the national absorptive capacity (see Section 2.1.1 for a discussion). The ability of Japan and the East Asian economies to profit from inward transfer of foreign technology has been backed by the development of a strong national innovation system (Mowery and Oxley 1995). Here, the national innovation system has provided the critical stock of knowledge and capabilities needed to exploit spillovers created by the foreign sources of knowledge, in particular through the buildup of a skilled production and technical labor force. Mowery and Oxley (1995) conclude that a sound national innovation system needs to be complemented by accompanying trade and economic policies to reduce market distortion and enforce domestic competition. This way foreign-sourced knowledge may be fully exploited.

(3) A third proxy for absorptive capacity which has been identified in the academic literature is the **outward orientation and openness** of an economy (Barrios and Strobl 2002). It can be assumed that the more an economy exports, the higher are the profits from the presence of home economy MNCs. The notion behind this is that exporting firms are more exposed to the international market and are therefore more likely to use advanced technologies and counter competition. As this improves their ability to identify and absorb advanced knowledge, economies with a higher number of export firms are more likely to profit from knowledge spillovers from MNCs. This hypothesis is supported by the findings of Barrios and Strobl (2002) who show, based on Spanish firm-level data, that exporting firms benefit more from spillovers from subsidiaries of foreign MNCs in Spain than non-exporting firms. Moreover, the total number of home country MNCs may give indications about the absorptive capacity of the home economy. Spillovers to the home economy may be greater, the larger the number of firms which have gained international experience through outward FDI themselves as they are more able to absorb potential spillovers. This is an important assumption for the model presented in Chapter 5.

(4) Another aspect of national absorptive capacity refers to the **support infrastructure** (Crespo and Fontoura 2007). Here, the level of financial system development is often used as a proxy to measure the absorptive capacity of an economy. In the literature on inward FDI, several empirical studies show that a soundly developed financial system favors the occurrence of FDI spillovers given that economies with well-developed financial markets can exploit FDI more efficiently (Alfaro et al. 2004, Hermes and Lensink 2003). Hermes and Lensink (2003) find that a healthy financial system is an important precondition for inward FDI to have a positive effect on host country growth as it promotes efficient resource allocation and technology diffusion associated with inward FDI. It therefore seems reasonable to assume that a sufficiently developed financial system also plays a crucial role with regards to outward FDI-driven reverse knowledge transfer. There are several arguments why the state of the financial system matters for outward FDI. First, a well-functioning financial system is able to mobilize private savings (Hermes and Lensink 2003), which in turn increases the amount of resources available to finance outward FDI projects. Second, a sound financial system is an important and mostly neutral arbitration to evaluate and decide which outward investments are promising and which are doomed to fail. Financial institutions may adopt an important screening and monitoring function of overseas investment projects. Inauspicious outward FDI projects are likely to be sorted out in advance which ensures that financial resources are allocated to the outward FDI projects that yield the highest returns and consequently enhance the home country growth rates (Hermes and Lensink 2003). Third, healthy financial institutions may encourage domestic firms to engage in investments abroad by providing venture capital. This reduces the costs and risks of firms to internationalize and to expand their innovative activities abroad. Finally, a well-developed financial system may provide the required capital for domestic firms to imitate and adopt the advanced technologies and practices of their multinational counterparts (Alfaro et al. 2004). This way a speedier reverse knowledge diffusion and upgrade of the home economy may be promoted.[87] Overall, well-developed financial markets may be a crucial precondition for the positive effects of outward FDI on reverse knowledge diffusion and on home country economic growth.

Overall, each of the components that add up to the national absorptive capacity is an important determinant for the knowledge spillovers to the home economy. However, what

[87] Alfaro et al. (2004) argue that for domestic firms in order to profit from new knowledge they need capital for the reorganization of their firm structure, the purchase of new equipment and the recruitment and training of managers and skilled labor force. They assume that the wider the gap between their old practices and the new knowledge requirements, the greater the need for external financing.

also is likely to determine the magnitude of spillovers is the technological gap between knowledge source and recipient country. On the country level, the technological gap concept refers to the relation of absorptive capacities of two or more economies. The following section will refer to this in more detail.

4.2.2. Technological Gap

It may be assumed that it is not only the absolute initial level of absorptive capacity which does matter for the magnitude and scope of spillovers, but also the relative technological difference between the MNCs and the home economy. The advantages and disadvantages of the relative technological gap between MNCs and developing host economies which stand at the outset of a process of industrialization and opening-up of the economy have been discussed in the literature on inward FDI (Findlay 1978, Rodríguez-Clare 1996). Some of the findings may be useful for the discussion on how technological gaps between MNCs and their home economies affect the magnitude for knowledge spillovers since MNCs are usually also technologically more advanced than other (non-multinational) firms in the home economy.

There are two views on technological gaps and its effect on knowledge spillovers. The first view backs the assumption that a large technological gap favors knowledge spillovers. In a pioneering study, Findlay (1978) emphasizes the importance of relative backwardness of host countries with regards to inward FDI-induced spillovers. In his model, Findlay hypothesizes that the rate of technological progress in a relatively backward country can be expressed as an increasing function of the gap between its own level of technology and that of an advanced country (which improves at a constant rate). Findlay argues that the greater the technological distance between the home country of the investing advanced MNCs and the host economy, the greater the backlog of available opportunities and therefore the greater the pressure to technologically catch-up for host economy firms.

> *"The idea is roughly that the greater the backlog of available opportunities to exploit, measured by the distance between the advanced and backward region's current levels of development, the greater the pressure for change within the backward region, and the faster the rate of growth."* (Findlay 1978, p.2)[88]

[88] However, Findlay (1978) constrains his hypothesis insofar as it only holds for a certain critical level of disparity between the two economies. In his model, backward countries need to possess a minimum level of absorptive capacity.

The second view represented by several authors assumes that the larger the gap, the less likely is the host economy to possess enough imitation investment to support high-tech inward FDI. Glass and Saggi (1998), for example, assume that imitation investments by host country firms generate the necessary knowledge and skill foundation for incoming FDI. They argue that the higher the initial imitation investment, the smaller the technology gap and the likelier FDI in high quality level products become feasible. This should increase the quality of technology transferred and thus also the potential for spillovers from inward FDI (Glass and Saggi 1998).[89] Conversely, if backward firms fail to sufficiently invest in imitation, the technology gap is too wide, and the host economy is only able to attract low technology production. Based on a formal model, Rodríguez-Clare (1996) supports the view that spillovers are negatively related to the size of the technological gap between the host and the home economies. The author argues that if the host country supply of intermediate goods is too poor due to technical constraints, MNCs will import their intermediate goods which can lead to a reduction in input variety and specialization of host country suppliers. Contrariwise, the more developed the host economy, the more inputs will MNCs draw from local suppliers and the likelier are spillovers from MNCs to host country firms via backward linkages (Rodríguez-Clare 1996). With regards to developing countries, Kraemer-Mbula and Wamae (2010) state that knowledge transfer is a question of the appropriateness of advanced technology. Advanced host country technology is often designed for the factor price ratios that prevail in these economies, namely expensive labor and abundant human and physical capital, and might not be appropriate for less developed home economies with opposed factor prices. Kraemer-Mbula and Wamae (2010) therefore suggest that less developed home economies might find it easier to transfer knowledge from similarly developed economies. In this regard South-South FDI might open the access to technologies that are not too far advanced for adoption in the home economy.

Several studies have approached the topic empirically, all of which can be found in the inward FDI literature and thus analyze knowledge transfer from MNCs to host country firms (Guellec and van Pottelsberghe de la Potterie 2001, Kokko et al. 1996). Nevertheless, they also provide valuable insights for the outward FDI and home country perspective. In line with the theoretical discussion, the empirical findings are twofold. Many empirical

[89] In the model of Glass and Saggi (1998), absorptive capacity is determined by the level of investment in imitation. The assumption behind that is that imitation upgrades the knowledge base and consequently the absorptive capabilities of firms.

studies substantiate the hypothesis that domestic firms can only benefit from knowledge spillovers if the technology gap between the MNCs and local firms is not too wide (Girma and Görg 2005, Guellec and van Pottelsberghe de la Potterie 2001, Kokko et al. 1996). Most of the empirical studies approximate technological gaps in terms of productivity differentials between foreign and domestic firms. Using a cross-section of plant-level data for Uruguayan manufacturing firms, Kokko et al. (1996) only find evidence for intra-industry productivity spillovers to local firms with a moderate technological gap to the investing MNCs. They find no empirical evidence for spillovers to domestic firms with large technology gaps vis-à-vis MNCs. Consequently, no spillovers are found to firms with a considerable lower technological capability as they lack the skills needed to apply and learn foreign technologies.[90] In a similar vein, Guellec and van Pottelsberghe de la Potterie (2001) examine the role of technological proximity by analyzing patent data of OECD countries. They find that countries are more likely to collaborate and share knowledge if they have a similar technological specialization. Thus, the more they have in common in terms of technological capabilities determined by the number of patents in technological classes, the likelier are countries to collaborate.

The findings by Girma et al. (2001) are twofold. They show that firms in the United Kingdom mainly profit from intra-industry productivity spillovers if there is a small gap between their productivity level and the productivity level of the (foreign-owned) MNC. However, if firms operate in sectors which are characterized by high level of skills and a high degree of international competition, they can profit from inward FDI even if they initially have to face a large technological gap. This is not the case for firms located in sectors with low skill levels and low levels of foreign competition.

Criscuolo (2009) supports the technological gap view. In a patent citation analysis of patents granted to European MNCs in the United States, Criscuolo (2009) finds that the extent of spillovers to home country firms depends on the existence of a technological gap between home and host country.[91]

To conclude, the evidence on the impact of the technological gap on reverse knowledge transfer is mixed. The majority of empirical evidence shows that large gaps between the

[90] Kokko et al. (1996) measure technology gaps as the ratio of the average labor productivity of locally-owned plants and the average labor productivity of foreign-owned plants. Large gaps occur if different technologies are applied in production or if different factor intensities are used.

[91] To measure the technology gap, Criscuolo (2009) uses the ratio of the number of patents in the same three-digit IPC of technology of the cited patent originating from the country in which the citing firm is headquartered relative to the ones patented in the United States during the same period.

capabilities of MNCs and their domestic counterparts attenuate the capture of spillovers. Therefore, it can be expected that technological gaps between the host and home economy in fact may promote reverse knowledge transfer, however, only if they are not too large.

4.2.3. Home Country Embeddedness

Another important condition for reverse knowledge transfer is the embeddedness of the MNC in their home economies. It can be expected that knowledge acquired abroad is channeled through the MNC's parent unit to other home country firms and institutions based on the MNCs' embeddedness in its home economy. The effects of outward FDI on the home economy is probably stronger the more linkages the investing MNCs have with other firms and public institutions in their home economy (Jaklič and Svetličič 2003). Some of these linkages have been addressed in the initial sections of this chapter (supplier and customer relationships, external network linkages).

It can be assumed that domestic MNCs are usually more embedded in their home economies than they are in the host economy. They do not have to overcome the costs of doing business abroad and face cultural or linguistic barriers (Castellani and Zanfei 2006). The formal and informal linkages to geographically and culturally close players in the home economy are considered "of a certain quality and intensity, different from the linkages that cut across national borders" (Sölvell and Zander 1995, p.20). This may increase the potential for knowledge spillovers to the home economy.

The empirical evidence on the impact of MNCs' home country embeddedness on reverse knowledge transfer is rather limited. One of the few studies is the one by Criscuolo (2009). Analyzing patent citations of patents granted to European MNCs, the author shows that reverse knowledge transfer and externalities to the home economy are positively related to the home country embeddedness of MNCs.[92]

4.2.4. Outward FDI Characteristics

It is plausible to assume that the home economy effects of outward FDI will depend on the type of MNC's outward FDI activity, in particular whether a MNC's foreign investment is vertical or horizontal. If MNCs from more developed, skill-abundant countries, for example, invest vertically in less developed, unskilled-labor abundant countries, it can be

[92] Criscuolo (2009) proxies a MNC's home country embeddedness by its average percentage of employees in the home country, the share of patents originating from the home-country out of total patents, the number of joint patent applications with other home country firms and institutions relative to the number of total joint patent applications.

assumed that they relocate part of their unskilled-intensive production process (Bitzer and Görg 2009). In the short run, this could reduce activities in the home market, but in the longer term a shift to higher value-added activities, a higher specialization and increased access to cheaper inputs in the foreign markets could increase the competitiveness of the home economy and could add to domestic output and productivity (Bitzer and Görg 2009, Blomström and Kokko 1998).

With horizontal investments, MNCs usually relocate part of their production activities abroad. In the short run, this may also negatively affect home country economic output. But again, the access to new markets and customers are likely to increase economies of scale, MNCs' competitiveness and home market productivity (Bitzer and Görg 2009). Horizontal investment may also positively affect productivity of MNCs' suppliers in the home market due to economies of scale – of course only if MNCs continue to source from home country suppliers (Blomström and Kokko 1998).

4.2.5. Size of the Home Economy

It may furthermore be expected that the effects of outward FDI on reverse knowledge transfer depend on the size of the home economy (in terms of GDP). Given that the absolute number of researchers is lesser in small countries, one might expect that the likelihood of international R&D cooperation and exchange between home country and foreign researchers is higher. Guellec and van Pottelsberghe de la Potterie (2001) support this assumption by showing that smaller countries are on average more internationalized than larger economies. But do the benefits from reverse knowledge transfer and spillovers differ between large and small countries? Lichtenberg and van Pottelsberghe de la Potterie (1998) find that the ratio of foreign R&D benefits (productivity increases) embodied in outward FDI to foreign R&D benefits conveyed in imports is higher for larger economies than for smaller economies. Using panel data regressions, Lee et al. (2009) analyze the effects of outward FDI from smaller but more developed economies (Hong Kong, Korea, Singapore and Taiwan) to a larger but less developed economy (China). They show that smaller investing countries will experience a reduction of home country employment, disparity and exports to the world market. By contrast, a larger country's (United States and Japan) FDI in China has no effects on its exports.

Again, the list of aspects which influence the outcomes of outward FDI and reverse knowledge transfer to the home economy could be easily extended. Some of the most important factors have been addressed in the previous sections. Empirics have supported

the hypothesis that the absorptive capacity of the home economy has a major impact on how easily host country knowledge is reversely transferred back and absorbed by the home economy. The next chapter will make a short excursion to the competition effects of outward FDI.

4.3. Outward FDI and Home Country Competition

The internationalization of firms and outward FDI activity is likely to change home country market structure and competition. It is plausible to assume that MNCs will operate on a higher productivity level than most of its home country counterparts, otherwise it would not be able to internationalize in first place (Barba Navaretti and Castellani 2003). As discussed in Chapter 3, outward FDI may further enhance the productivity of MNCs. This can have two opposing effects in the home economy.

On the one hand, increased competition due to the presence of the MNCs might incentivize home country firms to increase their efficiency and catch up technologically by allocating their given resources more efficiently or by adopting new technologies or techniques. It should be noted, that in the case of competition driven efficiency gains in the home economy, there is no actual reverse knowledge transfer involved and therefore there are no "genuine" spillovers (Criscuolo 2004).

On the other hand, competition due to the presence of the MNCs may negatively impact the home country market structure. One could think of similar effects in the home economy as the ones addressed by Aitken and Harrison (1999), who examined the effects of MNCs' market entry on host country firms. They find that the increase of foreign MNCs' investment in Venezuela had a significantly negative impact on the productivity of wholly domestically owned firms in the same industry. Domestic firms had lost market shares to entering foreign MNCs and since their fixed costs were spread over a smaller marked they had to experience a decrease in productivity. There was no supportive evidence for the existence of knowledge spillovers to the host economy from inward FDI which could have counterbalanced the negative competition effect.[93] If these findings are

[93] Part of these developments should also be attributed to Venezuela's strong dependency on natural resources and its open trade regime which led to the occurrence of the Dutch Disease phenomenon in recent years: The high dependency on commodity exports has led to an uncompetitive exchange rate which in turn harmed the competitiveness of the domestic manufacturing sector and its exports (Corrales 2013). In the meantime, Venezuela massively imported goods and services which even hurt the domestic industry more. In addition, stronger regulations of the domestic private sector have led to massive private capital flight (Corrales 2013).

translated to the home economy context, the following scenario might occur: While home country firms face fixed production costs, MNCs can lower their marginal costs of production by investing abroad. As a consequence, they could reduce prices and augment output at home. This could draw away demand and rents and lessen the market share of domestic competitors forcing them to reduce production. In an extreme case, this could even result in domestic companies being squeezed out of the market which would leave MNCs as market oligopolists or even monopolists (market-steeling effect).[94] Such decreased competition in the home economy could in the long run have a highly negative impact on the home economy.

Accordingly, competitive pressure may have both, positive and negative effects on competing home country firms. They are either forced to catch up and will become more efficient by allocating their given resources more efficiently or by adopting new technologies or techniques to ensure their survival. Or, if they fail to do so, they will have to face significant losses of market shares and a consequent increase of their average costs (Aitken and Harrison 1999). They might even be "crowded out" of the market.

4.4. Empirical Evidence on the Home Country Effects of Outward FDI

In industrialized countries, outward FDI has often been feared of having detrimental effects on the home economy. Critics raised concerns that outward FDI leads to a reduction of domestic output and a loss of jobs in the home economy. Others have addressed the opportunities for the home economy that come along with the internationalization of firms like cheaper production inputs or the access to new markets and advanced foreign knowledge sources and all the spillovers to home economy agents that come along with that.

The measurement of the net effects of outward FDI on the home economy as a whole is a rather difficult venture. As argued by Jaklič and Svetličič (2003), the effects of outward FDI take some time to unfold and a certain volume in first place. Moreover, it "is much easier to detect impacts of such investment at the firm level, whereas sectoral and macroeconomic effects are more difficult not only to detect but especially to distinguish from several other influences" (Jaklič and Svetličič 2003, p.161).

[94] See Hymer (1976) and Kindleberger (1969, 1984) for a similar discussion on the monopoly power of MNCs in host markets.

Whereas the focus in Section 3.3 has been on firm-level evidence, the following chapters summarize and discuss the theoretical and empirical findings on the net effects of outward FDI on the home country as a whole.

4.4.1. Impact on Employment, Trade and Domestic Investment

The impact of outward FDI on home country **employment** is probably the most controversial and thus the most frequently discussed topic in the outward FDI literature. Main public concerns have emerged that outward FDI shifts jobs abroad and reduces employment not only in the MNCs' headquarters but also in other home economy firms in related upstream and downstream industries. Earlier studies on the home country effect of FDI tried to add content to the political debate that emerged during the 1960s, especially in the United States, over the harmful consequences of outward FDI on domestic employment (Lipsey 2004). Several scholars voiced their concerns that the relocation of production activities could harm and reduce demand for domestic labor which in turn could result in lower wages and higher unemployment, especially when the production is relocated to low-wage countries (Lipsey 2004). The impact of outward FDI on the investing firm and in particular its parent unit in the home economy has been discussed in Chapter 3. Only few empirical studies have analyzed the indirect employment effects in the home economy, meaning the employment effects outside the MNC. A study conducted by the research institute Copenhagen Economics (2007) reveals that Irish outward FDI not only has positive effects on the investing firm's own employment, but also contributed to increased employment among non-multinational firms. However, this only holds for non-multinational firms among the vertical value chain of the investing firm such as suppliers or customers and thus not for direct competitors.

A second, major public concern has been that outward FDI reduces home economy **exports**. The impact of outward FDI on home country exports may be twofold. On the one hand, outward FDI may substitute exports if the relocation of production abroad replaces exports of certain products. This would reduce export activity in the home economy. On the other hand, exports may be a complement to outward FDI as the latter usually generates export demand for other products, such as intermediate goods or services which originate in the MNCs' home economies. Instead of exporting finished goods to consumers in the host markets, parent firms of MNCs ship intermediate goods to their subsidiaries located in major export markets (Blomström and Kokko 1994). Moreover, outward FDI could increase supplier exports to the host economy if the investment increases MNCs'

sales and its demand for intermediate goods.[95] Suppliers export to the host economy could also be increased due to the reverse knowledge spillover effects discussed in Section 4.1.3.

A lot of theoretical and empirical research has been conducted to analyze the linkages between FDI and exports (Helpman et al. 2004). The common view is that the net impact of outward FDI on exports may not be defined a priori. Whether outward FDI is substitutive or complementary to exports is determined by additional factors such as the tradability of goods produced or the conditions prevailing both in the host and home economy such as the income level, sales or factor prices (Jaklič and Svetličič 2003). The decisive factor might be the type of investment made by the MNC. Market-seeking FDI for example will probably lead to an increase of exports of intermediate goods and final goods. Efficiency seeking FDI could also boost intra-firm trade through the export and import of intermediate goods, but could in some cases also reduce exports if products are produced in the host economy instead of exported to it.

In the empirical literature, outward FDI is more often found to have a complementary relationship with home country exports than a substitutive one. Quite a few studies show that outward FDI promotes home country exports, in particular intra-firm trade (see e.g. Ellingsen et al. 2006 for Singapore, Jaklič and Svetličič 2003 for Slovenia, Kim 2000 for Korea, Lipsey et al. 2000 for Japan, Svensson 1996 for Sweden, Wu et al. 2003 for Singapore). Kim (2000) finds that the positive effect for Korean exports is even greater when the export destination is a developing country. One of the few studies which finds a negative relationship between outward FDI and exports is Lee et al. (2009). They observe that outward FDI from the Asian Tigers to China negatively affects their exports to GDP ratio. They find no such linkages between outward FDI of larger economies such as Japan and the United States to China and their export ratio.

However, the development of the Asian Tiger's export and the development of export composition in general should be seen in a broader context by keeping the dynamics of comparative advantages in mind. With the shift of its comparative advantages in the 1980s and 1990s, Taiwan, for example, had to restructure its production and outsource its labor intensive industries to less developed countries, such as China, which had overtaken the

[95] It has to be noted, however, that in the long run the sourcing strategy of MNCs could shift. Whereas MNCs usually continue to source their inputs in their home economies in the initial stages following their foreign investment, they might switch to local suppliers in the host economy in the long run. Such a shift can often been witnessed in less developed host countries where local suppliers increase their capacities and quality of products over time and become serious competitors to home country suppliers. As a consequence home country suppliers often decide to follow the MNCs by relocating their production site to their MNC customers abroad to keep their competitive edge.

competitive advantage of low cost labor production from the Asian Tigers. The shift prompted Taiwan and the other Tigers to upgrade and focus on new and more capital and knowledge intensive stages of production which helped them to climb up the value chain (e.g. automotive production, IT industry) and create a new export base. This regional pattern of shifts in the production of labor-intensive goods seems now to reproduce itself with China and lower tier countries such as Vietnam, Cambodia or Bangladesh.[96] Thus, an isolated consideration of the impact of outward FDI on exports of a single country might not be enough to draw more general conclusions and should therefore be treated with caution. Instead a more aggregate view on the overall effects (e.g. within regions and over time) might be more insightful to assess the impact of outward FDI on exports.

Finally, the public has for a long time expressed serious concerns about the effect of outward FDI on **home country investment** given its major role as a driver for GDP growth (Al-Sadig 2013). Critics argue that outward FDI may detract investments away from the home economy. On contrary, if profits made in the host country are repatriated back to the home economy, domestic investment may be increased. Outward FDI may affect domestic investment via financial markets and production channels (Herzer 2010, Stevens and Lipsey 1992). Through financial markets, outward FDI may discourage domestic capital accumulation if the capital transferred abroad (which is part of the domestic savings) increases interest rates in the home economy and makes borrowing more expensive for other domestic firms. This is, however, less likely if the country is open to international financial markets. Positive stimulus may come from the product market. Domestic investment may be stimulated if outward FDI increases market access for suppliers as discussed above (Herzer 2010).

Similar to the trade effects of outward FDI, the question is therefore whether outward FDI and domestic capital formation are complementary or substitutive. Overall, empirical findings suggest that the impact is country-specific and very much depends on the type of outward investment (Braunerhjelm et al 2005).[97] More recently, research has started to tackle the effects of outward FDI on domestic investment in developing countries. The empirical findings here are similarly controversial. A study by Al-Sadig (2013) shows that outward FDI flows negatively impact domestic investment in developing countries. There is, however, no evidence found in Jaklič and Svetličič (2003) that outward FDI of

[96] This view on the sequential technological development of Southeast Asia has its origin in the so called "flying geese paradigm" (Akamatsu 1962, Ozawa 2005).

[97] An extensive review of the empirical literature is provided by Al-Sadig (2013).

Slovenian MNCs dampens investment in the Slovenian home economy. By contrast, home country investment is stimulated significantly by activities abroad. Similar findings are presented by Wu et al. (2003) for Singapore. They find that Singaporean overseas investments have a statistically significant long-run impact on domestic investment.

The review indicates that theory and empirics are even inconclusive with regards to the partial effects of outward FDI (domestic employment, exports or investment), let alone the net effects. As already addressed above, an isolated consideration of the impact of outward FDI on specific parts of the economy and on single economies in a limited time frame might therefore not be expedient to draw conclusions on the home country effects of outward FDI. It becomes even more evident that a more aggregate treatment of the topic is needed to evaluate the net impact of outward FDI.

4.4.2. Impact on Knowledge Base

Patent citations to prior arts have proven to be a useful tool to trace knowledge flows and measure knowledge spillovers to the home economy. As already discussed in detail in Section 3.3.1.3, new patent applications usually contain references to earlier patents that have been crucial for the development of the new innovation. From a home country perspective, it can be assumed that there has been some kind of knowledge transfer if a patent which has been granted in another country is cited in a new patent application in the home economy. References to "foreign" patents in patent documents in the home economy may therefore be used as a proxy variable for international knowledge flows.

A comprehensive summary of the empirical studies that analyze the impact of outward FDI on the home economy knowledge base is provided in Table 3. One of the first empirical studies to use patent citation to prove the existence of spillovers from outward FDI to the non-multinational part of the home economy is the work by **Globerman et al. (2000)**. The authors analyze 220 patent applications filed by Swedish MNCs and small and medium sized Swedish enterprises without foreign operations[98] in 1986. They find significant evidence that higher outward FDI (measured by the number of employees in Swedish subsidiaries abroad) is associated with more patent citations to the countries the MNCs have invested in, by both Swedish MNCs and by Swedish non-multinational small and medium sized enterprises. The findings also hold when controlling for other factors influencing foreign patent citation such as trade or distance. According to Globerman et al.

[98] The sample covered 109 patents filed by Swedish MNCs and 111 patent applications made by small and medium sized enterprises and included 263 and 310 references respectively to earlier patents.

(2000), spillovers from the Swedish MNCs to non-multinational Swedish firms occur through the same formal and informal channels as discussed in the previous chapters, such as external business networks and labor mobility. The finding is one of the first quantitative evidences that knowledge may spill over from the headquarters of MNCs to other non-multinational firms in their home economy and backs the assumption of positive home country effects of outward FDI that occur beyond the one that benefit the investing MNCs themselves. The study of Globerman et al. (2000) also lends support to the proposition that countries tend to source knowledge in more knowledge-rich economies by showing that Swedish firms tend to have more references to countries with large patent stocks. Proximity to the knowledge source also plays a crucial role for reverse knowledge transfer, as Swedish firms tend to have more references to countries which are closely located to Sweden. Another interesting finding in the same study is the negative correlation between inward FDI and the number of citations to foreign patents. Thus, the activities of foreign MNCs in Sweden seem not to contribute to the Swedish knowledge base in form of new patent applications.

In her patent citation-based study on U.S. patents, **Popovici (2005**) provides further evidence on reverse knowledge flows and spillovers linkages between MNCs' foreign R&D activities and other home country firms. The patent citations record shows that U.S. firms which cite patents that were granted to U.S. subsidiary in a certain host country were more likely to cite other patents registered by other host country firms compared to U.S. firms which did not cite a U.S. subsidiary in that host country in first place. Expressed in numbers, the findings of Popovici show that citations to the host country become 51 to 55% likelier to be knowledge flows for U.S. firms which cited patents of the U.S subsidiary than for the rest of the U.S. firms, which did not refer to them.

A study by **Criscuolo (2009)** adds to the earlier findings by emphasizing the role of outward FDI as a channel of reverse knowledge transfer to the home economy. Based on citation analyses of patents granted by the European Patent Office (EPO) to 17 European chemical and pharmaceutical MNCs that operate subsidiaries in the United States, Criscuolo (2009) shows that firms in the MNCs' home economies are more likely to cite the patents of their foreign subsidiaries. Thus, MNCs act as a channel to tap U.S. knowledge and reversely transfer it back to other home country firms. The results show that home country firms benefit from the R&D activities by MNCs in the United States, especially those which are located in the same region as the home country unit of the investing MNC. This means that home country firms located in proximity to the cited

Table 3: Summary of empirical studies on the impact of outward FDI on home country knowledge base

Authors	Sample	Period	Hypothesis/research question	Data Source	Methods	Main findings	Impact of outward FDI
Criscuolo (2009)	EPO patents granted to 17 European chemical and pharmaceutical MNCs	1985–2005	What is the impact of R&D internationalization on the home country?	Patents granted by the OECD European Patent Office (EPO)	Track international knowledge flows through citation analysis, matching method	MNCs act as a channel for the transmission of knowledge developed in the United States back to the home economy; transfer is determined by the degree of MNCs' home country embeddedness, their asset-augmenting outward FDI strategies and the technology gap between the home country and the United States	positive
Globerman et al. (2000)	220 Swedish patents applied for by Swedish MNEs and small and medium sized enterprises (SMEs)	1986	Which knowledge channels (trade, inward and outward FDI) affect patent citation in Sweden?	n/s	Conditional logit estimation framework	The pattern of Swedish outward FDI is a significant determinant of the knowledge flows to Sweden: both MNCs and SMEs benefit from outward FDI; strong correlation between foreign citations and outward FDI, but not inward FDI; trade-related spillovers are more important for SMEs than for MNCs	positive
Popovici (2005)	Dataset of patents (894) assigned to U.S. companies that cite patents granted to U.S. affiliates abroad (675)	2001-2005	To which extent can U.S. firms benefit from U.S. MNCs' outward FDI?	NBER Patent-Citations data file	Track international knowledge flows through citation analysis, conditional logit regression	U.S. firms which cite patents of an U.S. subsidiary in a certain country were more likely to cite other patents registered by firms in that country than U.S. firms which did not cite that U.S. subsidiary	positive

MNC are more likely to cite patents owned by the MNC's U.S. subsidiary than other European firms.

Again, there are limitations to the methodology of patent citation to measure international knowledge flows. In addition to the ones already discussed in Section 3.3.1.3, one could argue that only those domestic, non-multinational firms which apply for patents are looked at in first place. Other firms which might profit from knowledge spillovers from MNCs in their home economy are neglected in the analyses and thus a sizeable share of potential spillover effects are ignored.

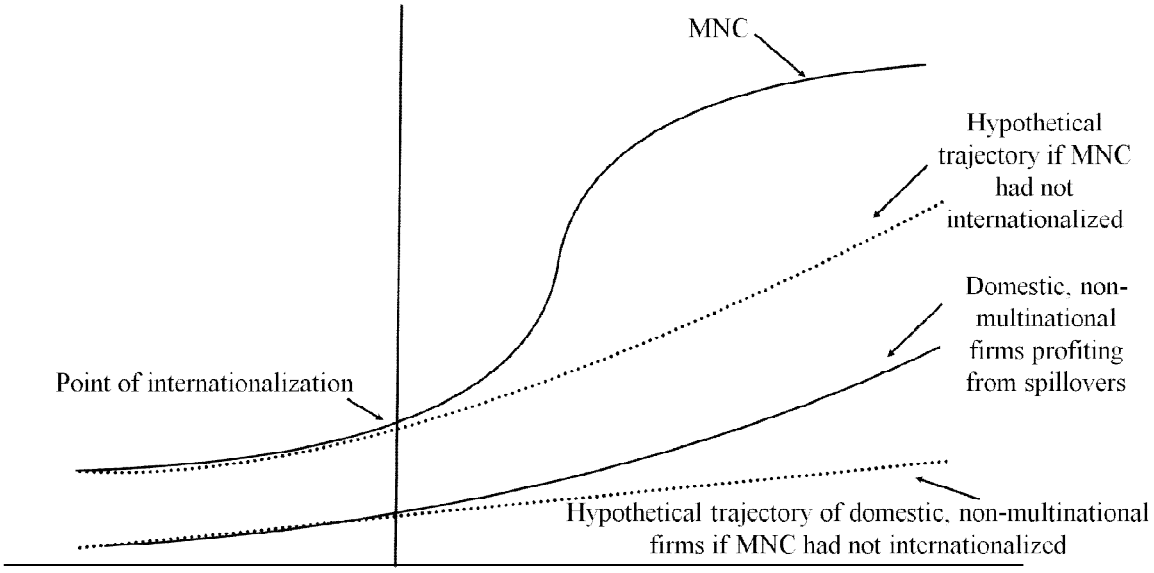
4.4.3. Impact on Productivity

As discussed in Section 3.3.2, the investing firm itself may face changes in productivity following its outward investment. In addition, outward FDI may also affect the productivity of other parts of the home economy. First, upstream industries could profit from economies of scale due to market expansion effect. This only holds, if MNCs continue to source their intermediate inputs in the home economy. Otherwise productivity would be negatively impacted. Second, as discussed above, upstream industries may be forced to increase production and process efficiency as a consequence of international competition. Increased competition is the second reason why outward FDI may have positive effects on productivity. Third, if it is assumed that MNCs are intermediate goods producers and given that their foreign activity enables them to offer advanced intermediate inputs on a higher technological level in their home markets, downstream industries may profit from increased production efficiency and thus increased productivity. Intermediate goods may now also be available at lower costs for home economy firms (Blomström and Kokko 1998). Overall, outward FDI could impact home country productivity both positively or negatively. As argued by Bara Navaretti and Castellani (2003), scale of home production could be reduced or increased, knowledge can either be taped or lost to competitors in the host economy and finally, new composition of factor inputs may strengthen or diminish home activities.

Assuming potential productivity spillover effects from MNCs to other firms in their home economy, the productivity trajectories as proposed by Barba Navaretti and Castellani (2003) and presented in Section 3.3.2 can be extended (see Figure 9). Again it is assumed that there are two types of firms in the home economy. Domestic, non-multinational firms which do not operate a foreign subsidiary in the period observed, and firms which switch from being national into being multinational (MNCs). Now, according to the potential

productivity spillover channels identified above, not only the firms that become multinational reach a higher productivity trajectory, the firms that stay purely domestic firms are able to increase their trajectory as well.

Figure 9: Productivity trajectories II



Remarks: Own illustration based on Barba Navaretti and Castellani (2003).

Can the empirical evidence support this hypothesis? Empirical literature has so far mainly focused on the home country productivity effects stemming from international trade and inward FDI (Coe and Helpman 1995). Recent studies have started to address the effects of outward FDI on home country productivity and here in particular the extent of foreign R&D and its effects on home country productivity (Lichtenberg and van Pottelsberghe de la Potterie 1998, 2001). A summary of the empirical evidence, which will be presented in the following, is provided in Table 4.

Using aggregate country-level data, **van Pottelsberghe de la Potterie and Lichtenberg (2001)** empirically analyze the impact of outward FDI (in particular technology-sourcing FDI) on the home country productivity of 13 industrialized economies. They find that total factor productivity is increased in cases where outward FDI is directed towards R&D intensive countries. Their results show that the same holds for import flows. On the contrary, incoming FDI from R&D intensive countries does on average not channel productivity spillovers to the host economies. The authors conclude that the findings give an indication for the technology-sourcing FDI strategies of MNCs which they compare with Trojan horses: “they are intended more to take advantage of the technology base of

the host countries than to diffuse the technology originating in the home country" (van Pottelsberghe de la Potterie and Lichtenberg 2001, p.497).[99] Consequently, in order to profit from knowledge transfer it is up to the host and home countries to find ways to actively tap these knowledge sources. Several studies have further developed the approach by van Pottelsberghe de la Potterie and Lichtenberg (2001). Bitzer and Kerekes (2008) for example expand their model by using a new dataset and by also accounting for third country effects. In contrast to van Pottelsberghe de la Potterie and Lichtenberg (2001), they find that inward FDI acts as a channel of knowledge transfer whereas outward FDI is not.

Several studies have measured the impact of outward FDI on productivity with the use of home country industry-level data. **Driffield et al. (2009)** study outward FDI from the United Kingdom on the industry-level to a heterogeneous sample of host locations which vary according to their labor costs and R&D intensity. They find that not only FDI in high cost, high R&D intensive host countries, but also outward FDI in low cost, low R&D intensive locations increase total factor productivity back home in the United Kingdom. Accordingly, not only technology-sourcing outward FDI positively influences domestic total factor productivity, but also efficiency-seeking FDI. Similar evidence is found in **Driffield and Chiang (2009)** who explore the productivity effects of Taiwanese outward FDI in China between 1995 and 2005. Based on industry level data, they report that Taiwanese labor productivity is positively influenced by outward FDI flows to China. As labor costs are reportedly lower in China compared to Taiwan, it can be assumed that the productivity gains are due to vertical or efficiency-seeking FDI which relocates low value-added activities to China. Both studies, Driffield et al. (2009) and Driffield and Chiang (2009), show that productivity gains do not necessarily depend on technology-sourcing FDI. Given that firms also relocate less productive activities in low cost locations and retain high value-added activities at home, home country productivity may be increased even without reverse knowledge transfer taking place. In contrast, based on industry data of 17 OECD countries, **Bitzer and Görg (2009)** reveal an on average negative relationship between outward FDI and domestic productivity at the industry level.[100] They argue that this may reflect the fact that the reduction in home market output associated with outward

[99] On the country level, the study shows that Japan, Germany and France benefit more from their outward FDI abroad than the rest of the world benefits from its outward FDI directed towards them. For the United States and the United Kingdom the benefits received from outward FDI are roughly the same than the benefits they provide to the rest of the world.

[100] Exceptions comprise France, Poland, Sweden, the United Kingdom and the United States, for which Bitzer and Görg (2009) detect a positive relationship between outward FDI and home country productivity.

Table 4: Summary of empirical studies on the impact of outward FDI on home country productivity

Authors	**Sample**	**Period**	**Hypothesis/research question**	**Data Source**	**Methods**	**Main findings**	**Impact of outward FDI**
van Pottelsberghe de la Potterie and Lichtenberg (2001)	13 countries (United States, Japan and 11 European countries)	1971-1990	Extent to which country *i* benefits (in terms of higher productivity) from the R&D performed by country *j* depends not only on the volume of country *i*'s imports from country *j*, but also on the extent of FDI between the two countries—both inward FDI (investment by country *j* in country *i*) and outward FDI (investment by country *i* in country *j*).	Total factor productivity (TFP) data from Coe and Helpman (1995); OECD's Main Economic Indicators and several others	Total factor productivity is regressed on a set of independent variables (domestic and foreign R&D stock incorporated in imports, and inward FDI and outward FDI)	A country's productivity is increased if it invests in R&D-intensive foreign countries, but not if foreign R&D-intensive countries invest in it	Positive
Bitzer and Görg (2009)	Industry- and country-level data for 10 manufacturing sectors for 17 OECD countries	1973 - 2001	Analyzing the effect of outward and inward FDI stocks in country *c* at time *t* on TFP in industry *j*	OECD STAN database, OECD ANBERD database	Estimation of transformed Cobb-Douglas production function	A country's stock of outward FDI is on average negatively related to productivity at the industry level (expect for France, Poland, Sweden, UK and U.S.), inward FDI is on average positively correlated with domestic productivity	Partly negative

Copenhagen Economics (2007)	Approx. 20,000 Irish companies	2004-2005	Test whether Irish industries become more productive the more employment they generate outside of Ireland	Amadeus database	Econometric analyses (matching-estimator techniques), five case studies	No signs of neither negative nor positive impacts on productivity of non-multinational firms	No evidence
Vahter and Masso (2007)	Approx. 41,000 Estonian firms per year in the manufacturing and service sector	1995-2002	Study spillover effects of both inward and outward FDI on productivity, in particular spillovers effects that occur outside of the investing MNCs in the home economy	Estonian Business Register, data from Balance of Payments Department of Eesti Pank	Estimation of augmented Cobb-Douglas production function	No evidence of positive spillovers outside the investing MNC that is robust to the model specification or independent of the sector being studied	No evidence
Zhao et al. (2010)	Country-level dataset on Chinese outward FDI in eight developed economies	1991-2007	Analyze effects of Chinese outward FDI in developed economies on Chinese productivity growth, and the contribution of technological progress and efficiency improvements	Various sources	Vector auto regression (VAR) decomposition analysis, Malmquist productivity index	Outward FDI in developed countries has improved TFP of Chinese firms, mainly due to efficiency gains, domestic R&D is the most import source of productivity gains	Positive

Castellani and Zanfei (2006)	Italian firm-level dataset	1993-2000	Compare the spillover effects deriving from parent companies of Italian MNCs and subsidiaries of foreign MNCs located in Italy to domestic Italian firms.	Elios dataset	n/s	Increase of home country activities of domestic MNCs have a positive impact on non-internationalized domestic firms' productivity, but an insignificant effect on domestic exporters and other MNCs	Positive
Driffield et al. (2009)	Industry-level dataset for 13 countries, 11 manufacturing sectors	1987-1996	Link the different determinants of inward and outward FDI to its effects (productivity and labor demand)	Various sources	Generalized method of moments instrumental variable estimators	No evidence applying aggregate data, but both outward FDI in high-cost, high-R&D intensive host countries as well as low cost, low R&D intensive countries generates productivity growth in the UK	Positive
Driffield and Chiang (2009)	Taiwanese industry-level dataset	1995-2005	Analyze the labor productivity effects of Taiwanese FDI in China	Various sources	GMM-IV panel data estimator	Productivity increases in Taiwan following outward FDI in China, as low value added activities are relocated	Positive
Herzer (2011b)	33 developing countries	1980-2005	Analyze the long-run relationship between outward FDI and TFP	World Development Indicators, UNCTAD FDI database	Panel cointegration techniques	Outward FDI has on average a positive long-run effect on TFP, the relationship is bi-directional	Positive

FDI could not have been compensated by an output expansion due to increased competitiveness in the long run (see Section 4.3 for a discussion). Again, the results underline that the spillover effects of outward FDI very much depend on characteristics of the home economy. Another branch of literature has used firm-level data to measure the home country effects of outward FDI. An empirical study on Irish outward FDI conducted by **Copenhagen Economics (2007)** finds no evidence on productivity spillovers to other non-multinational firms in the Irish economy, regardless of whether these are direct competitors or whether firms belong to the MNCs' vertical value chain. They only provide evidence on positive productivity effects for the Irish MNCs themselves. One of the reasons why only the investing MNCs benefit may be due to the fact that productivity gains stem from cost reduction due to access to cheaper inputs which are, however, only accessible by the MNCs and not transferable back to the home economy (Copenhagen Economics 2007). Similar evidence is provided by **Vahter and Masso (2007)**. Based on firm-level data, the authors study the effects of both inward FDI and outward FDI with regards to productivity spillovers in Estonia. While they find that outward FDI has a positive impact on Estonian MNCs' productivity, they reveal a lack of general statistical evidence on productivity spillovers via outward FDI to other firms in the home economy that is robust to the model specification or independent of the sector being studied. The effects vary to a great extent with the estimation framework used, the sector, time periods and the type of FDI.

Zhao et al. (2010) were the first to distinguish between different sources of productivity growth driven by outward FDI. The authors make use of the fact that, in theory, total factor productivity growth can be decomposed into two components, namely technological progress and technical efficiency change. Technological progress refers to a firms' capability to carry out innovation activities. Contrarily, technical efficiency is the maximum achievable output of a firm from a given set of inputs and technology and can therefore be improved through imitation or a more efficient application of existing knowledge and resource allocation. In order to emphasize the impact of technology-sourcing FDI, the empirical analysis is restricted to Chinese outward FDI directed to developed countries.[101] The findings show that Chinese outward FDI in developed economies has a significant effect on total factor productivity. Expressed in numbers, the findings show that a 1% increase in outward FDI between 1991 and 2007 was

[101] The sample comprises Australia, Canada, Germany, the United Kingdom, South Korea, the United States and Singapore.

accompanied by an increase of 0.55% in total factor productivity. Here, 0.33% was due to efficiency changes and 0.22% due to technological progress. Apparently, efficiency changes induced by outward FDI are a greater source for productivity growth than technology change. This implies that the potential for efficiency improvements is apparently greater for developing economies like China as there is a large catch-up potential to optimize technical and allocative efficiencies of given resources. In the case of outward FDI, this can mainly be achieved by the usage of demonstration and imitation channels (Zhao et al. 2010). Overall, the findings show that while domestic R&D capital stocks are the most important sources of productivity gains in China, outward FDI benefits the home economy, chiefly via the channels of efficiency improvements.

Castellani and Zanfei (2006) compare the spillover effects to domestic Italian firms deriving from parent companies of Italian MNCs and subsidiaries of foreign MNCs located in Italy. The findings show that while non-internationalized Italian firms significantly profit from spillovers from domestic MNCs in form of increased productivity, they do not benefit from the presence of foreign MNCs' subsidiaries. Only exporting firms profit from the presence of foreign MNCs' subsidiaries. Castellani and Zanfei assume that non-internationalized Italian firms lack the absorptive capacity to learn from the foreign MNCs. By contrast, they are more easily able to learn from domestic MNCs which are more rooted in their home economies due to the lack of barriers, such as linguistic obstacles. This once again supports the assumption made in Section 4.2.3 on the role of home country embeddedness of MNCs as a driver of reverse knowledge transfer to other home country firms.

Unfortunately, there are only few studies analyzing the home country productivity effects of outward FDI from developing countries. One of the few studies has been conducted by **Herzer (2011b)**. Based on a sample of 33 developing countries (1980-2005), he reports a positive, long-run relationship between their outward FDI and total factor productivity in the home economy. Moreover, Herzer shows that this relation is bi-directional, i.e., outward FDI is both a cause and consequence of increased factor productivity.

Overall, the findings largely seem to support the view that outward FDI increases the productivity of home country firms. These effects seem to vary considerably with the estimation method used, the industry considered, time periods and the type of FDI.

4.4.4. Impact on Domestic Output

As shown in the last sections, outward FDI affects various parts of activities in the home economy, ranging from employment and production to investment. A rather new strung of literature has approached the effects of outward FDI on the home country on an even more aggregate level by measuring its overall impact on domestic output and home country economic growth.[102]

A summary of the empirical studies is provided in Table 5. To my knowledge, Herzer (2008, 2009, 2011a, 2012) is among the few researchers to analyze the aggregate effects of outward FDI on the economy as a whole. **Herzer (2008)** empirically investigates the impact of net FDI outflows relative to GDP on home country economic output. Based on panel data of 14 industrialized economies over the period 1971 to 2005, he finds that there is a positive and bi-directional, long-run relationship between outward FDI and real GDP. That is, outward FDI is not only a cause but also a consequence of increased domestic output in the long term. Similar evidence can be found in Herzer (2011a) for a set of developing countries and in Herzer (2009) for Japan and in Herzer (2012) for Germany.

Only recently, studies have started to analyze the effects of outward FDI on long-term economic growth. Herzer (2010) is pioneering in this field. He examines a set of 50 countries using cross-country regressions and applying time-series analysis for a U.S. sample. The cross-country regressions show that outward FDI positively affects economic growth in the home economy. With regards to the time-series analysis of U.S. outward FDI, he finds that outward FDI and home country economic growth are mutually dependent, meaning that outward FDI is both a cause and a consequence of economic growth. Lee (2010a) takes up Herzer's time series approach for Japan and shows a long-run positive relationship between outward FDI and Japanese GDP per capita. However, the findings show that for Japan this causality is uni-directional, i.e., increased outward FDI is only a cause of increased income but not consequence. By contrast, no evidence for a long-run relationship between the two factors is found in Lee (2010b) for Singapore.

[102] There exists a large strung of empirical literature on the relationship between inward FDI and economic growth in the host economy (Borensztein et al. 1998, Zhang 2001). In particular there is a broad strand of literature on FDI-driven international technology diffusion including cross-country panel analyses as well as case studies. Several econometric studies analyze the effects of FDI inflows on GDP growth of the recipient country or productivity spillovers from foreign to domestic firms revealing diverse results. Using data on 11 economies in East Asia and Latin America, Zhang (2001) for example finds that inward FDI can boost economic growth in the recipient country, but the extent depends on country-specific characteristics such as a liberalized trade or macro-economic stability.

Table 5: Summary of empirical studies on the impact of outward FDI on domestic output and economic growth

Authors	**Sample**	**Period**	**Hypothesis/research question**	**Data Source**	**Methods**	**Main findings**	**Impact of outward FDI**
Herzer (2008)	14 industrialized countries	1971-2005	Examine the long-run relationship between outward FDI and domestic output	UNCTAD and WDI	Panel unit roots and cointegration techniques	Outward FDI has positive long-run effects on domestic output, long-run causality is bi-directional	Positive
Herzer (2009)	Japan	1970-2006	Examine the long-run relationship between outward FDI and domestic output	UNCTAD and WDI	Cointegration techniques	(i) Long-run relationship between outward FDI and domestic output, (ii) Outward FDI has positive effect on domestic output, both in short and long-run, (iii) long-run causality is uni-directional from outward FDI to domestic output	Positive
Herzer (2010)	50 countries	1980-2000	Examine impact of outward FDI on home country economic growth	Barro and Lee (2000) and WDI	Cross-country regressions and time series estimators	Outward FDI is positively associated with economic growth, causality is bi-directional	Positive
Herzer (2011a)	43 developing countries	1981-2008	Analyze the long-run effect of outward FDI on domestic output	UNCTAD and WDI	Panel unit roots and cointegration techniques	Outward FDI has, in general, a positive long-run effect on domestic output in developing countries (uni-directional)	Positive

Lee (2010a)	Japan	1977-2006	Assess the impacts of outward FDI on the economic growth of a home country and to investigate the causal relationship between outward FDI and income	WDI	Bivariate and multivariate Granger causality frameworks	Long-run positive, but unidirectional causality from outward FDI to GDP per capita. In the short-run, both per capita income and outward FDI do not allow Granger causality	Positive in the long-run
Lee (2010b)	Singapore	1972-2006	Examines the relationship between economic growth and outward foreign direct investment	WDI	Unit root tests, cointegration tests and Granger causality tests	No evidence of long-run causality between these two variables. Increased outward FDI leads to higher GDP per capita only in the short-run	No causality in the long-run, positive in the short-run

The empirical studies deliver interesting insights in the dynamics between outward FDI activity and home country economic development. An important question which has, however, not been addressed yet in previous studies is how the knowledge pool of the host countries feeds back to the home economy and how this reversely affects long-term economic growth in the home economy. As discussed in the previous chapters, host countries with a large pool of knowledge (for example in terms of R&D activities) are expected to have positive effects on the investing firms. This might positively spill over to the home economy due to reverse knowledge transfer channels. The very fact that the knowledge pools of host countries play an important role has already been supported by several studies such as Lichtenberg and van Pottelsberghe de la Potterie (1998, 2001). The empirical investigation by van Pottelsberghe de la Potterie and Lichtenberg (2001), for example, shows that a country's productivity is increased if it invests in R&D intensive countries. However, to date, there is to the knowledge of the author no study which analyzes this aspect for overall home country economic growth. In Chapter 6 the thesis will set out to fill this gap.

4.5. Summary

There is an ongoing controversial debate about the effects of outward FDI on the home economy. Whereas critics are concerned that outward FDI has a negative impact on the competitiveness of other home country firms and is "hollowing out" home country employment, exports and domestic investment activity, advocates argue that outward FDI can generate various benefits for the home economy, in particular with regards to reverse knowledge transfer. The previous chapters have screened the theoretical and empirical works on the potential reverse knowledge transfer channels and their determinants and reviewed the expected effects of outward FDI on the home economy.

As could be seen in Chapter 3, knowledge-sourcing activities and reverse knowledge transfer have been identified as important benefits to the investing firms themselves. To benefit the economy as a whole the acquired and reversely transferred knowledge has to spread and diffuse to a large number of firms in the home economy. Several channels have been identified in the literature review, namely demonstration effects and labor mobility as well as vertical and external network linkages. Spillovers to the rest of the home economy are, however, subject to certain conditions which may enhance or reduce the reverse knowledge transfer and spillover potentials of the four channels mentioned. A large

literature has identified the role of national absorptive capacity which in turn is determined by factors such as human capital and financial market development as well as the maturity of the national innovation system. A closely related determinant is the knowledge gap between the MNC and other home country firms. Although a certain gap may be beneficially with regards to knowledge spillover potential, a gap that is too large might be counterproductive. Hence, the findings reflect that MNCs need to be advanced enough to generate knowledge spillover opportunities for the home economy, while home country firms need to possess enough absorptive capacity to capture such opportunities. This finding gives support to the assumption that MNCs from emerging economies are more likely to successfully use outward FDI as a developmental tool than MNCs from less developed countries which have not yet developed sufficient capabilities. Other factors which are expected to impact reverse knowledge transfer comprise the MNCs' home country embeddedness, the size of the home economy and the type of outward flows.

So far, empirical evidence on the home country effects of outward FDI is scattered. Findings are very much country and industry specific and focus on different aspects and parts of the home economy. For example, studies are still inclusive how internationalization and outward FDI feed back to home country employment, exports and domestic investment. In contrast, many findings support the assumption that MNCs generate knowledge spillovers to other home country firms, thereby influencing their knowledge base and productivity. However, the decisive question how all these partial effects sum up to the net effect, that is, how all these aspects impact overall development and economic growth, has scarcely been addressed by the theoretical and empirical literature. Although there are first indications that economic growth is positively affected by outward FDI, academic research has provided us with a mixed picture and inadequate understanding of the net effects of outward FDI on home country economic development. What is still missing are a sound theoretical framework and an empirical assessment that takes into account reverse knowledge transfer processes to get a better understanding of the home country effects of outward FDI. The next two chapters set out to fill this research gap both from a theoretical and empirical perspective.

5. HOME COUNTRY EFFECTS OF OUTWARD FDI IN A THEORETICAL GROWTH MODEL

Economic growth is one of the most widely used indicators to measure and compare the economic development of countries.[103] The question whether economic growth benefits development – not only economically but also regarding other aspects of human development such as quality of life, health or education – has been subject of extensive controversial discussion among development economists dating backing to the 1950s (Bhagwati 1958, Dollar and Kraay 2002, Easterly 1999 among others). A more detailed assessment of the single arguments of advocates and opponents of the growth concept as a measure for development would be beyond the scope of this thesis. Given that many other aspects of wellbeing are, with some exceptions, correlated with economic progress (Barro and Sala-i-Martin 2004, Easterly 1999), it may be expected that economic growth is beneficial to the whole society if the increase in economic wealth is coupled with improvements in other aspects of human development (health, education, innovation and research, employment creation etc.). Thus, while keeping in mind that the growth concept has its limitations and that development implies more than just an increase in per capita income, it is assumed in the following discussion that economic growth is a crucial determinant of development processes and a good proxy for development in general.

Despite the critique of the growth concept, the ever-growing theoretical and empirical literature shows that economic growth has continued to stay on the academic agenda. Some of the most important milestones of economic growth theory will be presented in the following section.

[103] One has to distinguish between long-term and short-term economic changes. While the short-term variation of economic activity is referred to as the business cycle, the term "economic growth" is usually concerned with the long-run dynamics of economic development. One has to keep in mind that, given the effects of compounding, even minor ups and downs of the business cycle can have significant effects in the long-run. For example, while a growth rate of 2.5% per annum will lead to a doubling of GDP within 28 years, an average growth rate of 5% will result in a doubling of GDP within half of the time, roughly 14 years.

5.1. Role of FDI in Different Paradigms of Growth

5.1.1. Neoclassical Assessment

5.1.1.1. Solow Model

First approaches to understand the drivers of growth can already be found in Adam Smith's famous work on "The Wealth of Nations", which was first published in 1776 (Smith 1991). Smith identifies savings, competition and the efficient division of labor as the main pillars of economic development. For many growth theorists the work of Ramsey (1928) marks the starting point for modern growth theory (Barro and Sala-i-Martin 2004). His treatment of household optimization (intertemporal separable utility function) along with the optimality conditions has found wide application in growth theory. In the post-Keynesian models of Harrod (1939) and Domar (1946) the production functions allowed for little substitutability among the inputs and capital accumulation was the sole driver of economic growth.

What followed were the seminal works of Solow (1956) and Swan (1956) which build the foundation of the neoclassical or exogenous growth theory as it is known today. A basic property of the neoclassical growth theory is the neoclassical form of the production function with the three basic assumptions of positive and diminishing returns of factor inputs, constant returns to scale, and the Inada condition.[104] Neoclassical growth theorists stress the role of capital and model growth as a dynamic process of the accumulation of capital, in which countries move towards a steady state. In the equilibrium, the level of capital, labor and goods grow at the same rate and their marginal revenues are identical. Without technical progress growth of per capita income is coming to a halt.

Given the assumption of diminishing returns to capital, the major prediction of the Solow-Swan[105] model is the economic convergence of countries. Increasing capital relative to labor triggers economic growth, since people are getting more productive due to the increased capital. The model predicts that the lower the starting level of capital per worker of a country relative to its steady-state position, the higher the rates of return on capital investment and thus the higher the growth rates. Accordingly, poorer economies with less capital per worker will grow at higher rates because each capital investment will yield higher returns than in richer countries with a higher level of initial capital per worker.

[104] For a description of the basic properties of the neoclassical growth theory see Sala-i-Martin (2004).

[105] The term "Solow model" will be used in the following.

However, it is important to distinguish between absolute and conditional convergence. The models predict absolute convergence, if all economies have the same exogenous parameters (e.g. saving rates or population growth rate). All economies will then converge to the same steady state/long-run growth path. Accordingly, differences in growth rates between countries are explained with differences in the initial level of capital. Although there are examples of absolute convergence, for example the catch-up of East Asian Tigers to the group of high-income countries, empirical evidence rather shows a convergence between countries with similar characteristics. Conditional convergence implies that an economy converges to its own, country-specific long-run growth path, which is conditioned by its own structural characteristics (Mankiw et al. 1992).

The Solow model has several limitations and shortcomings. Early neoclassical growth models predicted the stagnation of income per capita in the long-run due to the assumption of diminishing returns to capital. However, empirically this was and is still not the case. Theorists argued that the shortcoming of the model was due to the ignorance of technological progress in early neoclassical growth models (Barro and Sala-i-Martin 2004). Solow addressed this deficiency by extending the original model which describes growth as a function of exogenously given technological change and by assuming that technological progress was given exogenously. Integrating technological progress has been a major improvement of the model as it allows for the possibility of a positive per capita growth rate in the long-run which is a better reflection of the empirical evidence (Barro and Sala-i-Martin 2004).[106] Some shortcomings and limitations remained: Both the saving rate and the rate of population growth are treated as constant and exogenously given. The major drawback of the Solow model, however, is that the long-run per capita growth rate is determined by a factor that is outside of the model: Technological progress as the main driver of economic growth is left unexplained (Barro and Sala-i-Martin 2004).[107] The model fails to explain the sources of technological progress and gives no answer to the question how technological progress may be influenced and fostered.

[106] Based on his theoretical model, Solow developed the so called "growth accounting" technique (Solow 1957) to test the contribution of production factors to economic growth. The method decomposes the GDP growth rate into contributions from changes (increases or decreases) in the amount of physical capital and labor and an unexplained factor – the so called "Solow-residual". The residual is considered as a change in the technology or productivity level and is therefore also called "Total Factor Productivity". Solow's growth accounting technique which shows that large parts of economic growth are driven by the Solow-residual has empirically revealed the deficient explanation power of the neoclassical growth models.

[107] The long-run growth rate of the level of economic output is also determined by the growth rate of population, which is exogenously given.

5.1.1.2. Impact of FDI on Growth in the Neoclassical System

As seen above, knowledge accumulation and technological progress have been important factors in explaining long-term economic growth in neoclassical growth models. However, given that knowledge accumulation and technological progress are exogenously given, the potential linkages between (inward and outward) FDI, knowledge accumulation and technological progress is also something that happens exogenously outside the model. Thus, the extent to which FDI can affect economic growth in standard neoclassical growth settings is limited.

There exist a few theoretical approaches to integrate FDI into the neoclassical growth setting. All of them address the effects of FDI from a host economy perspective and not from the view of a home economy. However, given that the main mechanism could also apply for the growth effects of outward FDI, the main findings of the literature deserve a brief review. Brems (1970) was one of the first studies to model the effects of inward FDI on economic growth of the host economy. The author treats inward FDI as an additional capital input in the production function of the host economy. Due to increases in the accumulation of capital, inward FDI is shown to have a positive effect on economic growth. The magnitude and duration of the short term impact depend on the transitional dynamics to the steady-state growth path (de Mello 1997). The main drawback of Brems' model is that FDI has only a temporary effect on per capita GDP given the diminishing returns to capital. Long-term effects on income per capita such as technological progress were left outside the model. The long-run growth rate is left unchanged as countries move towards a new steady state "as if FDI had never taken place, leaving no permanent impact on output growth" (de Mello 1997, p.8). Applying Brems' predictions to the case of outward FDI and home country economic growth, one might expect that outward FDI reduces the capital stock in the home economy (except for the case where earnings are retransferred to the home economy). However, given the assumption of diminishing returns to capital, this negative impact of outward FDI should again be limited to the short run. In light of these findings, it can be expected that FDI-promoting or restraining policies measures would only have limited effects, but no long-run impact on economic growth.[108]

[108] This does not mean that the transitional dynamics of different polices have no importance, since they do affect the long-term level of variables such as the level of income, capital and consumption and may also have an impact on the path towards the steady state. For instance, policies aimed to increase the saving rate should result in a higher income level in the steady state although they will have no effect on the long-run growth rates (Lucas 1988).

Another well-known theoretical work on FDI and economic development is the study of Findlay (1978). The author does not directly model the effects of FDI on economic growth, but constructs a dynamic model to determine the effect of inward FDI on the transfer of technology to the host economy. The model highlights the role of inward FDI in raising the rate of technological progress in the host country through spillovers to host countries originating in advanced technology of foreign firms.

In line with the neoclassical growth framework, Wang (1990) analyzes the growth effect of North-South FDI flows for developing host countries. Wang assumes that technological progress in less developed countries is determined by the amount of inward FDI and the technological gap between the host and the investing country. Incorporating the interaction among growth, technological change, and international capital movement, the model shows that shifts from autarky to free capital mobility increases technological diffusion, accelerates technological change and raises the long-run growth rate in developing countries - thus narrowing the equilibrium per capita income gap between a developing country and its developed counterpart.[109]

Despite the limitations of the neoclassical theory to model FDI as a determinant of economic growth, its main properties have contributed to the understanding of growth dynamics and the economic convergence of economies. The model's deficiencies have prompted economists to advance the understanding of growth dynamics which led to various reformulations of the Solow model and major departures from the neoclassical growth theory, such as the theory of endogenous growth which will be reviewed in the next section.

5.1.2. FDI and the Theory of Endogenous Growth

5.1.2.1. Overview

The "Endogenous Growth Theory", also known as the "New Growth Theory", mainly emerged out of the critique of the neoclassical growth model and its deficiency in

[109] An important side note with regards to international capital movements is that the standard neoclassical model predicts that capital flows are determined by relative factor endowments, flowing from capital abundant countries to capital poor ones. In the long-run this leads to an equilibrium, in which the capital-labor ratio and factor prices are equalized across countries. However, the predictions do not match with the empirical observation since the majority of FDI flows worldwide are between capital rich countries. This observation has become known as the "Lucas Paradox" (Lucas 1990). Moreover, as mentioned in Chapter 2, a significant increase in capital flows in the reverse direction can be observed, from capital scarce developing to capital rich developed countries (uphill flows). According to Hymer (1976), capital movements in the form of FDI are not driven by interest rates differentials, but can rather be explained by profit-seeking decisions of individual firms which want to exploit their firm-specific assets and gain control over foreign enterprises.

explaining long-term economic growth. The studies of Romer (1986) and Lucas (1988) are considered as the pioneering works.[110] The common ground of endogenous growth models is to determine technological progress and thus the long-run rate of economic growth "endogenously" within the models, in contrast to neoclassical models where technological progress as the main determinant is given exogenously.

The endogenous growth theory has introduced two major aspects: First, technological change is no longer treated as a product of non-market forces but modeled endogenously as the result of deliberate actions taken by profit maximizing economic agents who respond to market incentives. Second, endogenous growth theorists have broadened the concept of capital by including knowledge capital. Unlike physical capital in the Solow model, the accumulation of knowledge capital is not subject to diminishing returns. Knowledge can be shared and given its non-rival nature can (partly) spill over. Moreover, new ideas build on existent knowledge and knowledge can be accumulated without limits. In endogenous growth models, the increasing returns to knowledge are the basis of long-term economic growth. This new assumption leads to major changes in the conclusions that can be drawn from growth models.

So far, various endogenous growth models have been developed, each of which highlights different aspects of knowledge accumulation and economic structures. These models may be roughly classified into three groups:

1. Capital accumulation models (AK model) (Rebelo 1991)
2. Human capital models (Lucas 1988)
3. Innovation-based models (Schumpeterian growth models) (Romer 1990, Grossman and Helpman 1991, Aghion and Howitt 1992).

Whereas the first two model groups assume perfect competition, innovation models explicitly include imperfect competition. One of the most prominent representatives of the latter group, the Romer model (1990), which will be the main building block of the outward FDI driven growth model, will be shortly presented in the following section.

5.1.2.2. Romer's Endogenous Growth Model

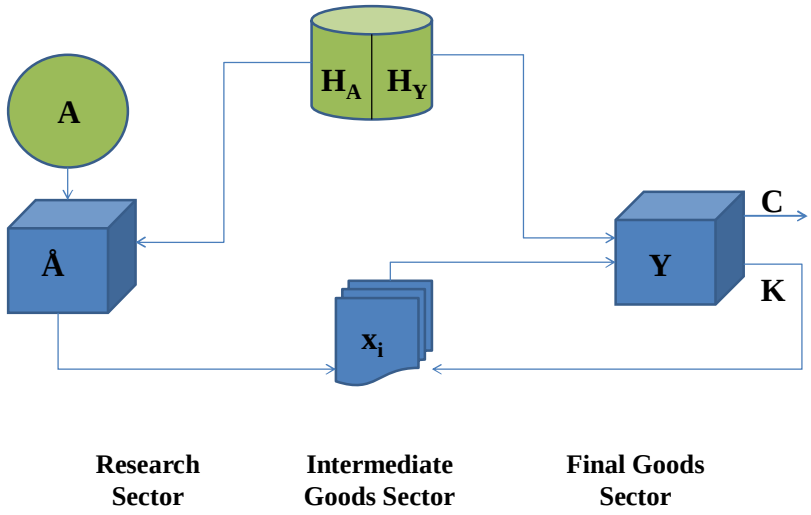
The focus of Romer's growth model (Romer 1990) is the endogenously determined process of knowledge accumulation and the assumption that long-term economic growth is

[110] The studies were partly based on the work of Arrow (1962b).

primarily driven by the continuous knowledge accumulation of profit maximizing agents. Romer's models (1986, 1990) introduce two important features: R&D activity and imperfect competition. R&D activity leads to innovation and due to imperfect competition R&D investments are rewarded by temporary monopoly power which stimulates further R&D activity.

In the standard endogenous growth model the economy consists of three sectors: A research sector invents new production designs $\dot{A}$ with the input of human capital (HA) and the available stock of knowledge A. These designs are then sold to the intermediate goods sector. The intermediate goods sector refines a constant share of capital goods (K) with the designs and turns them into differentiated capital goods (xi) with practical value. These are then in a final step sold to the final goods sector. In this competitive, final goods sector producers combine human capital (Hy) and intermediate inputs (xi) to produce a homogenous output good Y that either serves as a consumption (C) or as an capital good (K). The process is in a simplified form presented in Figure 10.

Figure 10: Structure of the Romer Model



Remark: Own Illustration based on Romer (1990).

In the Romer model, technological progress takes the form of an increase in the number of varieties of intermediate goods (horizontal product innovation). That is, a new technology corresponds to a new type of intermediate good that increases the efficiency of production in the final goods sector. Of course, the number of varieties of intermediate products has to

be considered as a metaphor for technological progress. However, it provides a suitable framework to analyze long-term growth (Barro and Sala-i-Martin 2004).[111]

Implementing a new technology necessitates a fixed cost to be incurred by the intermediate goods and research sectors. At this point a basic assumption used to be, however, that knowledge is non-rival (see Chapter 2). Under perfect competition this would mean that every researcher has access to new knowledge leaving researchers with no incentives to invest in innovation and for intermediate goods firms to buy patents since the investment does not pay off. This is why Romer introduces imperfect competition in the intermediate goods sector of the model. Accordingly, the acquisition of patents gives intermediate goods producers temporary monopoly power and rents, which compensate for the purchase of the production design. Given that other intermediate good firms may enter freely in the market, this leads to a situation of imperfect competition in the intermediate goods sectors, which in the end enables the research sector to absorb the monopoly rents. Thus, incentivized by the prospect of monopoly profits, researchers mobilize resources to discover new types of goods.

Another important assumption of Romer's model is that knowledge is only partly excludable from the use of others, for example because of problems in keeping innovations perfectly patented. Thus inventors can only partly prevent others from using a new idea. Due to the knowledge spillovers, other agents may profit from the knowledge generating activity of firms and the existing stock of knowledge (A) that has been accumulated in the past.

Several conclusions can be drawn from the Romer model. First, one of the main results is that innovations, in contrast to labor or physical capital, are not subject to diminishing returns. Second, the growth rate is increasing with the stock of human capital, whereas it is not determined by the total size of the labor force population. Third, the more integrated countries are into the world economy, the greater is the pool of knowledge from which they can draw from and the higher are the long-term economic growth rates. This has implications for the effects of FDI on economic growth as will be discussed in the next section.

[111] Another metaphor for technological progress used in other endogenous growth models is the improvement of the quality of existing capital goods (vertical product innovation). The so called quality ladder models can be found in Aghion and Howitt (1992) and Grossman and Helpman (1991).

5.1.2.3. The Effects of FDI in Models of Endogenous Growth

The new visions on growth have clearly deepened the understanding of economists about how technology acquisition and knowledge accumulation could drive the process of growth and how economic growth could be affected by an array of factors, other than the underlying factor endowment. Accordingly, the endogenous growth theory allows for a formalization of the link between FDI and economic growth as it treats a number of growth-inducing factors which can be related to FDI as endogenous variables such as learning by doing, R&D activity, human capital formation via education and training, and knowledge spillovers. In this regard, the contribution of FDI to economic growth may come through its role as a conduit for transfer and diffusion of knowledge between countries. FDI flows can accelerate growth by giving countries access to a larger pool of knowledge, allowing them to benefit not only from their national pool of knowledge but from the world-wide level of know-how. The lack of international exposure in rather closed economies and lags in the transmission of ideas across economies may impede knowledge transfer and curb economic growth (Romer 1990).

So far, only few studies have modeled the relationship between FDI and economic growth. The focus of academic research has been on the instruments of international trade (Romer 1990, Easterly et al. 1994) and inward FDI (Borensztein et al. 1998, Berthélemy and Démurger 2000) and their implication for economic policies. With regards to the growth effects of outward FDI, academic research has been limited to empirical studies.

The work of Borensztein et al. (1998) is one of the few studies which formalizes the effects of inward FDI on economic growth based on an endogenous growth setting. However, as noted in Berthélemy and Démurger (2000), Borensztein et al. did not account for the endogeneity of inward FDI. The theoretical and empirical findings of Borensztein et al. suggest that FDI is an important vehicle for technology transfer, contributing to economic growth to a greater extent than domestic investment. They furthermore find that the effect of inward FDI is determined by a complementary effect between inward FDI and the level of host country human capital. The higher the level of human capital development the greater are the effects of FDI on host country economic growth. But in order to have a positive effect on economic growth in first place, the host country has to have a minimum threshold stock of human capital. The authors conclude that the main conduit through which inward FDI affects economic growth is by stimulating technological progress, rather than by increasing total capital accumulation in the host economy.

The endogenous growth theory has significant implications for the discussion about the effects of FDI on economic growth. In contrast to neoclassical growth models which pinpoint the mere capital accumulation effect of FDI on growth, the endogenous growth theory attributes the growth-contributing effect of FDI to technology transfer and spillovers and makes the endogenously determined knowledge accumulation a crucial link in the relationship between FDI and growth. In this setting, FDI in general or FDI policy in particular can be shown either to favor or deter growth, depending on whether it favors or deters technology acquisitions and knowledge accumulation.

Despite the crucial role of MNCs as instruments to tap foreign pools of knowledge, the transmission channels of outward FDI on economic growth have not been modeled yet. To the knowledge of the author, there exists to date no theoretical work in the endogenous growth literature, which describes the relationship between outward FDI and home country economic growth. In particular, there exists no theoretical work to examine the direct (Chapter 3) and indirect growth effects (Chapter 4) of outward FDI on the home economy. The following chapter sets out to fill this gap.

5.2. An Endogenous Model of Outward FDI

The following model is developed closely along the lines of Romer's (1990) R&D-based model and builds on a modified version by Berthélemy and Démurger (2000)[112] who adapt Romer's framework to model the dynamics between inward FDI and economic growth. It is based on the assumption made by Romer that technological change is the main driver of long-term economic growth and that technical progress and innovation takes the form of an expansion of the number of varieties of intermediate goods available in an economy.

The ongoing process of innovation activity in the model prevents decreasing returns in the long-run and allows for sustained growth. However, whereas Romer assumes the same technological level for every firm engaged in R&D activity, an idea brought forward by Berthélemy and Démurger (2000) is integrated who distinguish between two different technological levels in the innovation process. Accordingly, two types of firms are defined in the intermediate goods sector of the economy, with the one producing goods arising from an innovation process on a high technological level while the other develops low

[112] The same model has also been published and discussed in an OECD publication (Démurger 2000). The following analysis draws from the discussion in both publications.

technology designs.[113] Berthélemy and Démurger (2000) attribute these distinct technological capabilities to a firm's country of origin and differentiate between domestic (low-tech) firms and foreign-funded (high-tech) firms, assuming that the latter embody a more advanced technology than local firms. In the following model, their logic and analysis is applied to the case of MNCs and outward FDI by distinguishing between domestic, non-multinational firms which exclusively operate (innovate and produce) in their home country and multinational firms which control one or more subsidiaries abroad and are able to tap advanced knowledge.[114] In contrast to the model of Berthélemy and Démurger (2000), both types of firms have their origin and thus headquarter in the same country, the distinctive feature is whether they have internationalized or not.[115] The key rationale of the model is that multinational firms are assumed to explore and acquire advanced technology and knowledge by operating in foreign market, in particular in more advanced countries. The knowledge is applicable to the production of new intermediate goods at home, which may be already available in other economies. Such kind of reverse knowledge transfer should not only expand the technological capabilities and productivity of the investing firm (as seen in Chapter 3), but can also create spillovers to the domestic sector (as discussed in Chapter 4). Expressed in the logic of the model this means that goods originating from an innovation process at a higher technological level are produced by firms which operate internationally, while domestic, non-multinational firms produce low technology goods. The assumption on productivity differences between domestic and multinational firms is in line with the empirical findings discussed in Section 3.3.2. This approach makes it possible to show that the rate of economic growth partly depends on the relative weight of each category of firms in an economy and that it can be expressed as a function of the relative level of outward FDI.

Based on the approach of Berthélemy and Démurger (2000), the findings made in Chapter 3 and 4 are integrated in the model. In detail, it will be shown that outward FDI positively

[113] Intermediate products typically not only embody semi-processed materials, but also firm-specific intangible assets such as technological knowledge or skills enclosed in goods and human capital such as organization, management or marketing competences (Kokko 2006).

[114] Of course, one has to keep in mind that, in reality, MNC are not only intermediate goods producers but may be final goods producers. This constraint is made to simplify the model. However, there is in fact evidence that MNCs specialize their activities at home in R&D and the production of (knowledge-intensive) intermediate goods. For example in Sweden, as noted by Blomström and Kokko (1998), Swedish MNCs concentrate their home country activities in R&D and intermediate good production.

[115] Although foreign-owned firms play a very important role in the economic catch-up process, the presence of foreign-owned companies in the domestic market, as analyzed in Berthélemy and Démurger (2000), is disregarded for the sake of simplicity.

impacts the home economy due to two effects. The first impact comes from the so called "extension effect" and the direct reverse knowledge channels discussed in Chapter 3. The extension effect is a direct result of outward FDI activities of internationally operating firms since they endow the domestic economy with new varieties of intermediate goods and thus extent the total number of varieties available. The second effect, which is referred to as "spillover effect", comes from the indirect reverse knowledge channels discussed in Chapter 4. Its underlying principle is that some of the advanced knowledge which is imported by internationally operating firms creates externalities to the domestic R&D sector which incorporates the new ideas, at least in parts, in its research activity. Accordingly, the spillover effect has an indirect impact on the home economy by adding to the existing knowledge stock.

5.2.1. Model Setup

5.2.1.1. Overview

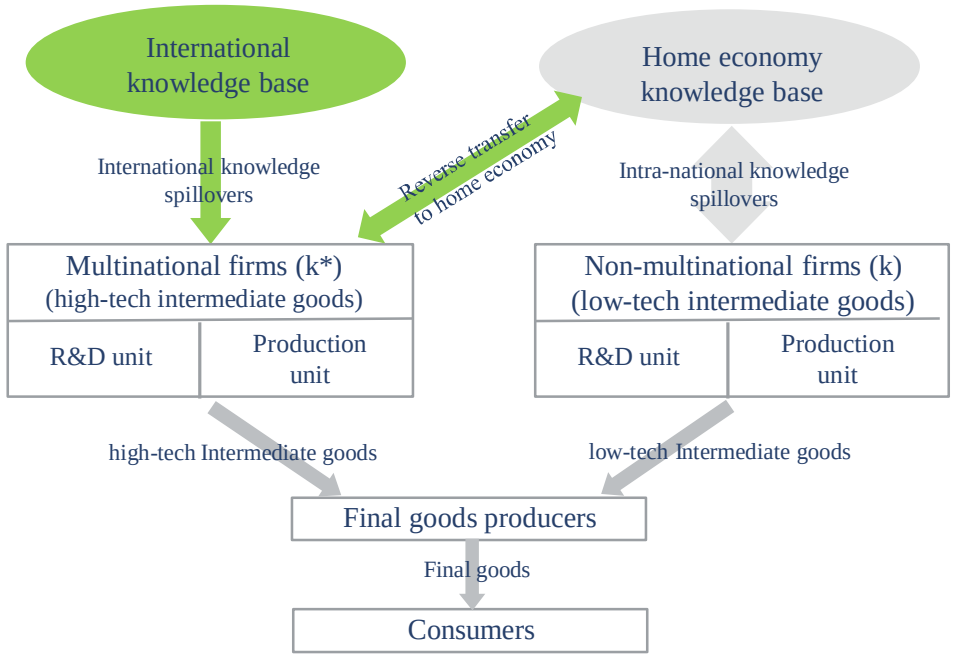
As in Berthélemy and Démurger (2000), the economy produces a single consumption good. Four inputs are used in the production process: capital, labor, human capital, and an index of the level of technology. Capital may be measured in units of consumption goods and is made up of a continuum of intermediate goods *x(i)*. Physical labor *L* refers to skills that are available from a physical body and is measured by the number of people living in an economy. Human capital *H* refers to the stock of knowledge and skills of the labor force accumulated through formal education, on-the job training and experience. To keep the model's focus on the dynamics of interest, simplifying assumption are made on the supply of the aggregate factors physical labor *L* and human capital *H* which are fixed and given exogenously. An analysis of fertility, population growth, labor force participation, variations in hours worked or the accumulation of human capital is thus precluded (Romer 1990). Also, it is assumed that capital (intermediate goods) does not depreciate.[116]

In contrast to the rival factor *H*, the existence of the non-rival, technological knowledge *K* is independent from any individual and can thus grow boundlessly. In the model, each new unit of knowledge corresponds to a new design for an intermediate good. Aggregate knowledge *K* thus corresponds to the total number of designs available in an economy.

[116] According to Romer (1990, p.82), "(A)dding depreciation would merely add a familiar term to the user cost of capital".

In the conventional Romer model there are three types of sectors in the economy (see Figure 11). The first sector is composed of R&D firms which use human capital and the existing stock of knowledge available in the economy to produce new knowledge in form of new designs. The new designs are then sold to the second sector, the intermediate goods sector. Intermediate goods firms use the designs alongside foregone output to produce intermediate goods, which are differentiated given the uniqueness of the designs applied in their production. The intermediate goods are then rented to the final goods sector which uses physical labor, human capital, and a set of intermediate goods to produce a homogenous good which can either be consumed by households or saved as new capital for the production of intermediate goods. The following model follows the approach by Berthélemy and Démurger (2000) and merges R&D and intermediate good firms to a single "integrated" firm made up of two sub-units: the R&D unit, which creates new designs for intermediate goods and the production unit, which applies the new technology to produce intermediate goods.[117]

Figure 11: Model Setup



Remark: Own illustration.

[117] Romer (1990) explicitly addresses the possibility of such an integrated approach. Here, it allows for the introduction of different technological capabilities and the assumption that firms with low-tech R&D initially only forward their designs to low-tech production firms while those with high-tech R&D can only forward their designs to high-tech firm.

Thus, in contrast to Romer (1990), the following model consists of two sectors, but adheres to Romer's setup in terms of economic activities conducted. As in standard neoclassical models, the final good serves as a numeraire so that all prices can be measured in units of the homogenous final good which equals one. The following chapters provide an overview of the household decisions as well as the production decisions made in each sector.

5.2.1.2. Final Goods Sector

The final goods sector in the home economy consists of final goods firms, each one producing a homogenous good which is either consumed by households or saved as new capital and applied in intermediate goods production. Aggregate output *Y* is expressed as a function of physical labor *L*, human capital deployed to final output H_Y, and physical capital which is made of *K* distinct varieties of intermediate goods $x(i)$ produced by the intermediate goods sector. The aggregate final production function takes the form of an extended Cobb-Douglas production function:

$$Y(H_Y, L, x) = H_Y^{\alpha} L^{\beta} \int_0^K x(i)^{1-\alpha-\beta}\, di \qquad (1)$$

where $0 < \alpha < 1,\ 0 < \beta < 1,\ 1 - \alpha - \beta > 0$ and $x(i)$ is the employment of the *i*th type of a specialized intermediate good. All producers use the same technology and inputs. The production function differs from its usual form in its assumption that capital is disaggregated into a finite number of distinct types of intermediate goods. This is expressed by an additively separable function of all the different types of intermediate goods.[118] [119] Whereas in the traditional neoclassical theory intermediate goods are perfect substitutes, Romer (1990) sets up a production function in which all durables have additively separable effects on output. Consequently, with the introduction of a new type

[118] Given that *K* represents the number of kinds of intermediate goods the variable should be treated as discrete. However, Barro and Sala-i-Martin (2004) suggest *K* to be a representative variable for the complex techniques of the production processes or the average degree of specialization of the applied inputs. The broader notion of *K* is thus rather continuous than discrete. In equation (1) this is reflected by the integral over the continuum of types of intermediate goods (instead of a sum over a discrete number of types).

[119] The first approach to express consumer preference over varieties comes from Spence (1976) and was refined by Dixit and Stiglitz (1977). Ethier (1992) was the first to apply this to describe production with a variety of intermediate goods as inputs to the production process. Romer (1990) was the first to apply the varieties of intermediate goods in an economic growth model.

of intermediate good the already existing types of intermediate goods continue to exist and do not get outdated.[120]

Equation (1) implies that the marginal product of each intermediate good, $\delta Y/\delta x(i)$, is infinite at $x(i) = 0$, and then diminishes as $x(i)$ rises. If *K* types of goods are available at finite prices, each firm will be motivated to use all *K* types symmetrically. In equilibrium, intermediate goods will thus be utilized in the same quantities, henceforth denoted as $\bar{x}$. The production function can now be rewritten so that:

$$Y(H_Y, L, x) = H_Y^{\alpha} L^{\beta} K \bar{x}^{1-\alpha-\beta} \qquad (2)$$

Technological progress takes the form of an increase in the number of differentiated intermediate goods, *K*, which are available in the home economy. To illustrate the effect of an expansion in *K*, the equation is transformed so that output can be expressed as:

$$Y(H_Y, L, x) = H_Y^{\alpha} L^{\beta} (K\bar{x})^{1-\alpha-\beta} K^{\alpha+\beta} \qquad (3)$$

For a given *K*, the equation implies that production exhibits constant returns to scale in *L*, H_Y and $K\bar{x}$, the total quantity of intermediate inputs. For given quantities of *L*, H_Y and $K\bar{x}$, *Y* increases with *K* in accordance with the term $K^{\alpha+\beta}$. This effect, which captures a form of technological progress, reflects the benefit from spreading a given total of intermediates, $K\bar{x}$, over a wider range, *K*. The benefit arises because of the diminishing returns to each $x(i)$. For fixed *L* and H_Y, the equation implies that an expansion of intermediates, $K\bar{x}$, encounters diminishing returns if it occurs through an increase in $\bar{x}$ for a given *K*. There are no diminishing returns, however, if the increase in $K\bar{x}$ takes the form of a rise in *K* for a given $\bar{x}$. Thus, technological change in the form of continuing increases in *K* avoids the tendency for diminishing returns. This feature of the production function provides the basis for endogenous growth in the model.

Given the perfect substitutability of final goods, the final goods sector is one of perfect competition. Every final goods producer takes prices as given and uses the same technology. To maximize profits subject to the technological constraint, the producer decides on the quantities of physical labor (compensated by the given wage rate of physical labor w_L), human capital (compensated by the given wage rate of human capital w_{H_Y}), and

[120] In this sense, the marginal product of an intermediate good does not dependent on the input of another intermediate good in the production of a final good. As a new type of intermediate good may be a direct substitute to or a direct complement with the already existing varieties, the specification of the independence of marginal products seems reasonable on average.

intermediate goods $x(i)$ (at the rental rate $m(i)$). The maximization problem for a representative firm can be written as follows:

$$\max_{H_Y, L, x(i)} Y - w_{H_Y} H_Y - w_L L - \int_0^K m(i)x(i)di$$

$$s.t.\ Y(H_Y, L, x) = H_Y^{\alpha} L^{\beta} \int_0^K x(i)^{1-\alpha-\beta}\, di \tag{4}$$

According to the first order condition, the prices of the input factors equal the marginal product of the factors in production of the final good. That is, for the intermediate good *i*:

$$\frac{\partial Y}{\partial x(i)} = 0 \Leftrightarrow m(i) = (1-\alpha-\beta) H_Y^{\alpha} L^{\beta} x(i)^{-\alpha-\beta} \tag{5}$$

for human capital H_Y:

$$\frac{\partial Y}{\partial H_Y} = 0 \Leftrightarrow w_{H_Y} = \alpha \frac{Y}{H_Y} \tag{6}$$

for unskilled labor *L*:

$$\frac{\partial Y}{\partial L} = 0 \Leftrightarrow w_L = \beta \frac{Y}{L} \tag{7}$$

5.2.1.3. Intermediate Goods Sector

The intermediate goods sector consists of *K* firms which develop and produce *K* different types of intermediate goods.[121] As discussed above, the firms are classified in two different categories according to their international activity which determines their technological capability. Accordingly, the sector consists of *k* non-multinational firms which solely operate in their home market and thus possess rather backward, low technological competences and k^* MNCs which operate internationally and therefore produce with advanced knowledge. This means that $K = k + k^*$. Each firm *(i)* in the intermediate sector has two sub-units with distinct activities: In the R&D unit it creates a new design, and in the production unit it translates the new technology into a workable intermediate product

[121] Here, the model setting implies that each intermediate good firm *(i)* only produces one special type of differentiated intermediate good *(i)*.

(i)[122], which can be used in final production. In the following, the two units are analyzed in detail.

5.2.1.4. R&D Unit

The R&D unit creates new designs and varieties for the production of intermediate goods by using as inputs human capital H_R employed in R&D and the existing stock of knowledge *K* composed of both low-tech knowledge *k* and high-tech knowledge k^* which were accumulated in the past.[123] R&D output is furthermore determined by the productivity parameters δ for low-tech firms and δ^* for high-tech firms. By aggregating all low-tech firms engaged in research, the accumulation of low-tech knowledge evolves according to:

$$\dot{k} = \delta H_R k^{\mu} k^{*(1-\mu)} \qquad (8)$$

with $0 < \mu \leq 1$.

The knowledge function is assumed to have constant returns with respect to the two variables low-tech knowledge *k* and high-tech knowledge k^*. Human capital H_R enters linearly. Equation (8) shows that the more human capital is devoted to research and the larger the existing stock of designs (k, k^*), the higher the rate of research output will be. Note that the dot on the variable describes changes of this variable over time. The model fits Romer's assumption on the non-rivalry, non-exclusivity of knowledge in R&D activity, which implies that R&D activity creates knowledge spillovers. The spillover effect implicates that researchers not only profit from their own discoveries, but also from past discoveries made by R&D units outside their firm. This means that internationally operating firms with high technological R&D activity contribute to the body of knowledge available for research in non-multinational, low-tech intermediate firms. However, the approach again follows an assumption made by Berthélemy and Démurger (2000), who presume that each researcher can use only a part of the sum of available knowledge to produce additional knowledge. Therefore a spillover parameter μ for non-multinational, low-tech firms and a spillover parameter μ^* for internationally operating, high-tech firms is introduced. Whereas in Romer's model the weighting factor of the externalities equals one

[122] Each design (innovation) is thus associated with one intermediate good.

[123] The fact that research is relatively human capital- and knowledge-intensive is translated into the extreme assumption that knowledge and human capital are the only inputs in R&D activity while labor and capital do not enter at all. According to Romer (1990), relaxing these assumptions would not change the basic dynamics and results of the model.

($\mu = 1$), here μ is set to be one or less than one to formalize the lack of absorptive capacity of a low-tech firm to make use of the entire set of discoveries available in the economy. One can think of several explanations for the inability of non-multinational firms to absorb and apply existing knowledge. As discussed above, the perhaps simplest explanation may be the lack of absorptive capacity to comprehend new techniques. Another reason may be that low-tech firms basically do not need state of the art technology to conduct research given their specialization in the production of low-tech goods. Moreover, the incapability could be due to the fact that researchers from low-tech firms simply do not know that new designs have been invented by internationally operating firms.

A transformation of the above equation shows that, given the level of high-tech knowledge n^*, and positive externalities ($(1-\mu) > 0$), then for a constant level of human capital devoted to low-tech research and a constant productivity parameter, the lower the level of technology *k*, the higher the rate of accumulation of knowledge in form of new designs:

$$\frac{\dot{k}}{k} = \delta H_R \left(\frac{k^*}{k}\right)^{1-\mu} \tag{9}$$

Symmetrically, it is assumed that high-tech firms conduct their R&D activity so that:

$$\dot{k}^* = \delta^* H_R^* k^{*\mu^*} k^{1-\mu^*} \tag{10}$$

with $\frac{1}{2} < \mu^* \leq 1$. H_R^* is the human capital devoted to research in high-tech R&D units and δ^*denotes the respective productivity parameter. Given the assumption that non-multinational and internationally operating firms usually differ in their technological capabilities, it is expected that δ^* exceeds δ. As seen above, this is due to the fact that internationally operating firms are able to increase their productivity by sourcing and absorbing knowledge in more advanced economies. With regards to a high-tech firm's spillover potential, it is plausible to assume that it creates more externalities than a low-tech firm. Consequently, the weighting coefficient for high-tech firms μ^* is greater than μ. The model follows the assumption made by Berthélemy and Démurger (2000) that μ^* exceeds ½, which can be deduced from the fact that technology intensive firms are more likely to benefit from R&D conducted by firms with the same level of technology than from the one of low-tech firms. However, it is also possible to think of spillovers generated by non-multinational, low-tech firms from which high-tech firms can profit, although at a much smaller scale. Externalities may e.g. occur when non-multinational firms possess specific knowledge, for example because they are more familiarized with the local market and better specialized in producing products that suit the preferences of local consumers.

As mentioned above, non-multinational, low-tech firms are assumed to benefit less from R&D conducted by same-level firms than they profit from the spillovers generated by more advanced firms. In the model, μ is thus expected to be smaller than ½.

Once a new design is discovered by the R&D unit the right to produce it is "sold" to the production unit at price P_k in case of low-tech firms and at price ${P^*}_k$ in case of high-tech firms.[124] Profit optimization across all non-multinational, low-tech R&D units thus yields:

$$\max_{H_R} \pi_R = P_k \dot{k} - w_{H_R} H_R \tag{11}$$

Substituting equation (8) in (11) yields:

$$\max_{H_R} \pi_R = P_k \, \delta H_R k^{\mu} k^{*(1-\mu)} - w_{H_R} H_R$$

Since the R&D sector takes "prices" as given, human capital will be paid by its marginal productivity:

$$w_{H_R} = P_k \frac{\partial \dot{k}}{\partial H_R} = P_k \delta k^{\mu} k^{*(1-\mu)} \tag{12}$$

Symmetrically, the wage rate for human capital ${w_{H_R}}^*$ in the high-tech R&D sector is given by:

$${w_{H_R}}^* = {P_k}^* \frac{\partial \dot{k}^*}{\partial {H_R}^*} = {P_k}^* \delta^* {k^*}^{\mu^*} k^{(1-\mu^*)} \tag{13}$$

5.2.1.5. Intermediate Goods Production Unit

The production unit of the intermediate goods firm produces new intermediates with the design input "purchased" from the R&D unit of the firm. Since it is assumed that it uses the same production technology as final goods producers, intermediate goods producers may convert a certain number of final good units η into an intermediate good unit. Thus, instead of using the resources in final goods production they are now used to produce intermediate goods.[125] Once a firm has produced a design for an intermediate good *i*, it can

[124] Given that the R&D unit and the production unit are integrated in a single firm, there is in fact no real price to be paid. Berthélemy and Démurger (2000) thus suggest that prices can be interpreted as initial investment costs of designing a new product. Adapted to the case of internationally operating firms, prices can also be interpreted as costs of acquiring foreign R&D know-how by acquiring in a "strategic asset-seeking mode" foreign firms or shares of foreign firms. In both cases, it can be seen that the price for the design will enter in the production function of the intermediate good as a fixed cost.

[125] This rather extreme assumption is made for the sake of simplicity. To assume that intermediate goods can be considered as foregone output is equivalent to assume that intermediate goods are produced in a separate

obtain an infinitely lived patent on that design. It then manufactures $x(i)$ units of the good and sells it to final goods firms at price $m(i)$.

Since the intermediate goods firm will be the only provider of the differentiated good *i*, the producer retains a perpetual monopoly right over the production and sale of the good.[126] Producers may thus charge a monopoly price that exceeds the marginal cost of production to counterbalance the fixed costs of investing in the invention. However, the intermediate goods are also substitutable which results in monopolistic competition in the intermediate goods market: Due to free market entry, each monopolistic firm has to compete with other intermediate good firms. In the long run their benefits of differentiation will decrease and the price difference among intermediate goods will diminish.

Each intermediate goods firm takes prices for designs, the price of one for final goods, and the interest rate as given. In a monopolistic competition environment, equilibrium in the intermediate goods sector may thus be defined as follows: each enterprise sets prices to maximize its profit based on the demand curve of final goods producers while monopolistic competition will reduce intermediates firm's profit to zero. Thus, the producer has to make two decisions: first on its market entry and then on its production level.

Net profit across all production units of low-tech firms can be expressed as follows:

$$\pi_P = -p_k + \int_t^{\infty} [m(i)x(i) - \eta x(i)] e^{-(\tau - t)} d\tau \qquad (14)$$

In a first step, the number of low-tech firms entering the market will increase as long as the revenue obtained by each firm is at least equal to the fixed cost ($\pi_P(t) = 0$). Hence, the no-entry condition is given by:

$$p_k = \int_t^{\infty} [m(i)x(i) - \eta x(i)] e^{-(\tau - t)} d\tau \qquad (15)$$

The equation shows that the decision to produce a new intermediate good is determined by the discounted value of the net income of the monopoly and the price p_k of the patent for a

sector that has the same technology as the final goods sector. Foregone consumption is then equivalent to the shift of resources from the consumption sector into the intermediate goods sector. According to Romer (1990), relaxing this assumption would not change the basic dynamics and results of the model.

[126] Although it would be more realistic to assume that monopoly rights are temporary, the model assumes an infinite time horizon for the sake of simplicity.

new design. Once the entry condition is met, the firm decides in a second step on the production level by maximizing discounted net profits subject to the demand constraint in form of the inverse demand function of the final good producers which was determined in equation (5):

$$\max_{x(i)} \pi_P = \int_t^{\infty} [m(i)x(i) - \eta x(i)] e^{-(\tau - t)} d\tau$$

$$s.t.\ m(i) = (1 - \alpha - \beta) H_Y^{\alpha} L^{\beta} (x(i))^{-\alpha-\beta} \tag{16}$$

$$\Leftrightarrow \max_{x(i)} \pi_P = \int_t^{\infty} \left[(1 - \alpha - \beta) H_Y^{\alpha} L^{\beta} x(i)^{1-\alpha-\beta} - \eta x(i)\right] e^{-(\tau - t)} d\tau$$

Maximizing net profits with respect to $x(i)$ yields the quantity of production of intermediate good $\bar{x}$ in equilibrium:

$$\frac{\delta \pi_P}{\delta x(i)} = 0 = (1 - \alpha - \beta)^2 H_Y^{\alpha} L^{\beta} x(i)^{-\alpha-\beta} - \eta$$

$$\Leftrightarrow x(i) = \bar{x} = \frac{(1 - \alpha - \beta)^{\frac{2}{\alpha+\beta}} H_Y^{\frac{\alpha}{\alpha+\beta}} L^{\frac{\beta}{\alpha+\beta}}}{\eta^{\frac{1}{\alpha+\beta}}} \tag{17}$$

Substitute equation (17) into equation (5) leads to the equilibrium rental price for the intermediate good:

$$m(i) = \bar{m} = (1 - \alpha - \beta) H_Y^{\alpha} L^{\beta} \left(\frac{(1 - \alpha - \beta)^{\frac{2}{\alpha+\beta}} H_Y^{\frac{\alpha}{\alpha+\beta}} L^{\frac{\beta}{\alpha+\beta}}}{\eta^{\frac{1}{\alpha+\beta}}} \right)^{-\alpha-\beta}$$

$$\Leftrightarrow \bar{m} = \frac{\eta}{1 - \alpha - \beta} \tag{18}$$

The monopoly rental price is constant over time and can be interpreted as the markup on the marginal cost of production. The price is the same for all intermediate goods regardless of the technological content because it is assumed that the cost of production is the same for all goods. From equation (15) it is known that $p_k = \int_t^{\infty} [m(i)x(i) - \eta x(i)] e^{-(\tau - t)} d\tau$. Given equations (17) and (18) for the equilibrium quantity and price of intermediate goods the market value of a patent p_k in equilibrium is thus given by:

$$p_k = \frac{\bar{m}\bar{x} - \eta \bar{x}}{r} \tag{19}$$

By dissolving η from equation (18) one receives $\eta = \bar{m}(1-\alpha-\beta)$ which is inserted in equation (19). This leads to:

$$p_k = \frac{\bar{m}\bar{x} - \bar{m}(1-\alpha-\beta)\bar{x}}{r} = \frac{\bar{m}\bar{x}(\alpha+\beta)}{r}$$

Substituting equation (5) and given that in equilibrium $Y(H_Y, L, x) = H_Y^{\alpha} L^{\beta} K \bar{x}^{1-\alpha-\beta}$ the equilibrium price for the design is received:

$$p_k = \frac{(\alpha+\beta)(1-\alpha-\beta)}{r}\frac{Y}{K} \qquad (20)$$

The decision path of internationally operating, high-tech firms proceeds analogously to the one of low-tech firms. It is assumed that the production technology used by high-tech firms expressed in η^* is the same as the technology η used by non-multinational, low-tech firms. This is of course an extreme assumption given that one could have assumed that the technology and productivity in the production unit of an intermediate good firm which gets designs from high-tech research units is different than in the one that buy designs from low-tech research. According to Berthélemy and Démurger (2000), the introduction of this additional feature would have had, however, no influence on the way the long-term growth rate is determined.

5.2.1.6. Consumers

In a final step, the consumer side of the economy is considered to analyze the consumption and saving behavior of households. As in Romer's model, the economy is populated by individual agents with standard Ramsey preferences. Each consumer purchases final goods and accumulates savings from wage and interest incomes. The saving rate can be derived endogenously from the households' intertemporal utility function which is expressed as follows:

$$U = \int_0^{\infty} U(C)\, e^{-\rho t} dt \qquad (21)$$

$$with\ U(C) = \frac{C^{1-\sigma}}{1-\sigma}\ \ and\ \ \rho \in [0,\infty], \sigma \in [0,\infty]$$

In the intertemporal utility function consumers' preferences is determined by the total consumption of households *C*, the inverse of the intertemporal elasticity of substitution of

consumption σ as an indicator for risk aversion and the rate of time preference ρ[127]. Assuming infinite life-spans, household now maximize their utility subject to their intertemporal budget constraint:

$$\max_{C,A} U = \int_0^{\infty} \frac{C^{1-\sigma}}{1-\sigma} e^{-\rho t} dt$$

$$s.t. \quad \dot{A} = W + rA - C$$

A represents the stock of net financial assets of households, *W* households' wage income and *r* the fixed market interest rate for financial assets. For consumers, both the wage rate *w* and interest rate *r* are given. The intertemporal maximization of utility yields the Keynes-Ramsey optimality conditions:

$$\frac{\dot{C}}{C} = \frac{(r-\rho)}{\sigma}$$

The equation shows that the growth rate of consumption is determined by the interest rate *r*, the degree of preference for the present ρ, and risk aversion σ. Since in equilibrium output and consumption grow at the same rate (given stationary population), the Keynes-Ramsey rule not only yields the optimal consumption path chosen by consumers, but also the equilibrium relation between the growth rate of the economy and interest rate, the intertemporal elasticity of substitution of consumption and the rate of time preference:

$$g = \frac{\dot{C}}{C} = \frac{(r-\rho)}{\sigma} \qquad (22)$$

5.2.2. Solution for Growth Equilibrium

As shown in equation (2) $Y = H_Y^{\alpha} L^{\beta} K \bar{x}^{1-\alpha-\beta}$ aggregate output increases with $\dot{K}$, if $L, \bar{x}$ and H_Y are constant. The model is solved for an equilibrium in which *L*, H_Y and $\bar{x}$ are fixed and the stock of knowledge *K*, consumption *C* and output *Y* grow at the same constant rate. As shown in equation (9) and (10), *K* will grow at a constant rate if the amount of human capital H_R and H_R^* devoted to research stays constant. Following Romer (1990), it hence has to be shown that prices and wages are such that H_R and H_R^* remain constant as *K*, *C* and *Y* grow.

[127] A small *p* indicates a low degree of preference for the present which induces consumers to save more.

The assumption of full employment of human capital leads to the following equation:

$$H_Y + H_R + H_R^* = H \tag{23}$$

The condition that human capital is allocated constantly between the sectors is met if the respective wage rates equalize in each sector in equilibrium. With regards to the research units this implies that $w_H = w_H^*$. Equalizing the wage rates given in equations (12) and (13) yields:

$$P_k \delta k^{\mu} k^{*(1-\mu)} = {P_k}^* \delta^* k^{\mu^*} k^{(1-\mu^*)} \tag{24}$$

In long-term equilibrium, also the prices for designs have to equalize, that is $P_k = {P_k}^*$. A transformation of the above equation yields:

$$\frac{\delta}{\delta^*} = \left(\frac{k^*}{k}\right)^{\mu+\mu^*-1} \tag{25}$$

This equation implies that, in equilibrium, the rate of accumulation in low-tech knowledge has to equal the rate of accumulation in high-tech knowledge; that is:[128]

$$\frac{\dot{k}}{k} = \frac{\dot{k}^*}{k^*} \tag{26}$$

Inserting equations (8) and (10) results in:

$$\delta H_R \left(\frac{k^*}{k}\right)^{(1-\mu)} = \delta^* H_R^* \left(\frac{k}{k^*}\right)^{(1-\mu^*)} \tag{27}$$

Equation (27) together with equations (23) and (25) yield the following result for H_R:[129]

$$H_R = \frac{H - H_Y}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} \tag{28}$$

Substituting this equation into expression $H_R^* = H - H_R - H_Y$ yields:[130]

$$H_R^* = \frac{(H - H_Y)\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} \tag{29}$$

[128] As it was already shown in equation (20) the market value of an invention in equilibrium is in fact independent of the technology level it embodies.

[129] A detailed deviation is provided in Appendix A.1.

[130] A detailed deviation is provided in Appendix A.1.

To receive equal wages paid to human capital in all sectors, the amount of human capital used in the final sector ($H_Y = H - H_R - H_R^*$) has to be chosen so that, the wages are equal in each sector:

$$w_{H_Y} = w_{H_R} = w_{H_R^*}$$

Equalizing equations (6), (12) and (13) results in:

$$P_k \delta k^{\mu} k^{*(1-\mu)} = P_k{}^{*} \delta^{*} k^{*\mu^{*}} k^{(1-\mu^{*})} = \alpha K H_Y^{\alpha-1} L^{\beta} \bar{x}^{1-\alpha-\beta} \tag{30}$$

Substituting the value for P_k which was received in equation (20) yields: [131]

$$H_Y = \frac{\alpha}{\delta(\alpha+\beta)(1-\alpha-\beta)} \left(\frac{k}{k^*}\right)^{-\mu} \left(1 + \frac{k}{k^*}\right) r \tag{31}$$

Given that in equilibrium $x(i) = \bar{x}$, the production function for the final good is provided by equation (2). If L, H_Y and $\bar{x}$ are fixed, output increases at the same rate as K:

$$\frac{\dot{K}}{k} = \frac{\dot{k} + \dot{k}^*}{k + k^*} = \frac{k}{K}\frac{\dot{k}}{k} + \frac{k^*}{K}\frac{\dot{k}^*}{k^*} \tag{32}$$

Since it is known from equation (26) that the accumulation rates are equalized, one gets:

$$\frac{\dot{K}}{k} = \frac{\dot{k}}{k} = \frac{\dot{k}^*}{k^*} \tag{33}$$

This together with equation (27) yields

$$g = \frac{\dot{C}}{C} = \frac{\dot{Y}}{Y} = \frac{\dot{K}}{K} = \delta H_R \left(\frac{k^*}{k}\right)^{(1-\mu)} = \delta^{*} H_R^{*} \left(\frac{k}{k^*}\right)^{(1-\mu^{*})} \tag{34}$$

If equations (25), (28) and (31) are substituted one receives:[132]

$$g = H\delta \left(\frac{\left(\frac{\delta}{\delta^*}\right)^{\frac{1-\mu}{\mu+\mu^*-1}}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} \right) - \frac{\alpha}{(\alpha+\beta)(1-\alpha-\beta)} r \tag{35}$$

Given the relationship between r and g received in equation (22) the rate of economic growth is as follows:[133]

[131] A detailed deviation is provided in Appendix A.1.

[132] A detailed deviation is provided in Appendix A.1.

[133] Given that the model is based on Berthélemy and Démurger (2000) the same relations are derived for the case of inward FDI and the presence of foreign MNCs in the home economy.

$$g = \left[H\delta \left(\frac{\left(\frac{\delta}{\delta^*}\right)^{\frac{1-\mu}{\mu+\mu^*-1}}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} \right) - \gamma\rho \right] \Big/ (1 + \gamma\sigma) \qquad (36)$$

$$with\ \gamma = \frac{\alpha}{(\alpha + \beta)(1 - \alpha - \beta)}$$

The equation shows that the economic growth rate is determined by several factors. First, it indicates that the rate of economic growth g depends on the overall level of human capital H, which can be considered as a proxy for the absorptive capacity and the ability of the home economy to make use of the presence of domestic MNCs. An economy with a high amount of human capital can enjoy a high growth rate since human capital is invested in the accumulation of knowledge and helps to absorb and advance foreign knowledge. By contrast, an economy poor in human capital runs the risk of being trapped in poverty and may be incapable to absorb foreign knowledge. In case of the extreme assumption that there is no human capital allocated to the R&D sector ($H_R = 0$), there would be no development at all. Second, equation (36) provides the same results as in the Romer model according to which the rate of economic growth is determined by consumer patience (ρ) (the more consumers are patient, the higher the rate of growth) and the intertemporal elasticity of substitution $1/\sigma$ (the higher the intertemporal elasticity of substitution or the less risk averse consumers are, the higher the rate of growth). These results can also be found in the Romer model.

By contrast, the stock of labor has no influence on the long-term economic growth rate. The reason for this is that an increase in labor increases productivity and hence wages of human capital employed in the final goods sector as well as the demand for intermediate goods. The greater demand for intermediate goods results in higher monopoly prices and higher wages for human capital in the research sector. For the function forms used in the Romer model wages for human capital in research and manufacturing sector increase in equal measures and thus the net effect is zero as both effects offset exactly in equilibrium (Romer 1990).[134] The same linkage applies for a reduction of η.

[134] However, as stated in Romer (1990), this net effect is not robust to slight modifications. In an extended model, it may be possible that an increase in labor may be impeding growth.

The main novelty of the growth equation is the dependency of the growth rate on the productivity ratio of non-multinational and internationally operating firms $\delta/_{\delta^*}$. In the following, this relationship will be analyzed in more detail.

5.2.3. Analyzing the Impact of Outward FDI on Economic Growth

We continue to assume that high-tech firms are domestic MNCs which operate subsidiaries abroad and operate with high productivity δ^* and low-tech firms are domestic firms which only operate in their home market and with a lower productivity level δ. Accordingly, the existing home country knowledge level *K* partly depends on the number of firms which operate internationally (k^*). As could be seen in equation (36) the economic growth rate depends on the productivity ratio between non-multinational firms and internationally operating firms ($\delta/_{\delta^*}$) and given equation (25) thus indirectly on the number of internationally operating firms relative to non-multinational firms in the home economy. The results show that MNCs might not only contribute to the increase of knowledge *K* and hence the overall technological level at home (extension effect). MNCs' advanced technological know-how also creates externalities to the domestic economy (spillover effect). From an analysis of the equilibrium growth rate conclusions can now be derived on the impact of outward FDI on economic growth. The partial derivative of g with respect to ($\delta/_{\delta^*}$) yields:[135]

$$\frac{\partial g}{\partial\left(\frac{\delta}{\delta^*}\right)} = \frac{\delta H}{1+\gamma\sigma}\left[\frac{\left(\frac{\left(\frac{\delta}{\delta^*}\right)^{\frac{(2-2\mu-\mu^*)}{(\mu+\mu^*-1)}}}{(\mu+\mu^*-1)}\right)\left(1-\mu-\mu\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{(\mu+\mu^*-1)}}\right)}{\left(1+\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{(\mu+\mu^*-1)}}\right)^2}\right] \qquad (37)$$

It can be assumed that:

$$\frac{\partial g}{\partial\left(\frac{\delta}{\delta^*}\right)} \geq 0 \quad if \quad \left(\frac{\delta}{\delta^*}\right) \leq \left(\frac{1-\mu}{\mu}\right)^{(\mu+\mu^*-1)}$$

[135] Given that the model is based on Berthélemy and Démurger (2000) the same results are derived for the case of inward FDI and the presence of foreign MNCs in the home economy.

It can be seen that economic growth increases with the productivity ratio between non-multinational and multinational firms up to a threshold of $\left(\frac{1-\mu}{\mu}\right)^{(\mu+\mu^*-1)}$. This threshold is determined by the externality coefficients μ and μ*. Given equation (25) this means that economic growth is positively correlated with the number of internationally operating firms in an economy. Since the lower productivity of non-multinational firms compared to MNCs will always result in $\left(\frac{\delta}{\delta^*}\right) < 1$ and since $\left(\frac{k^*}{k}\right)$ is likely to be also less than one in equilibrium[136], it can be assumed that the sum of the two externality coefficients has to be greater than one ($\mu + \mu^* > 1$) so that the condition in equation (25) is met. Now, if μ is less than ½, the threshold effect ceases because $\left(\frac{1-\mu}{\mu}\right) > 1$ and outward FDI will always result in economic growth given that non-multinational firms profit heavily from internationally operating firms. If μ is greater than ½, the threshold effect exists, but is a decreasing function of μ, which means that the higher the value of μ, the less pronounced is the impact of outward FDI on economic growth. The higher the value of μ, the more low-tech research units will benefit from their own research, but will not profit from spillovers from internationally operating firms (some of the reasons for the lack of spillovers were already discussed above). Thus, the smaller the spillover effect of internationally operating firms on non-multinational firms, the lower the threshold. By contrast, the lower μ, the smaller the knowledge gap and the more spillovers between both types of firms. This will also result in higher growth rates for the economy.

5.2.4. Reviewing Limitations of the Model and Potential for Future Research

There are some limitations to the model. First, for the sake of simplicity, it makes the assumption that increased economic growth is a consequence of outward FDI and thus the model long-run causality only runs from outward FDI to economic growth (outward FDI-led growth). In doing so, potential feedback effects from increased economic growth to outward FDI flows (growth-driven outward FDI) are ignored. However, it is also economically rationale to assume that economies with faster economic growth usually provide better opportunities for firms to internationalize and invest abroad. This view is along the line with the investment development path (Dunning 1981, 1986) which predicts that steady economic growth provides firms with the ability to develop ownership

[136] Here, $k^*/_k$ measures the ratio of internationally operating firms and non-multinational firms. Given that there are probably less multinational firms than non-multinational ones in an economy, the ratio must be less than one in equilibrium.

advantages before they engage in outward FDI. The growth equation set up above is therefore to be remodeled. Berthélemy and Démurger (2000) show that from a transformation of equation (26) it can be derived that economic growth not only is determined by FDI but at the same time also influences FDI flows. Given the increasing internationalization of firms from economies in their early stages of development, it is reasonable to assume a bi-directional relationship between outward FDI and economic growth, which means that outward FDI is likely to be not only a cause but at the same time also a consequence of economic growth and that causality may run in either direction. In this view, outward FDI and economic growth could be positively interdependent and could lead to a reinforcing causal relationship. The dynamic relationship between outward FDI and economic growth will be discussed in more detail in Chapter 7 of this thesis.

Furthermore, the model may be criticized for its assumption that there is no price differentiation for designs or intermediate goods based on their technological content (low-tech and high-tech) because the technology for production is the same for all intermediate goods. Another limitation of the model is that its sole focus is on outward FDI disregarding other drivers which are known to positively or negatively impact economic growth. The model does for example not account for trade or disinvestment in the home economy (see Section 4.4.1 for a discussion). A further restraint of the model is that home country MNCs only occur in the intermediate goods sector and not in the final goods production.

Another critique concerning Romer type growth models like the one presented above is related to the innovation process (knowledge accumulation function) and the occurrence of scale effects (Jones 1995).[137] The model predicts that the innovation of a new intermediate good and therefore the growth rate is determined by the level of human capital and increases with the number of people employed in research. Jones (1995) criticizes that this assumption is arbitrary and that no empirical evidence can be found for that. This has led to the development of semi-endogenous growth models (Jones 1995).

The model leaves room for future research. Little is known about the mechanisms and conditions under which knowledge is reversely transferred. One has to keep in mind, that the model is based on the extreme assumption that MNCs retransfer foreign knowledge to their home economy without any difficulty. It would be interesting to examine rigidities in the internal transfer process which should lead to partly losses of the knowledge gained

[137] Other endogenous growth models such as Aghion and Howitt (1992) and Grossman and Helpman (1991) show similar scale effects.

abroad. The model thus leads to a nexus of further research questions: What are potential barriers to knowledge spillovers from the host economy to the subsidiary, from the subsidiary to the parent and from the parent to the home economy? Future research should thus examine the process of reverse technology transfer more systematically and identify the different conditions and channels through which reverse knowledge diffusion takes place.

5.3. Summary

There is a vast amount of theoretical literature examining the sources of economic growth. Despite its potential as a mean of mediating knowledge flows, little theoretical research has been conducted on the home country effects of outward FDI, in particular with regards to the long-run effects on home country economic growth. So far, theoretical literature has mainly modeled the effects of trade or inward FDI on economic growth. To the knowledge of the author there are no contributions which attempt to model the relationship between outward FDI and economic growth formally. The model presented in the last chapter therefore contributes to the existing literature. Based on the framework of Berthélemy and Démurger (2000), the novelty of the model was the introduction of the differentiation of non-multinational (low-tech) and internationally operating (high-tech) firms, both headquartered in the home economy. This feature allowed for the analysis of the impact of internationally operating firms and outward FDI, respectively, on the home country's rate of long-term economic growth.

Several findings can be drawn from the model. The results support the hypothesis that outward FDI can positively influence a country's development. The findings highlight outward FDI as an instrument for the transfer of foreign technology and accelerator of technology diffusion. The existence of both outward FDI induced extension and spillover effects should, from a theoretical perspective, have a long-term effect on outward FDI. The results, however, also show that the developmental role of outward FDI is also subject to the ability of the home economy to absorb and make use of the advanced knowledge the MNCs reversely transfer back to their home economies. Spillover effects will be subject to essential preconditions as externalities heavily depend on the absorptive capacity of the home country. Accordingly, outward FDI may only unveil its full impact on the home economy, if the MNCs themselves and non-multinational firms have the potential to absorb advanced knowledge. Absorption potential is expected to depend also on the

development of related industries or a strong supplier network in the home economy. Thus, the more linkages between firms, the higher are the gains that the home economy can derive from its outward FDI. In this context, the findings imply that spillovers to the home economy depend on the knowledge gap between multinational and non-multinational, domestic firms. If the host economy's knowledge base and the capabilities of MNCs are too far away from the ones of the domestic productive sector, there might be no spillovers to the non-multinational part of the economy and this may hamper economic growth.

Since these conclusions are so far derived from a theoretical model based on simplifying assumptions, they still need empirical testing. This will be the focus of Chapter 6. Furthermore, some open questions with regards to the linkages and dynamics between outward FDI and home country economic growth and development in general remain. They will be addressed in Chapter 7.

6. EMPIRICAL ASSESSMENT

The literature review of Chapter 3 and 4 provided an insight into the potential feedback effects of outward FDI on the investing firm itself and into potential spillovers to other parts of the investing firm's home economy. The endogenous growth model outlined in Chapter 5 integrated the main findings and established the main assumptions related to outward FDI and economic growth. In this chapter, hypotheses will be developed based on these findings. In order to test these hypotheses on empirical evidence, a general econometric model specified in conjunction with the theoretical model is introduced. Due to the fact that there exist different approaches to specify reverse knowledge transfer channels and to find empirical evidence for the hypotheses, the general model is estimated in three different set-ups (specifications). Novelty of this analysis is that it advances existing measures by Herzer (2010) and introduces new specifications allowing for a more detailed analysis of the home country effects of outward FDI. Hence, the analysis provides a new empirical contribution to the field of outward FDI as only few studies have so far empirically analyzed the effect of outward FDI on economic growth (see discussions in Section D 4.4.4).

Chapter 6 is organized as follows. Section 6.1 will elaborate the four main hypotheses based on the findings of the literature review of Chapter 3 and 4 and the endogenous growth model represented in Chapter 5. The corresponding general econometric model will be introduced and tested for the three different specifications in Section 6.2. Each subsection of Section 6.2 will provide information on the data used and will discuss the empirical results and the robustness of the findings. Section 6.3 will discuss the four hypotheses in light of the empirical results. Section 6.4 will summarize the main findings of the chapter and will provide an outlook on potential future research.

6.1. Hypotheses

The literature review of Chapter 3 and 4 and the endogenous growth model presented in Chapter 5 draw a quite positive picture of the effects of outward FDI on the home economy, in particular with regards to knowledge-sourcing FDI. It may therefore be expected that outward FDI has on average a positive impact on both the investing firm and its home economy as a whole. Based on the empirical findings of the previous chapters, the hypotheses proposed for the empirical assessment are formulated as follows:

(1) The higher a country's outward FDI activity, the higher its economic growth.
(2) The less developed the home economy, the higher its catch-up potential in terms of higher growth rates**.**
(3) The higher the home economy's absorptive capacity, the larger the effects on economic growth.
(4) The higher the home economy's share of outward FDI directed to knowledge intensive countries and thus the larger its foreign knowledge stock, the greater the positive growth effects on economic growth.

In the following, the four hypotheses are discussed in more detail.

Net growth effects of outward FDI: The literature review in Chapter 4 has shown that outward FDI may affect very different parts of the home economy, from exports to investment and technological learning. The question is to which net effect all these partial effects sum up to and how outward FDI affects the home economy as a whole in terms of economic growth. This question has so far been only approached by few empirical studies (Herzer 2010, Lee 2010a, Lee 2010b). The majority of the studies show a positive linkage between outward FDI and economic growth (Herzer 2010, Lee 2010a). In a similar vein, the theoretical model presented in Chapter 5 shows how MNCs, which usually operate on a higher technological level than their domestic, non-multinational counterparts (Barba Navaretti and Castellani 2003), may enlarge the home country knowledge base and create externalities – dynamics which in turn have a positive effect on home country economic growth. The existing empirical evidence and the predictions of the endogenous growth models lead to the following hypothesis:

Hypothesis 1: *A country's per capita economic growth is positively related to its outward FDI activity. Thus the higher the outward FDI activity, the higher the home country's economic growth per capita.*

Home economy's stage of development and catch-up potential: Another question that has emerged in the literature review is whether the development status of the home economy (for example in terms of the absolute level of GDP per capita) influences the rate of economic growth (see Chapter 5). Outward FDI may be of particular importance for emerging countries (UNCTAD 2006). They may have a chance to tap actively into the worldwide stock of knowledge by investing abroad (Kokko 2006). This could affect the economic growth rates of these economies. Likewise, studies argue that the lower the

initial stage of development, the higher the potential for economies to catch-up with more advanced ones and therefore the higher the likelihood of increased economic growth (Solow 1956). The notion behind these catch-up models is that due to their backwardness, economically less developed countries initially may grow faster than advanced economies, subsequently converging to the advanced economies' income levels (Solow 1956). This leads to the following hypothesis:

Hypothesis 2: *The less developed the home economy, the higher its catch-up potential in terms of higher growth rates.*

Absorptive capacity: Another question is related to the conditions under which investing countries may profit from outward FDI. It is clear that firms, which intend to acquire and adopt advanced foreign knowledge generated by other firms or public institutions in the host economy, will have to possess a minimum level of absorptive capacity, for example in form of imitative or adaptive research capabilities. Similar, other home country firms which want to profit from spillovers from the investing MNCs will need to possess a minimum level of absorptive capacity. As could be seen in the endogenous growth model presented in Chapter 5, the rate of economic growth depends on the overall level of human capital, which may be considered as a proxy for the absorptive capacity of the home economy. An economy which is rich in human capital may enjoy higher growth rates, since it is able to allocate more resources to the accumulation of knowledge and may therefore more easily be able to acquire and absorb foreign knowledge and to diffuse it in the home economy. On the contrary, economies that are poor in human capital may run the risk of being incapable of making use of the possibilities that open up to them following outward investments. This brings us to the next hypothesis:

Hypothesis 3: *The higher the home economy's absorptive capacity, the larger the impact on economic growth.*[138]

Foreign knowledge stock: Growth effects triggered by reverse knowledge spillovers are certainly not an automatic consequence of outward FDI activity. In order to explain knowledge spillover effects stemming from outward FDI – in particular from explicit knowledge-sourcing FDI – one has to account for the foreign knowledge pool a country is

[138] It should be noted, that the relationship may be bidirectional. Increased GDP may be a cause and a consequence for higher absorptive capacity (see chapter 4.2.1 for a discussion on this topic).

potentially able to tap from via its outward investments. A more refined question therefore might be how the knowledge pool of the FDI host countries affects economic growth of the home economy. It can be assumed that a country with a large pool of advanced knowledge and various knowledge sources (firms, universities, research institutes etc.) is more likely to generate spillovers for the investing MNCs and – assuming reverse knowledge transfer – for its home economy (Castellani 2002, Falzoni and Grasseni 2005, Pradhan and Singh 2008). This consideration leads to the fourth and last hypothesis:

Hypothesis 4: *The higher the home economy's share of outward FDI directed to knowledge intensive countries and thus the larger its foreign knowledge stock, the greater the positive growth effects on economic growth.*

In the following sections, it will be tested whether empirical evidence for the four hypotheses can be found.

6.2. Cross-country Regressions

6.2.1. General Model Approach

Before introducing the general econometric model, it is helpful to briefly recall the findings of the endogenous growth model presented in Chapter 5. The equilibrium growth equation (36) shows all factors that – from a theoretical point of view – impact economic growth in the long-run. Amongst other factors, the equilibrium growth equation expresses the long-term growth rate as a function of outward FDI and describes outward FDI as a driver of long-term economic growth. It is assumed that one of the main drivers of this growth effect is outward FDI acting as a channel of reverse knowledge transfer.

However, from studies like Barro and Sala-i-Martin (2004), Herzer (2010) and Levine and Renelt (1992) it is known that there are additional factors contributing to economic growth. These were not included in the theoretical model since the focus should be on the effects of outward FDI. Omitting these variables in the empirical assessment could, however, severely bias the regression results. Control and policy variables will therefore be incorporated, which are meant to be an additional potential source of economic growth to prevent the omitted variable bias.

To perform the empirical analysis on the above mentioned hypotheses and in light of the universe of potential economic growth drivers, an appropriate econometric model is

required. The analysis follows Herzer (2010) by working with the following general linear econometric model:

$$GDPGR_{i,t} = \alpha + \gamma K_{i,t} + \sum_{s=1}^{S} \beta_s A_{i,s,t} + \varepsilon_{i,t}$$

where i is a country index and t is a time index, $GDPGR_{i,t}$ is the growth rate of real GDP per capita. $K_{i,t}$ is the variable representing the reverse knowledge transfer channel. $K_{i,t}$ will be further specified in three different specifications presented in the following sections. α, γ, β_s are coefficients and $\varepsilon_{i,t}$ is the error term. A represents a set of other control and policy variables which are expected to have an impact on economic growth according to the empirical growth literature (Barro and Sala-i-Martin 2004, Herzer 2010, Levine and Renelt 1992).[139]

Depending on the specifications, A may include the following variables: The average ratio of gross fixed capital formation in GDP $(GFCF)$ gives an indication of the investment activity of an economy and is expected to have a positive effect on economic growth (Barro and Sala-i-Martin 2004, Levine and Renelt 1992, Solow 1956). The log of initial real GDP per capita, $GDP(0)$, is often applied in growth models to test the absolute or unconditional convergence hypothesis (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). It should give us an indication whether less developed economies tend to catch-up in absolute terms, i.e., other things equal, grow faster than more developed economies. Accordingly, the coefficient should show the rate of convergence (Barro and Sala-i-Martin 2004). The log of human capital, represented by a schooling indicator $(Educ)$, provides information on the absorptive capacity of an economy and is expected to have a positive impact on economic growth. The log of life expectancy at birth (LEB) points to the health situation of an economy and is therefore assumed to positively affect economic growth (Barro and Sala-i-Martin 2004). The ratio of domestic credit to the private sector to GDP $(DCPS)$ gives an indication of the development and soundness of the financial system and is also expected to positively impact growth (Barro and Sala-i-Martin 2004, King and Levine 1993, Levine and Renelt 1992). The annual growth rates of exports (Exp) and imports (Imp) represent the trade openness of an economy. It is assumed that trade openness may lead to the improvement of resource allocation and specialization in the home economy which in turn may positively affect international competitiveness. Thus,

[139] For a detailed description and discussion of the control and policy variables as well as for the references to the data sources see Appendix A.2.

the export and import variables are assumed to be positively correlated with GDP per capita growth (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). By contrast, the inflation rate (Inf) and the ratio of government consumption to GDP $(GovCons)$ are expected to have a negative effect on economic growth (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). It is expected that high inflation may lead to high uncertainties and distortions in economic decisions. Similarly, government consumption is often associated with the waste of public funds and the distortion of private decisions.

When it comes to decide on the set of A for each specification, i.e., to determine an appropriate specification of the general model, the standard econometric top-down approach is applied. This means, in the first run, the entire set of A is included in the estimation. Sequentially, control and policy variables are dropped for which the corresponding coefficient estimate's p-value deceeds most the 10% significance level.

Beyond the specification of the general model and estimation of the coefficients of interest, robustness checks are implemented in two ways. First, the variable for the reverse knowledge transfer channel $(K_{i,t})$ is tested on robustness by sequentially including the control and policy variables (see Herzer 2010). Here, it is crucial to effectively understand whether $K_{i,t}$ shows any severe interdependencies with the other control and policy variables. A second robustness test is implemented by testing whether the estimates for the knowledge transfer variable is primarily driven by one specific country. To do so, one country is removed at a time from the data sample and it is analyzed how this affects the regression results and the t-statistics of the coefficient estimate for $K_{i,t}$.

In the following sections, the general model will be further detailed based on the specification of the knowledge channel $K_{i,t}$, as $K_{i,t}$ can take different forms depending on the context.

6.2.2. Specification 1: Outward FDI Stock

Given the assumption that outward FDI per se is a knowledge transfer channel, an outward FDI variable is used to specify the reverse knowledge transfer channel $K_{i,t}$ in the first specification of the general model. Outward FDI can either be expressed in terms of outward FDI flows (transactions) or outward FDI stocks (positions). The decision, which variable to use in the empirical model, should be made with caution. Herzer (2010), which is so far the only existing cross-country study to measure the impact of outward FDI on economic growth, uses outward FDI flows (as a percentage of GDP). There are, however,

several limitations to this approach. First, FDI flows are often highly volatile. To smooth strong fluctuations and remove short term noise, many studies use moving averages (van Pottelsberghe de la Potterie and Lichtenberg 2001). This way, important information may get lost. A second disadvantage of flow data is that they are a snapshot and do not account for previous investments abroad. It can therefore be assumed that the stock of outward FDI, which accumulates the initial and all the subsequent transactions in the period considered, is more appropriate to measure the effects of outward FDI on economic growth. In contrast to flows, stocks are more likely to capture the long-run impact of outward FDI and this is what this analysis is primarily interested in. Thus, stock data instead of flows is used. This is the first extension to the existing empirical literature such as Herzer (2010).

The first specification is defined as follows:

$$GDPGR_{i,t} = \alpha + \gamma OFDI_{i,t}^{USD} + \sum_{s=1}^{S} \beta_s A_{i,s,t} + \varepsilon_{i,t}.$$

$OFDI_{i,t}^{USD}$ is the growth rate of the outward FDI stock in US Dollar of country i in time t. Set of variables in A and the coefficients α, γ, β_s and $\varepsilon_{i,t}$ are as defined above.

6.2.2.1. Data

For the first specification, an extensive panel data set covering 46 countries over the period 1982 – 2007 is used.[140] To consider as many different development levels as possible, all developing countries for which continuous data is available are included. Of the 46 countries included in the sample, 61% are developing countries.[141]

Data on per capita GDP growth and data on the outward FDI stock are taken from the UNCTAD Statistics. The outward FDI stock is measured in US Dollar at current prices and current exchange rates. The annual growth rates of the outward FDI stock are calculated. The mean of outward FDI stock growth rates is 15.53%, the standard deviation amounts to 24.78%. Among the 1,196 observations a few extreme data points can be observed. These outliers may either be due to extreme investments or disinvestments or could be caused by

[140] For the list of countries see Appendix A.3.

[141] The classification whether a country is developing or not is based on its GDP per capita level on the outset of the analysis (World Bank Classification). Such a developing country label might in some cases be misleading as some developing countries have in the meantime caught up to or even surpassed some other developed countries as in the case of South Korea. However, such a classification is nevertheless helpful given that it provides us with information on where the economies come from.

extreme exchange rate fluctuations. There might also be data errors involved, although there is no proof for that available. Either way, such extreme side issues may severely distort the regression results. Therefore all observations that exceed two times the sample's standard deviation, which is approximately 50%, or that deceed -50%, are excluded. Of the 1,196 observations in the sample this only applies for 70 observations (roughly 5.9% of total observations). The majority (80%) of these outliers can be observed for the growth rates of outward FDI stocks from developing countries. The high rate might point to the occurrence of extreme exchange rate fluctuations, which are probably more likely to occur in developing countries than in developed ones, or even data quality issues.

To proxy the human capital stock as a measure for the absorptive capacity of the home economy, annual educational attainment measures in form of the log of average years of total schooling in the total population over age 25 are applied. Data is taken from the Barro and Lee (2013) data set.[142] Data on the ratio of gross fixed capital formation in GDP, life expectancy at birth, domestic credit to private sector, inflation and general government consumption are taken from the World Development Indicators (WDI). Data on import and export growth of goods and services is taken from the IMF statistics.

6.2.2.2. Findings

Table 6 reports the estimates for all coefficients of the top-down approach (model 8) and the robustness check models (1-7). As mentioned above, model 8 is the appropriately specified model and the remaining models serve for robustness checks – differing in the composition of A.

Starting with the results of model 8, it can recognized that the growth of outward FDI stock ($OFDI^{USD}$) has a positive and statistically significant impact on economic growth – coefficient estimate is significant at the 1% level. As such, empirical evidence is found for the assumption derived from the endogenous growth model that outward FDI is growth enhancing. The estimated coefficient implies that an increase in the growth rate of outward FDI stock by one unit augments the growth rate by 0.019 units per year. Coming to the control and policy variables, the estimates of the coefficients for the ratio of gross fixed

[142] Barro and Lee (2013) report the data at 5-year intervals. The compound annual growth rate is used to calculate the annual values for the years between the 5-year intervals.

Table 6: Cross-country regression analysis: 1982-2007, 46 countries, outward FDI stock growth (stock in US Dollar)

	K	A_S								
	$OFDI^{USD}$	**GFCF**	**GDP(0)**	**Educ(0)**	**Exp**	**Inf**	**LEB**	**DCPS**	**GovCons**	**Imp**	**adj. R^2**
Model 1											
Coefficient	0.036	0.188	-0.833	3.091							0.2013
std.err.	0.007	0.033	0.254	0.771							
p-value	*0.000*	*0.000*	*0.001*	*0.000*							
Model 2											
Coefficient	0.026	0.164	-0.604	2.469	0.169						0.3450
std.err.	0.007	0.025	0.200	0.635	0.024						
p-value	*0.000*	*0.000*	*0.003*	*0.000*	*0.000*						
Model 3											
Coefficient	0.026	0.164	-0.605	2.465	0.169	-0.0001					0.3445
std.err.	0.007	0.025	0.201	0.638	0.024	0.000					
p-value	*0.000*	*0.000*	*0.003*	*0.000*	*0.000*	*0.411*					
Model 4											
Coefficient	0.024	0.142	-0.799	1.867	0.163	0.0000	4.818				0.3545
std.err.	0.007	0.023	0.204	0.621	0.023	0.000	1.819				
p-value	*0.000*	*0.000*	*0.000*	*0.003*	*0.000*	*0.604*	*0.008*				
Model 5											
Coefficient	0.024	0.140	-0.804	1.821	0.163	0.0000	4.734	0.001			0.3541
std.err.	0.007	0.025	0.204	0.626	0.023	0.000	1.732	0.004			
p-value	*0.000*	*0.000*	*0.000*	*0.004*	*0.000*	*0.588*	*0.006*	*0.729*			
Model 6											
Coefficient	0.024	0.137	-0.746	1.795	0.162	-0.0001	4.694	0.001	-0.024		0.3545
std.err.	0.007	0.027	0.237	0.618	0.022	0.000	1.800	0.004	0.033		
p-value	*0.000*	*0.000*	*0.002*	*0.004*	*0.000*	*0.480*	*0.009*	*0.725*	*0.470*		
Model 7											
Coefficient	0.019	0.100	-0.706	1.291	0.112	-0.0004	4.873	0.002	-0.018	0.109	0.4550
std.err.	0.006	0.031	0.231	0.589	0.026	0.000	1.840	0.003	0.034	0.018	
p-value	*0.001*	*0.001*	*0.002*	*0.029*	*0.000*	*0.007*	*0.008*	*0.471*	*0.595*	*0.000*	
Model 8 (top-down approach)											
Coefficient	0.019	0.107	-0.739	1.396	0.114	-0.0004	5.059			0.109	0.4548
std.err.	0.006	0.027	0.211	0.602	0.027	0.000	1.918			0.018	
p-value	*0.001*	*0.000*	*0.000*	*0.021*	*0.000*	*0.008*	*0.008*			*0.000*	

Remarks: All models have been estimated with a panel dataset of 46 countries (period from 1982-2007). Dependent variable is annual real per capita GDP growth rate. $OFDI^{USD}$ is the growth rate of outward FDI stock denominated in US Dollar, GFCF is average ratio of gross fixed capital formation in GDP, GDP(0) is the log of initial level of real GDP per capita, Educ is the log of average years of schooling in population over 25, Exp (Imp) is the growth rate of exports (imports) of goods and services, Inf is the inflation rate based on the consumer price index, LEB is the log of the average life expectancy at birth, DCPS is the share of domestic credit to the private sector in GDP, GovCons is the ratio of government consumption to GDP. Each model is estimated with pooled OLS. In each estimation routine robust standard errors (HAC) are used in order to account for both heteroscedastic and autocorrelated residuals. Estimates, robust standard errors and two-sided p-values for each coefficient, as well as adjusted R^2 are reported.

capital formation to GDP ($GFCF$), initial real GDP ($GDP(0)$) and human capital ($Educ(0)$) show no surprises. As expected, the coefficient signs of the ratio of gross fixed capital formation in GDP and the proxy for the human capital stock are positive and statistically significant at the 1% and 5 % level. This means that both the ratio of gross fixed capital formation to GDP and human capital have a positive and significant impact on economic growth in the sample. The coefficient sign for initial real GDP stock, is negative and statistically significant at the 1% level. Thus, as expected, the initial level of real GDP is negatively correlated with the rate of economic growth meaning that the lower a country level of development, the higher its catch-up potential. For the coefficient of growth rate of exports (Exp) a positive and highly significant impact on economic growth can be observed. This supports the assumption that outward orientation in form of exports has a positive effect on the exporting country. By contrast, the effect of the inflation rate (Inf), is as expected negative and statistically significant. This is in line with previous empirical studies like Borensztein (1998). Furthermore, the use of the indicator life expectancy at birth (LEB) controls for the impact of the health situation on economic growth. It is found that the variable has a positive and highly significant impact on economic growth. For imports of goods and services (Imp) it can be seen that, similarly to export growth, import growth has a positive and statistically significant impact on economic growth. Closing remark to the model specified with the top-down approach is that domestic credit variable ($DCPS$) to control for financial development, and government consumption ($GovCons$) are not in the final representation.[143]

The results of the top-down approach are meant to be tested on robustness in the following. It is crucial to understand whether the positive significance of outward FDI stock growth may be due to the interdependencies with the control and policy variables. To test for the robustness, the analysis starts with estimating a reduced model and subsequently includes other control and policy variables (model 1-7), which are known from the vast empirical literature on economic growth to have an impact on economic growth (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). Throughout these seven models, it can be observed that the coefficient of outward FDI stock growth ($OFDI^{USD}$) stays statistically significant and of similar magnitude across all estimated models. Thus the positive effect of outward FDI stock growth, which has been identified in model 8, is robust to the in- and exclusion

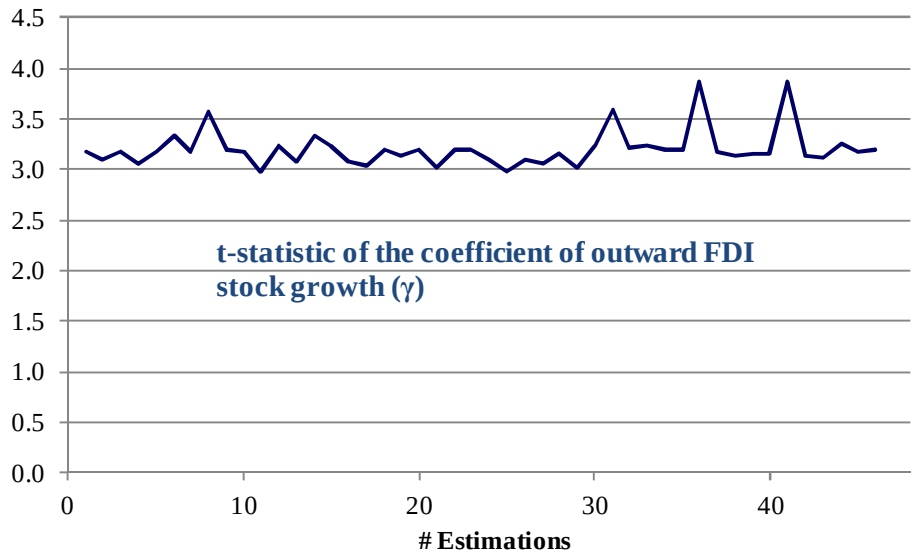
[143] Although the results in general support the empirical findings made by Herzer (2010), the model coefficients cannot be compared to the ones of Herzer (2010), given that outward FDI stocks are used instead of outward FDI flows and a different set of countries as well as a longer time period.

of additional determinants of economic growth and seems not to be caused by interdependency effects with the control and policy variables.

A final topic which should be addressed with regards to the robustness of the findings is to test whether the coefficient estimates for the knowledge transfer variable is primarily driven by one specific country and has as such distorted the results presented above. To do so, one country at a time is removed from the data sample and it is analyzed how this affects the regression results and the t-statistics of the coefficient of $OFDI^{USD}$ in model 8.

The results of the t-statistic are presented in Figure 12. It can be observed that the findings for the outward FDI growth coefficients are from a statistical point of view robust to the choices of countries in the sample. In each estimation routine of the coefficient of the outward FDI stock growth, a t-statistic beyond the 5% level of significance is obtained.

Figure 12: Robustness test for first specification



Remarks: The panel graphs the t-statistic of the coefficient of outward FDI stock growth (γ). Each estimation output is based on a reduced number of countries, i.e., for each estimation, a different country i is left out. Basis is the panel dataset of 46 countries (period from 1982-2007) and the model specification 8 as of Table 6.

To sum up the findings of the first specification, it can be said that there is empirical evidence for a positive and significant growth impact of outward FDI stock. This result is robust against the inclusion of various other determinants of growth. Furthermore, the possibility that these findings are driven by one specific country in the sample is ruled out.

A limitation of the first specification is related to potential currency effects. The growth rate of the outward FDI stock is derived from an outward FDI stock that is reported by UNCTAD in US Dollar for each economy. So far, the denomination in US Dollar is

common practice in the outward FDI literature (Herzer 2010, Lee 2010a, Lee 2010b). It is, however, quite likely that exchange rate fluctuations, which are embodied in the data, may significantly deter the outcomes of the estimations. This may also explain the number of outliers in the data set which were addressed above.

6.2.3. Specification 2: Outward FDI Stock in Local Currency

In order to address the limitations of the first specification and in order to reduce potential exchange rate related distortions, the second approach differs from previous empirical approach and uses outward FDI stock which is reported in local currency (instead of US Dollar). The use of growth rates of outward FDI stock as an explanatory variable gives us the possibility to compare data on outward FDI stock internationally.

The second specification of the general model is defined as follows:

$$GDPGR_{i,t} = \alpha + \gamma OFDI_{i,t}^{LocCur} + \sum_{s=1}^{S} \beta_s A_{i,s,t} + \varepsilon_{i,t}$$

with the reverse knowledge transfer channel $OFDI_{i,t}^{LocCur}$ being represented by the growth rate of the outward FDI stock of country i in time t, denominated in its local currency. The set of variables in A and the coefficients α, γ, β_s and $\varepsilon_{i,t}$ are generally as defined above in the first specification.

6.2.3.1. Data

The UNCTAD database, which is drawn from in the first specification and which provides information on outward FDI stock for most countries worldwide, does not provide outward FDI stock data in local currencies. To receive outward FDI stock data in local currency, data is drawn from the OECD database which provides outward FDI stock data for most OECD countries (both in US Dollar and local currency).[144] Given the data availability, the number of countries which can be included in the sample has to be reduced to 18 countries, of which only one country, namely South Korea, may be classified as an emerging country, at least at the starting point of the period under review.[145] The new data sample covers the years from 1986 to 2007. Definitions and sources of all other variables included stay as described above in the first specification.

[144] The only country which does not report in its local currency is South Korea, which reports in US Dollar. Therefore outward FDI stock data denominated in US Dollar for South Korea is used.

[145] For the list of countries included see Appendix A.3.

Once more it is important to have a look at the features of outward FDI stock growth data (based on local currency). The mean of outward FDI stock growth rates is 15.00%, the standard deviation amounts to 14.89% and is thus in the same range as in the sample of the first specification. A few extreme data points can be observed. As in the first specification, all observations that exceed two times the sample's standard deviation, which is approximately 50%, or deceeds -50%, are excluded. Of the 396 observations in the sample this only applies to 10 observations. Accordingly, the share of outliers in total observations is reduced significantly (2.5% of total observations instead of 5.9% of total observations in the first specification). The decrease may be driven by two factors. First, the composition of the sample has changed. The increased share of developed countries in the sample could reduce the likelihood to have sharp increases or decreases of outward FDI stocks. Second, the reduction of outliers may be due to the fact that exchange rate fluctuations are discarded by using outward FDI stock data denominated in local currency.

6.2.3.2. Findings

The results of the estimations for the second specification are reported in Table 7. Again, the analysis starts with looking at the results of model 8 (top-down approach) and then continues with the discussions on robustness of the coefficients for the reverse knowledge transfer channel.

Most importantly, the results of the second specification substantiate the findings of the first specification by showing that the growth rate of outward FDI stock ($OFDI^{LocCur}$) continues to have a positive and statistically significant impact on economic growth (see output for model 8). The estimated coefficient in model 8 is significant at the 5% level and implies that an increase in the growth rate of outward FDI stock by one unit augments the growth rate by 0.014 units per year.

For the set of control and policy variables A it can be observed that the composition of considered variables is differing to the first specification. Highlighting the changes, the new specification indicates that there exists no empirical evidence for an impact of human capital stock ($Educ(0)$) on GDP growth per capita. This finding might be due to the sample composition and the fact that the majority of the countries in the sample are

Table 7: Cross-country regression analysis: 1986-2007, 18 countries, outward FDI stock growth (stock with reported/local currency)

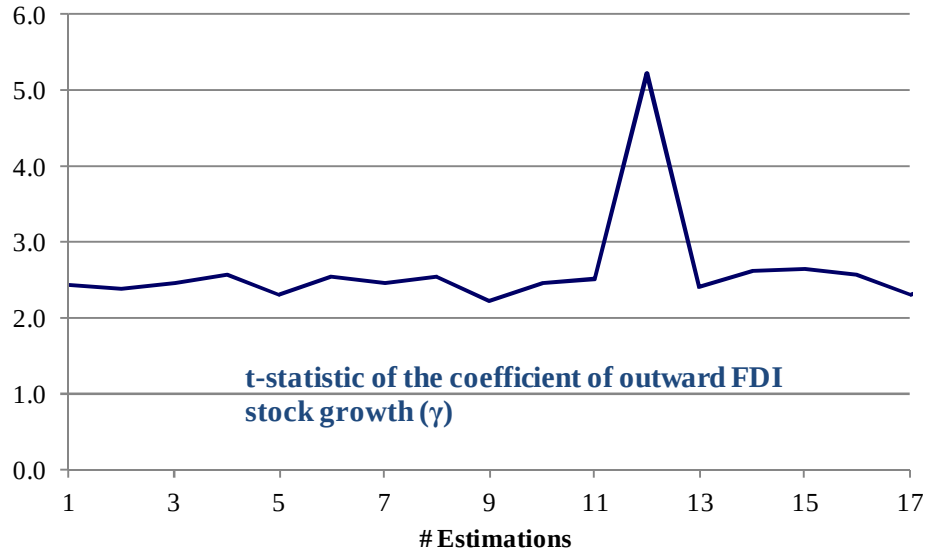
	K	A_S								
	$OFDI^{LocCur}$	**GFCF**	**GDP(0)**	**Educ(0)**	**Exp**	**Inf**	**LEB**	**DCPS**	**GovCons**	**ImpGS**	**adj. R^2**
Model 1											
Coefficient	0.029	0.105	-0.898	0.086							0.1728
std.err.	0.011	0.048	0.524	0.760							
p-value	*0.006*	*0.029*	*0.088*	*0.910*							
Model 2											
Coefficient	0.019	0.117	-0.316	-0.432	0.157						0.2925
std.err.	0.010	0.038	0.369	0.502	0.017						
p-value	*0.051*	*0.002*	*0.393*	*0.390*	*0.000*						
Model 3											
Coefficient	0.022	0.131	-0.485	-0.725	0.149	-0.1435					0.3106
std.err.	0.010	0.038	0.438	0.527	0.016	0.083					
p-value	*0.023*	*0.001*	*0.268*	*0.170*	*0.000*	*0.084*					
Model 4											
Coefficient	0.019	0.129	-0.416	-0.264	0.139	-0.2161	-16.200				0.3376
std.err.	0.009	0.031	0.367	0.553	0.020	0.092	7.477				
p-value	*0.042*	*0.000*	*0.257*	*0.634*	*0.000*	*0.020*	*0.031*				
Model 5											
Coefficient	0.017	0.142	-0.306	-0.218	0.138	-0.2290	-13.591	-0.005			0.3419
std.err.	0.009	0.036	0.391	0.597	0.019	0.087	8.566	0.004			
p-value	*0.074*	*0.000*	*0.435*	*0.716*	*0.000*	*0.009*	*0.113*	*0.219*			
Model 6											
Coefficient	0.018	0.091	0.058	-0.599	0.131	-0.2399	-10.303	-0.008	-0.138		0.3704
std.err.	0.009	0.040	0.403	0.638	0.020	0.081	8.490	0.004	0.064		
p-value	*0.042*	*0.023*	*0.885*	*0.349*	*0.000*	*0.003*	*0.226*	*0.039*	*0.032*		
Model 7											
Coefficient	0.016	0.072	-0.036	0.092	0.040	-0.1930	-11.793	-0.006	-0.065	0.189	0.5850
std.err.	0.006	0.036	0.336	0.648	0.018	0.048	7.215	0.003	0.046	0.025	
p-value	*0.014*	*0.048*	*0.915*	*0.887*	*0.022*	*0.000*	*0.103*	*0.053*	*0.157*	*0.000*	
Model 8 (top-down approach)											
Coefficient	0.014	0.104			0.044	-0.1842	-13.037	-0.005		0.195	0.5806
std.err.	0.006	0.030			0.014	0.044	7.215	0.003		0.025	
p-value	*0.016*	*0.001*			*0.002*	*0.000*	*0.072*	*0.071*		*0.000*	

Remarks: All models have been estimated with a panel dataset of 18 countries (period from 1986-2007). Dependent variable is annual real per capita GDP growth rate. $OFDI^{LocCur}$ is the growth rate of outward FDI stock denominated in local currency, GFCF is average ratio of gross fixed capital formation in GDP, GDP(0) is the log of initial level of real GDP per capita, Educ is the log of average years of schooling in population over 25, Exp (Imp) is the growth rate of exports (imports) of goods and services, Inf is the inflation rate based on the consumer price index, LEB is the log of the average life expectancy at birth, DCPS is the share of domestic credit to the private sector in GDP, GovCons is the ratio of government consumption to GDP. Each model is estimated with pooled OLS. In each estimation routine robust standard errors (HAC) are used in order to account for both heteroscedastic and autocorrelated residuals. Estimates, robust standard errors and two-sided p-values for each coefficient, as well as the adjusted R^2 are reported.

classified as developed countries. Differences between developed countries with regards to the average years of schooling might not be too pronounced anymore (as in comparison to developing countries) (Barro and Lee 2013). This finding indicates that a more refined proxy for the absorptive capacity of economies than school achievement rates might be needed. A similar differentiation issue might be the reason for an insignificant parameter for initial real GDP ($GDP(0)$). A surprising result is obtained for the coefficient estimate of life expectancy at birth (LEB). In stark contrast to the findings of the first specification, the impact on the growth rate is not only negative, but also statistically significant (coefficient level is significant at the 10% level). This is surprising, given that higher life expectancy is usually associated with good health and a more productive work force and thus payoffs for higher growth rates (Barro and Sala-i-Martin 2004). Newer research, however, shows that improvements in life expectancy may lead to fast population growth which in turn in some cases may negatively impact per capita income due to reduced capital-to-labor and land-to-labor ratios (Acemoglu and Johnson 2007). Continuing the discussion of the key findings with regards the control and policy variables, it can be observed that the impact of domestic credit to the private sector ($DCPS$) is negative and significant (coefficient level is significant at the 10% level). This contradicts the previous assumption.

As before, it is of interest to test the results, concerning sign and statistical validity of the outward FDI stock growth coefficient, on robustness in two ways. First, it is analyzed whether the positive effect of outward FDI stock growth, which has been identified in model 8, is robust to the in- and exclusion of other determinants of economic growth per capita. Across all of the seven models (model 1-7), the estimate of the outward FDI stock growth coefficient is directionally the same and stays statistically significant. Second, it is analyzed whether the estimates for the knowledge transfer variable are primarily driven by one specific country. The results are presented in Figure 13. Once more, the significance of the outward FDI stock growth coefficients is quite robust to the choices of countries in the sample. For each of the estimations the coefficient of the outward FDI stock growth variable is similar in sign and level as well as statistical significance. This finding maintains the robustness of the results.

Figure 13: Robustness test for second specification



Remarks The panel graphs the t-statistic of the coefficient of outward FDI stock growth (γ). Each estimation output is based on a reduced number of countries, i.e., for each estimation, a different country i is left out. Basis is the panel dataset of 18 countries (period from 1986-2007) and the model specification 8 as of Table 7.

Summing up the findings of the second specification, there is empirical evidence that the growth effect of outward FDI stock growth based on local currency denomination is positive. This conclusion remains statistically valid for two different robust checks.

The estimations of the first and second specification have shown that outward FDI per se seems to positively affect economic growth per capita. Such a positive growth effect could be driven by various factors: cheaper production inputs that can be sourced in foreign markets, for example labor input, or economies of scale due to higher production and sales activities in foreign markets. However, coming from the discussions of the initial chapters of this thesis, what is still left unexplained is how the very part of outward FDI that is related to potential reverse knowledge transfer affects home economy economic growth. In short, how does the outward FDI stock work as a reverse knowledge channel? To answer this question, a variable needs to be developed which accounts for both the amount of outward FDI stock a country holds abroad and the potential stock of foreign knowledge that a country may access abroad via its outward investments. Such a variable will be introduced in the third and last specification of the general model.

6.2.4. Specification 3: Outward FDI Weighted Foreign Knowledge Stock

The two previous specifications provided empirical evidence for outward FDI being growth enhancing. What has not been considered yet is the knowledge-sourcing part and

the potential for reverse knowledge transfer that goes along with outward investments and how these factors impact economic growth. Thus, the growth-enhancing knowledge spillovers to the home economy which are embodied in the outward FDI stock still need to be empirically tested. Therefore the knowledge pool of the host country from which the investing country potentially can draw from via its outward investments should be taken into consideration. In order to account for this foreign knowledge, a variable representing an outside pool of knowledge embodied in the country's outward FDI is needed. To do so, the analysis draws from the works of Coe and Helpman (1995) and Lichtenberg and van Pottelsberghe de la Potterie (1998, 2001)[146] and constructs a foreign stock of knowledge embodied in the outward FDI stock. This new variable will substitute the outward FDI stock growth variable from the first and second specification.

Accordingly, the third and last specification of the general model goes as follows:

$$GDPGR_{i,t} = \alpha + \gamma SGR^{F}_{i,t} + \sum_{s=1}^{S} \beta_s A_{i,s,t} + \varepsilon_{i,t}$$

with $SGR^{F}_{i,t}$ being the growth rate of the foreign stock of knowledge $S^{F}_{i,t}$ which country i holds abroad in time t. The coefficients α, γ, β_s and $\varepsilon_{i,t}$ are as defined above in the first and second specification. The set of control and policy variables A is reduced by the variable of life expectancy at birth (LEB) as the previous specification showed that the variable might need some more granular measurement approach (Acemoglu and Johnson 2007).

For each country i and each point in time in the sample a stock of foreign R&D capital $S^{F}_{i,t}$ is constructed based on the weighted sum of its host countries' cumulative R&D spending $S^{D}_{j,t}$. Weighting corresponds to the ratio of outward FDI stock to absolute gross fixed capital formation of country j. Thus, the foreign knowledge capital stock of country i, $S^{F}_{i,t}$, is the sum of all its outward FDI embodied in the R&D capital intensity of the host countries:

$$S^{F}_{i,t} = \sum_{j \neq i} \frac{SOFDI_{i,j,t}}{AGFCF_{j,t}} S^{D}_{j,t}$$

where $SOFDI_{i,j,t}$ is the outward FDI stock of country i in country j in time t and $AGFCF_{j,t}$ is the absolute gross fixed capital formation of country j.

[146] Whereas this approach analyzes the effects of outward FDI on economic growth per capita, van Pottelsberghe de la Potterie and Lichtenberg (1998, 2001) analyze the effects of trade and FDI on home country productivity (see Chapter 4 for a discussion of their findings).

The domestic R&D stocks at time t $(S_{j,t}^{D})$ consist of cumulative real gross domestic expenditures on R&D allowing for depreciation. R&D stocks are calculated from real R&D expenditures (R) based on the perpetual inventory model proposed by Coe and Helpman (1995):

$$S_{j,t}^{D} = (1 - \delta)S_{j,t-1}^{D} + R_{j,t-1},$$

with δ being the depreciation rate which is set at 5% as proposed by Coe and Helpman (1995).

In order to receive the annual R&D stocks for each year of the sample period, the starting value for the capital stock $S_{j,0}^{D}$ needs to be calculated according to the following formula applied by Coe and Helpman (1995):

$$S_{j,0}^{D} = R_{j,0}/(g + \delta),$$

with g being the average annual log growth of R&D expenditures over the sample period. $R_{j,0}$ refers to the R&D expenditure of the starting year of the sample period.

6.2.4.1. Data

In the following, the construction of variables will shortly be reviewed and some interesting features of the data used in the regression will be highlighted. As in the second specification, the number of countries in the sample sums up to 18 countries.[147] The available data covers the time period from 1986 to 2007. Definitions and sources of control and policy variables A are as defined above.

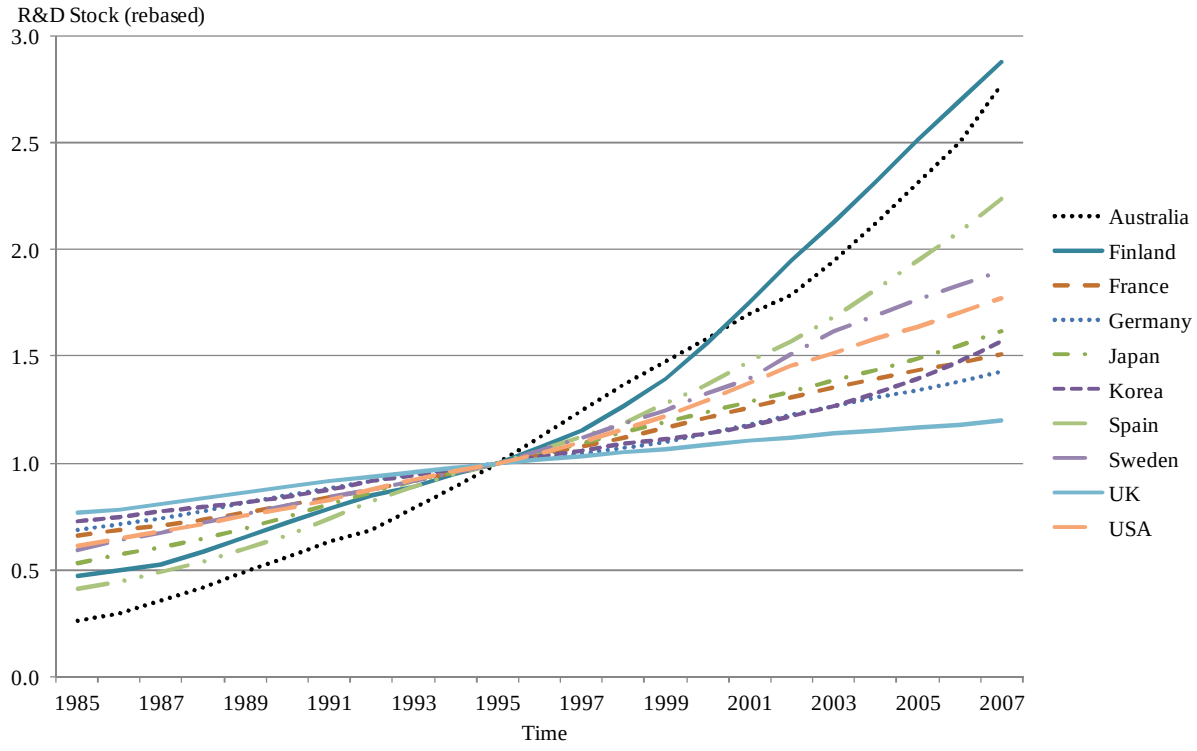
Data on outward FDI stock is drawn from the OECD database. OECD is one of the few institutions which provide information on bilateral outward FDI stocks for a large set of OECD countries. For each country, its outward FDI stock is broken down to receive the distribution of its outward FDI stock over the target countries. Given data availability, all target countries considered are OECD countries.

In addition, in order to receive the outward FDI weighted foreign R&D capital stock $S_{i,t}^{F}$ for each country, the domestic R&D stocks $S_{j,t}^{D}$ need to be calculated for a large set of

[147] For the list of countries included see Appendix A.3.

target countries where outward FDI of the 18 countries is directed to. The estimates of the domestic R&D capital stocks are based on real business R&D expenditure data from the OECD Science Technology and Industry Outlook. In cases where for some countries data was missing for single years, gross fixed investment data was used to approximate the missing R&D expenditure data. The trend of domestic R&D stocks for selected countries is shown in Figure 14. For comparison purposes, the figures are rebased with index 1995=100. As can be seen, the domestic knowledge stock has increased significantly in most economies during the time period considered. The highest increase can be registered for Australia, whose domestic R&D more than doubled between 1985 and 2007. The lowest expansion can be observed for the United Kingdom, which only experienced a 45% growth of its R&D knowledge stock.

Figure 14: Domestic R&D capital stocks (index 1995=100 for each country)



Remarks: The panel graphs domestic R&D capital stocks from 1985-2007 for a selection of 10 countries. Indexation basis of 1995=100 applies to each country.

Based on the bilateral outward FDI stocks and the respective knowledge stocks of the target countries, the outward FDI weighted foreign R&D capital stock $S_{i,t}^{F}$ for each country can now be calculated. It can be seen that the mean of the data sample is 16.23%, the standard deviation amounts to 19.63%. Again, as in the first and second specification, a few extreme data points can be observed. All observations that exceed two times the

sample's standard deviation, which is approximately 50%, or deceed -50%, are excluded from the sample. Of the 396 observation in the sample this only applies for 18 observations (4.5% of total observations).

6.2.4.2. Findings

For the discussion of the empirical findings, the focus is on the results of primary interest – the output of the top-down approach. The results of the regression are shown in Table 8. It can be seen that the variable of interest, the growth rate of the outward FDI stock weighted foreign R&D capital stock (SGR^F), has a positive and statistically significant impact on the growth rate of GDP per capita (estimated coefficient is significant at the 10% level). This implies that countries which are open to outward FDI and invest in other countries that have a high stock of knowledge, here in form of the R&D stock, experience positive feedback effects to the home economy in terms of higher GDP per capita growth rates. This finding points to the existence of outward FDI-induced international R&D spillovers. Thus, the foreign pool of knowledge seems to play a marked role with respect to the home country effects of outward FDI. This is one of the central findings of the empirical assessment. Their economic implications will therefore be assessed in more detail with the discussion of hypothesis (4) in the next section.

With regards to the other determinants of growth included, similar effects as in the second specification can be observed: The coefficient estimates of the ratio of gross fixed capital formation to GDP ($GFCF$), the growth rates of exports (Exp) and imports (Imp) of goods and services, the inflation rate (Inf) as well as the government consumption ($GovCons$) have signs as expected and are all statistically significant. Similar to the second specification, it can be observed that the impact of domestic credit to the private sector ($DCPS$) is negative and significant at the 1% level. Again, this contradicts the previous assumption.

Table 8: Cross-country regression analysis: 1986-2007, 18 countries, R&D stock growth

	K	A_S								
	SGR^F	**GFCF**	**GDP(0)**	**Educ(0)**	**Exp**	**Inf**	**LEB**	**DCPS**	**GovCons**	**Imp**	**adj. R^2**
Model (top-down approach - excl. Life Expectancy at Birth)											
β	0.013	0.073			0.052	-0.1517		-0.010	-0.080	0.189	
std.err.	0.008	0.036			0.016	0.029		0.003	0.043	0.024	0.5733
p-value	*0.083*	*0.046*			*0.001*	*0.000*		*0.000*	*0.065*	*0.000*	

Remarks: All models are estimated with a panel dataset of 18 countries (period from 1986-2007). Dependent variable is annual real per capita GDP growth rate. SGR^F is the growth rate of outward FDI stock weighted foreign R&D stock denominated in local currency, GFCF is average ratio of gross fixed capital formation in GDP, GDP(0) is the log of initial level of real GDP per capita, Educ is the log of average years of schooling in population over 25, Exp (Imp) is the growth rate of exports (imports) of goods and services, Inf is the inflation rate based on the consumer price index, LEB is the log of the average life expectancy at birth, DCPS is the share of domestic credit to the private sector in GDP, GovCons is the ratio of government consumption to GDP. Each model is estimated with pooled OLS. In each estimation routine robust standard errors (HAC) are used in order to account for both heteroscedastic and autocorrelated residuals. Estimates, robust standard errors and two-sided p-values for each coefficient, as well as the adjusted R^2 are reported.

6.3. Discussion of Hypotheses

The empirical findings of the first and second specifications, which apply the growth rate of outward FDI stock as an explanatory variable, provide empirical evidence for the assumption that outward FDI has in general a positive effect on home country economic growth per capita. Accordingly, MNCs seem to profit from their investments abroad and in doing so they also increase the benefits for their home economies. The findings on the outward FDI stock growth variable are robust to several variations of the models, for example the inclusion of other factors which, based on the theoretical and empirical literature, are expected to have a significant impact on economic growth. In total, there is empirical evidence for Hypothesis (1) which says that the effect of outward FDI on economic growth of the home economy is positive.

The empirical results give us also an indication on how the development level of the investing country affects its GDP per capita growth. In Hypothesis (2), it was assumed that the less developed the home economy, the higher its catch-up potential in terms of higher growth rates. Looking at the results of the three specifications, this can only be partly supported. Whereas the results of the first specification substantiate the hypothesis that the lower the initial level of GDP per capita, the higher the effects on growth, these conclusions cannot be supported by the second and third specification. Here, the effect of the initial level of GDP is shown to be statistically insignificant. This finding may be related to the country sample applied for the testing of the second and third specifications. They nearly completely consist of developed countries, for which differences in the initial level of real GDP per capita might not to be too big.

Similarly interesting results are found with regards to Hypothesis (3) which assumes that the higher the home economy's absorptive capacity and the more educated its labor force, the larger the effects on economic growth. Similar to Hypothesis (2), a positive correlation between the average years of schooling and economic growth and thus empirical evidence for Hypothesis (3) can be found in the first specification. But no impact can be observed for the second and third specification. This may very likely also be reasoned with the composition of the data samples. Whereas the first specification is tested with a large data set and a higher share of developing countries in the sample, the second and third specification test the hypothesis for a smaller amount of countries, of which only one is considered as a developing country. For a data sample consisting of more developed

countries a more specific proxy for the absorptive capacity might be needed given that the average years of school enrollment of developed countries tend to be similar and all on a rather high level (Barro and Lee 2013). Thus, the school enrollment proxy that is used in all three specifications might not be precise enough to account for the fine differences in the knowledge stock between more developed countries. A more sophisticated measure might be needed to proxy the human capital stocks or the absorptive capacity in general (see Section 3.2.1 for a discussion of absorptive capacity indicators).

Finally, Hypothesis (4) relates to the topic of knowledge-sourcing FDI and the question how the host country knowledge pool may feed back to the home economy via reverse knowledge transfer. The first and second specifications gave us a hint that outward FDI has positive effects on economic growth, but it was not clear whether the knowledge pool and reverse knowledge transfer have played an active part in that. The approach of the third specification provided the opportunity to address this gap by creating a foreign stock of knowledge embedded in the outward FDI stock. By testing the effects of foreign stocks of knowledge on real GDP per capita growth, empirical evidence for Hypothesis (4) is found: The higher the sample countries' share of outward FDI directed to knowledge intensive countries and thus the larger its foreign knowledge stock, the greater the positive growth effects on economic growth.

This finding provides interesting insight to the knowledge-sourcing FDI discussion and proves the existence of international R&D spillovers. In fact, it confirms the assumption that MNCs from developed countries whose FDI is motivated by the access to advanced knowledge in partner countries entails significant feedback effects for the investing firms and their home economies. They seem to benefit from the scientific and technological capacities of the host countries they can access via outward FDI thereby increasing economic growth in the home economy. This may be due to the increased amount of products embodying foreign knowledge which are made available through outward FDI and reverse knowledge transfer. Investing countries can for example profit from the access to a larger variety of intermediate products in the host market and from useful knowledge they would have otherwise costly created themselves. Growth effects may also be due to outward FDI-induced cross-border learning of organizational and production processes or

products which help to increase the productivity of both MNCs and other domestic firms in the home economy.[148]

One should, however, exercise caution with regards to the generalization of these findings. Do the results imply that countries which invest in economies with a high knowledge stock experience higher rates of economic growth per capita than they would have if they had invested in host countries with a lower level of R&D knowledge? Based on the findings above, this question would be answered in the affirmative. However, one has to keep in mind that the country sample used in this third model specification mainly consists of developed countries. It may be expected that firms from these countries have already developed sufficient firm-specific advantages and have enough absorptive capacities to profit from knowledge-sourcing FDI and the R&D base of the host economies. The findings might change significantly if more developing countries are included in the database. Given their knowledge gap to developed economies, developing country firms might not profit as much from investments in advanced economies as firms from developed countries do. The findings of the third specification should therefore be considered in light of the development status of the countries included in the data sample. The central question on knowledge-sourcing outward FDI and the required home country preconditions will be taken up once more in concluding Chapter 7.

6.4. Summary and Future Research

The aim of the empirical analysis was to test some of the main assumptions which were derived from the literature review of Chapter 3 and 4 and the predictions from the endogenous growth model presented in Chapter 5. In order to test four different hypotheses, three different specifications of the general model were set up which applied different proxies for the reverse knowledge transfer channel. The results confirm that across all specifications, outward FDI has a significantly positive and robust impact on economic growth per capita. Furthermore, it can be seen that the absorptive capacity of the home economy, in form of a human capital proxy, does play, at least in the first specification, a decisive role. The results show that when the data sample consists almost

[148] It should be noted, that this consideration is sharpened to the case of knowledge-sourcing FDI. In this context, it should be kept in mind that the positive growth effects might also stem from other factors such as increased sales activity following market-seeking FDI. For examples, if emerging countries invest in advanced host market to enlarge their sales activity of lower-cost goods this might have positive growth effects for their home economies (e.g. Chinese computer company Lenovo has sales and marketing operations worldwide, also in North America, Europe or Japan).

only of developed countries, the human capital proxy might not be adequate and a more refined proxy for the absorptive capacity might be needed to account for the small differences in absorptive capabilities between countries. These findings are more or less in line with the ideas which were derived from the literature review in Chapter 3 and 4 as well as the predictions which were derived from the endogenous technological growth model presented in Chapter 5.

Among the main novelties of this empirical assessment is the consideration of the knowledge stock of the host countries and the amount of knowledge that is potentially embodied in the outward FDI stocks of countries and that might positively spill over to the home economies. This is the first study to measure the effects of outward FDI on economic growth rates of the FDI source countries by accounting for knowledge-sourcing outward FDI and reverse knowledge transfer. Findings show that outward FDI which is biased towards countries which have large cumulative experience in R&D positively affects growth rates in the home economy. An unanswered question in this context is, whether this relation also applies for developing and emerging economies. This issue will be discussed in the next and final chapter of this thesis.

Before looking at the potential conclusion which can be derived from the theoretical and empirical analysis, this chapter shall end with some remarks on potential topics for future research. First, it would be desirable to extend the empirical analysis to more developing countries. In particular, the effects of the foreign knowledge stocks as set up in the third specification deserve a closer inception. Due to data limitations, the data sample of the second and third specification had to be limited to developed countries. Data availability for developing countries is, however, likely to change in the years to come given that more and more developing countries improve their outward FDI statistics. Second, future research could test the models for different types of FDI (vertical vs. horizontal FDI). As discussed in Chapter 4, vertical FDI may have different feedback effects than horizontal FDI. Third, it would be very interesting to extend the analysis to the industry level. Further research on specific industry effects might be meaningful given that each industry has its own characteristics and might therefore differently benefit from outward FDI. Fourth, a promising line of future research may be to investigate different types of absorptive capacities. School enrollments rates might be too imprecise and thus inadequate to account for the differences in absorptive capacities of developed economies. An alternative measure for a country's ability is needed to make use of foreign knowledge acquired via outward FDI. Fifth and last, the different host country knowledge types might deserve a

closer inception. The knowledge stocks are calculated with the use of R&D data, which represent, however, only one aspect of the knowledge stock (input side). Alternative measures for the knowledge stocks would for example be patent data, number of scholars or university graduates.

7. CONCLUSION

The findings of this thesis point to the potential of outward FDI in promoting knowledge accumulation and spurring economic growth in the home economies. Both, in the endogenous growth model presented in Chapter 5 and in the empirical assessment of Chapter 6, evidence is found that the internationalization of firms and the associated formation of an outward FDI stock could be a decisive instrument for the home economy to tap into foreign sources of advanced knowledge, foster reverse knowledge transfer and accelerate the development of the national knowledge stock and economic growth. The thesis may therefore provide interesting insights for academia, private sector and policymakers alike.

Based on the findings of the theoretical and empirical parts of this thesis, some questions will be raised and some conclusions and recommendations shall be drawn in the following. In this context, it is crucial to distinguish between outward FDI from developed economies and investments from developing countries (NICs in particular) when drawing conclusions given that home country conditions vary significantly, both between and within these country groups.

7.1. On the Magnitude of Outward FDI Activity

As shown in the theoretical and empirical analyses of this thesis, outward FDI may have a positive effect on economic growth. Does this imply that a high volume of outward FDI flows and a large number of domestic MNCs is desirable for every country? To what extent is this applicable to developing countries? The question what is needed for a firm to be able to invest and operate abroad in first place and for the whole home economy to profit from this investment in second place has been brought up several times throughout the thesis. It seems obvious that this question cannot be discussed without taking into account the development status of the investing country. Once more, the IDP concept (Dunning 1981, 1986, Dunning and Narula 1996) provides a valuable macroeconomic framework to discuss this issue. It specifies how outward FDI activity changes with the economic development of countries. As already addressed in Chapter 2, the IDP predicts that as a country develops, its international investment position moves through several stages. Outward FDI flows and consequently the outward FDI stock should increase

sequentially given that economic growth (or more general development) and outward FDI are interconnected and mutually reinforcing.

The stages of interest in the IDP with regards to outward FDI from emerging countries are the stages when a country's outward FDI activity starts to pick up and the turning point when its outward FDI flows eventually exceed its FDI inflows. The speed of this development and the point of time when countries enter new stages are considered to depend not only on economic growth but also on various other home country factors such as the openness of the economy, its resource endowments, the dynamism in the shift of comparative advantages, the size of local markets as well as the political strategy of governments (Dunning 1986). Given that the characteristics of these factors are country specific, each economy will follow its own individual investment path and will engage in outward FDI at earlier or later stages of economic development.

The influence of the home country environment will be particularly pronounced in a developing country context. It can be expected that the assets of firms and the way they internationalize will strongly be shaped by the conditions prevailing in their home economies as will be the magnitude and character of their outward FDI with regards to geographical reach, sector specification and mode of investment (greenfield, M&A etc) (Narula 2011). Especially in early phases of development the very lack of sound and supportive environments (e.g. lack of finance or basic infrastructure) often constrains the development of ownership assets of firms and hampers their internationalization process (Narula 2011). One could now argue that the very internationalization of firms and the acquisition of foreign knowledge through MNCs could be an instrument for less developed countries to acquire knowledge and technologies to generate these firm-specific advantages.[149] In fact, there are examples of MNCs which emerged at rather early stages of their home countries' development and sometimes from rather poor overall conditions, some of which engaged in asset-augmenting strategies (e.g. Chinese MNCs at the end of the 1990s). But even these firms often "profited" from very special home country conditions, such as the strategic support by governments, e.g. in form of preferential loans, or the privileged access to natural resources (such as the Venezuelan state-owned oil and natural gas company Petróleos de Venezuela). However, it can be expected that the majority of firms from developing countries will need to have developed a minimum amount of firm-specific advantages and absorptive capacities in order to overcome the

[149] This has been proposed by Moon and Roehl (2001), see Chapter 2.

liabilities of foreignness and be successful in the medium- and long-run when investing abroad. Here again, the analysis comes back to the home country conditions given that MNCs' absorptive capacities are in turn determined by the availability of human capital and the capabilities of the knowledge infrastructure in their home economies. In particular in early phases of development, these factors are needed to supplement and support firm-specific knowledge (Narula 2011). At later stages of development, when firms have developed sufficient firm-specific advantages, home country conditions become less decisive for the success of MNCs abroad (Narula 2011). But then, again, the sound home country conditions will be essential for the rest of the home economy to profit from outward FDI and reverse knowledge transfer.

The linkage between economic development, outward FDI flows and home country conditions is to a certain extent reflected in the current pattern of outward FDI activity of countries worldwide. Whereas many developed countries are net sources of FDI, outward FDI from developing countries is on average still low and very heterogeneous. Although it can be observed that some countries have accelerated their movements along the IDP and invest abroad at quite early stages of development, the bulk of countries at lower levels of development still have little or no outward FDI activity at all given their low capacities and fragile economic structures. It is mainly the fast-growing emerging countries like China, Brazil or Chile which have developed to investor countries with a significant magnitude of outward FDI. And they mostly bring the corresponding prerequisites: flourishing domestic private sector, developing knowledge infrastructure and marked outward orientation among other things. This has helped many firms in these countries to accumulate sufficient knowledge and absorptive capacities to internationalize (see Pradhan and Singh 2008 for examples of Indian automotive companies).

Consequently, although the findings of this thesis lend support to the assumption that outward FDI is growth enhancing, one should keep in mind that there is interdependence between outward FDI and economic growth. The magnitude of outward FDI flows and stock will usually develop sequentially with the level of economic development. For an emerging country to successfully invest abroad another crucial factor comes into play: sound home country conditions which complement and support the investments, help to build firm-specific capabilities and contribute to the absorptive capacity of firms.

7.2. On Knowledge-sourcing FDI and Knowledge Gaps

One of the central findings of the empirical assessment of Chapter 6 was that a country's economic benefit from outward FDI in terms of economic growth will be positively determined by the knowledge stock of the countries it invests in. Does this finding imply that it is advisable to direct as much investment as possible to knowledge intensive countries? And again, to what extent does this nexus hold true for developing countries? The findings of the theoretical model presented in Chapter 5 contribute an interesting thought to that discussion. They indicate that the knowledge gap between MNCs and host economies as well as between MNCs and other domestic firms, respectively, should not be too large. If outward investment is disconnected from the domestic sector, this may have a debilitating effect on economic growth. MNCs might not be able to access and absorb the advanced host country knowledge nor are they able to compete in the long run. Moreover, spillovers might be easier identified and used by domestic firms if the technological capabilities of domestic MNCs are not too far away from their own.

Thus, both the empirical and theoretical findings transport important messages for countries and firms following a knowledge-sourcing FDI strategy: Investments in knowledge intensive economies are valuable to upgrade the home country knowledge base, but only as long as the knowledge gap enables learning and spillovers. Consequently, what is needed is an investment path that allows for knowledge-augmenting FDI without widening the knowledge gap between the host and home country too much. To determine a path of optimal geographical and technological spread of outward FDI one may draw on the logic of the "flying-geese" paradigm which was briefly introduced in Chapter 2. Similar to the paradigm, according to which the production of (low-tech) goods is relocated to countries with lower-cost inputs as comparative advantages of countries shift, it can be assumed that the host countries of outward FDI also change with the sequential technological development of the home economies. In this context, it may be expected that outward FDI activity of countries starts with "outsourcing" and relocating parts of the production to countries which provide inputs at lower costs (efficiency- or resource-seeking FDI), while the home economy focuses more on higher value-added activities.[150] At the same time, the "flying geese" pattern of production may be applied to the knowledge-sourcing activity of countries and the selection of knowledge intensive

[150] One should not forget market-seeking FDI that is also part of the outward FDI activities, in particular to exploit already existent firm-specific advantages.

activities abroad that sequentially come along with it: With the upgrade of home country capabilities and the increase of technological know-how, countries may successively increase knowledge-sourcing outward FDI and knowledge intensive activities in more developed countries.

Some examples of sequential expansion and upgrading of outward FDI activity could be observed in the past, like in Singapore. Singapore initially attracted inward FDI to bring in advanced technologies via foreign MNCs. As its comparative advantages shifted, it step by step relocated manufacturing activities at the lower end of the value chain via outward FDI in countries with lower labor or land costs such as China or Malaysia. At the same time, production at home was successfully upgraded to more knowledge-intensive stages while FDI started to be directed to more advanced countries with the aim to acquire knowledge and complement firm-specific advantages (Ellingsen et al. 2006). Similar trends could be observed in South Korea and Taiwan.

It may be concluded that, just as the production and technological path of countries is often shaped by its home economy characteristics (Narula 2011), the same may apply to a country's knowledge-sourcing outward FDI activity: The reach of their outward investments (in terms of geographical spread, knowledge-intensity of sector) should follow their capabilities and be expanded sequentially, starting in countries and sectors with similar market conditions and knowledge levels (for example neighboring or culturally similar countries). South-South investment, for example, gives access to technologies that are not too far advanced for adoption in emerging home economies (UNCTAD 2006). Once more capabilities and firm-specific advantages have been built up (also with the support of other knowledge transfer instruments such as inward FDI or trade), investments are more likely to be successively expanded to more advanced and knowledge rich countries. Firms may now have the chance to engage in more knowledge intensive steps and higher value-added segments of the value chain (be it in horizontal, upstream or downstream industries). With the gradual expansion of knowledge intensive activities abroad, both MNCs as well as their emerging home economies may steadily enhance their technical, managerial or organizational capacities, which in turn feeds back to outward FDI activity and economic growth, respectively.

7.3. On the Role of Policy

Policy measures to support internationalization of firms and augment outward FDI activity should be discussed against the backdrop of sound home country conditions. It has become clear in the previous sections that the success and feedback effects of outward FDI for the MNCs and their home economies are strongly influenced by the domestic capacities and knowledge infrastructure, in particular in NICs. Therefore, before looking at the potential of concrete policy measures, one should look at what is needed to strengthen the home country conditions that are the prerequisite for firms to develop, flourish and internationalize in first place.

A sound home country setting is characterized by an open, growth friendly and supportive environment in which the private sector can mature and develop firm-specific advantages; an environment that brings forward capable entrepreneurs and encourages them to internationalize and share their knowledge with the rest of the home economy. Such a setting is impacted by many different factors. It starts with a skilled and qualified workforce with technical, scientific and managerial skills (indigenous scientists, engineers and managers) that is able to develop ideas and to absorb, adopt and advance the knowledge reversely brought back to the home economy by domestic MNCs. Favorable business environments for outward investing firms also include a sound financial system which facilitates access to financing for foreign investment ventures (UNCTAD 2006). Communication infrastructure is another central prerequisite since it reduces the costs for MNCs for the coordination and international communication with their foreign subsidiaries. Similarly, adjusted national norms and standards to international benchmarks can facilitate the global activities of MNCs. Moreover, a well-developed private sector with efficient domestic supplier networks will help MNCs to maintain their embeddedness in their home economies. This way, also non-multinational parts of the home economy may benefit from outward FDI via the linkages discussed in Chapter 4. In addition, home economies' capabilities to make use of outward FDI are significantly determined by the institutional framework for innovation, that is, the national innovation system (NIS) with a broad spectrum of institutions as well as scientific and technological networks. A sound mixture of these factors will not only enable the MNCs to engage abroad and eventually share the acquired knowledge with other home country actors, it will also be decisive to ensure the attractiveness of the home economy as a location for production and innovation in the long-run.

What role can policy play in this context? Several policy measures that aim to stimulate outward FDI have been discussed in the literature, ranging from financial incentives (tax rebates, preferential loans), risk insurances to the establishment of investment promotion agencies as a platform for knowledge exchange (see UNCTAD 2006 for an extensive summary of direct and indirect policy measures). When discussing the implementation of policy measures one should carefully weigh the potential benefits and costs of the policies implemented. Strong state interventionism in outward FDI activities of firms as observed in China should be treated with caution given the dependency on government support and lack of incentives to develop firm-specific advantages and capabilities which are needed to sustain in the long-rum. Government-led outward FDI strategies should, however, not be doomed in the forefront. Some examples show, that strategic outward FDI liberalization and government-backed internationalization of firms worked out pretty well for countries like Singapore or South Korea. Many of their MNCs are nowadays large global players such as Hyundai or Samsung (see Ellingsen et al. 2006). Yet, when setting up measures, policymakers should consider that their design and incentives do not distort market mechanisms. Thus, while government can secure macroeconomic stability and contribute to the sound framework conditions addressed above (reduction of administrative burdens and red tape, educating skilled workforce, development of R&D capabilities and the strengthening of research institutes), outward investment decisions of firms should continue to be based on economic expectations and rationale. Policymakers should restrict themselves to ensure and strengthen the attraction of the home economy for the MNCs as well as to remove barriers which may hinder firms to internationalize. According to Globerman et al. (2000, p.18),

> *"improving the physical and communications infrastructure of a country or region, raising the education and skill level of the workforce, and encouraging innovation-related activities are important components of best practice policies to encourage foreign direct investment."*

It can be concluded, that outward FDI in itself is not per se a condition to generate positive developmental effects for the home countries of the investing MNCs. The potential to feed back and contribute to economic development in the home economy varies markedly between different types of outward FDI: Different motives of outward FDI at different stages of development provide different potential for domestic spillovers. Similarly,

investment in some host economies will have different implications for the home economy than outward FDI activities in others.

The thesis can therefore not provide a “one-size-fits-all” approach. However, some general conclusions for the role of outward FDI for home country development can be drawn. While investments abroad do positively affect economic development, outward FDI and economic development are mutually reinforcing meaning that economic growth is a function of outward FDI and vice versa. It should be kept in mind that in order to benefit from the internationalization, sound home country conditions and a certain amount of absorptive capacities are needed. An incremental expansion of outward FDI activity which accounts for technological gaps between host and home economies will facilitate reverse knowledge transfer and enhance the developmental impact on the home economies.

A. APPENDIX

A.1. Mathematical Derivations

A.1.1. Derivation of Equilibrium Human Capital in Research Sector

By solving equation (27) $\delta H_R \left(\frac{k^*}{k}\right)^{(1-\mu)} = \delta^* H_R^* \left(\frac{k}{k^*}\right)^{(1-\mu^*)}$ for H_R^*, one receives:

$$\mathrm{H_R^*} = \frac{\delta \mathrm{H_R} \left(\frac{\mathrm{k^*}}{\mathrm{k}}\right)^{(1-\mu)}}{\delta^* \left(\frac{\mathrm{k}}{\mathrm{k^*}}\right)^{(1-\mu^*)}} = \mathrm{H_R} \frac{\delta}{\delta^*} \left(\frac{\mathrm{k^*}}{\mathrm{k}}\right)^{(1-\mu)} \left(\frac{\mathrm{k^*}}{\mathrm{k}}\right)^{(1-\mu^*)} = \mathrm{H_R} \frac{\delta}{\delta^*} \left(\frac{\mathrm{k^*}}{\mathrm{k}}\right)^{(2-\mu-\mu^*)} \quad \text{(a)}$$

Dissolving equation (25) $\frac{\delta}{\delta^*} = \left(\frac{k^*}{k}\right)^{\mu+\mu^*-1}$ for $\left(\frac{k^*}{k}\right)$ yields:

$$\left(\frac{\mathrm{k^*}}{\mathrm{k}}\right) = \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}} \quad \text{(b)}$$

(b) is inserted in (a). This results in:

$$H_R^* = H_R \frac{\delta}{\delta^*} \left(\frac{\delta}{\delta^*}\right)^{\frac{(2-\mu-\mu^*)}{\mu+\mu^*-1}} = H_R \left(\frac{\delta}{\delta^*}\right)^{1+\frac{(2-\mu-\mu^*)}{\mu+\mu^*-1}} = H_R \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}} \quad \text{(c)}$$

Dissolving equation (23) $H_Y + H_R + H_R^* = H$ for H_R yields:

$$H_R = H - H_Y - H_R^* \quad \text{(d)}$$

Substituting equation (c) in (d) results in:

$$H_R = H - H_Y - H_R \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}} \quad \text{(e)}$$

Which can now dissolve for the equilibrium level of human capital deployed in low-tech research H_R:

$$H_R + H_R \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}} = H - H_Y$$

$$H_R \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right) = H - H_Y$$

$$\mathrm{H_R} = (\mathrm{H} - \mathrm{H_Y}) \Big/ \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right) \quad (28)$$

To obtain the equilibrium level of human capital deployed in high-tech research H_R^* equation (23) is dissolved for H_R^* so that:

$$H_R^* = H - H_Y - H_R$$

Substituting equation (28) yields:

$$H_R^* = H - H_Y - (H - H_Y) \Big/ \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)$$

$$H_R^* = \left[(H - H_Y)\left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right) - (H - H_Y)\right] \Big/ \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)$$

$$H_R^* = \left[H\left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right) - H + H_Y - H_Y\left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)\right] \Big/ \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)$$

$$H_R^* = \left[H\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}} - H_Y\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right] \Big/ \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)$$

$$H_R^* = \left[(H - H_Y)\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right] \Big/ \left(1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right) \qquad (29)$$

A.1.2. Derivation of Equilibrium Human Capital in Final Goods Sector

Given that $\alpha K H_Y^{\alpha-1} L^{\beta} \bar{x}^{1-\alpha-\beta} = \frac{\alpha Y}{H_Y}$ based on equation (2) and if P_k in equation (30) is replaced by the equilibrium price for design received in equation (20) $p_k = \frac{(\alpha+\beta)(1-\alpha-\beta)}{r}\frac{Y}{K}$ yields:

$$P_k \delta k^{\mu} k^{*(1-\mu)} = \alpha K H_Y^{\alpha-1} L^{\beta} \bar{x}^{1-\alpha-\beta} = \frac{\alpha Y}{H_Y}$$

$$\frac{(\alpha+\beta)(1-\alpha-\beta)}{r}\frac{Y}{K}\delta k^{\mu} k^{*(1-\mu)} = \frac{\alpha Y}{H_Y}$$

We now solve for the equilibrium level of human capital employed in final goods production to get equation (31):

$$H_Y = \frac{\alpha r}{(\alpha+\beta)(1-\alpha-\beta)\delta}\frac{K}{k^{\mu} k^{*(1-\mu)}}$$

$$H_Y = \frac{\alpha r}{(\alpha+\beta)(1-\alpha-\beta)\delta}\frac{(k+k^*)}{k^{\mu} k^{*(1-\mu)}}$$

$$H_Y = \frac{\alpha r}{(\alpha+\beta)(1-\alpha-\beta)\delta}(k+k^*)k^{-\mu}k^{*(\mu-1)}$$

$$H_Y = \frac{\alpha r}{(\alpha+\beta)(1-\alpha-\beta)\delta}(k+k^*)\left(\frac{k}{k^*}\right)^{-\mu}k^{*-1}$$

$$H_Y = \frac{\alpha r}{(\alpha+\beta)(1-\alpha-\beta)\delta}\left(\frac{k}{k^*}\right)^{-\mu}\left(kk^{*-1}+\frac{k^*}{k^*}\right)$$

$$H_Y = \frac{\alpha r}{(\alpha+\beta)(1-\alpha-\beta)\delta}\left(\frac{k}{k^*}\right)^{-\mu}\left(1+\frac{k}{k^*}\right)$$

$$H_Y = \frac{\alpha}{\delta(\alpha+\beta)(1-\alpha-\beta)}\left(\frac{k}{k^*}\right)^{-\mu}\left(1+\frac{k}{k^*}\right)r \qquad (31)$$

A.1.3. Derivation of the Equilibrium Rate of Economic Growth

The following equations have already been derived:

$$g = \delta H_R\left(\frac{k^*}{k}\right)^{(1-\mu)} \qquad (34)$$

$$H_R = \frac{H - H_Y}{1+\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} \qquad (28)$$

$$H_Y = \frac{\alpha}{\delta(\alpha+\beta)(1-\alpha-\beta)}\left(\frac{k}{k^*}\right)^{-\mu}\left(1+\frac{k}{k^*}\right)r \qquad (31)$$

Equations (28) and (31) are substituted in equation (34):

$$g = \delta\,\frac{H - \frac{\alpha}{\delta(\alpha+\beta)(1-\alpha-\beta)}\left(\frac{k}{k^*}\right)^{-\mu}\left(1+\frac{k}{k^*}\right)r}{1+\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}\left(\frac{k^*}{k}\right)^{(1-\mu)}$$

Simplifying the expression leads to:

$$g = H\delta\frac{\left(\frac{k^*}{k}\right)^{(1-\mu)}}{1+\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} - r\delta\frac{\frac{\alpha}{\delta(\alpha+\beta)(1-\alpha-\beta)}\left(\frac{k}{k^*}\right)^{-\mu}\left(1+\frac{k}{k^*}\right)}{1+\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}\left(\frac{k^*}{k}\right)^{(1-\mu)}$$

$$g = H\delta \frac{\left(\frac{k^*}{k}\right)^{(1-\mu)}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} - r \frac{\frac{\alpha}{(\alpha+\beta)(1-\alpha-\beta)}\left(\frac{k^{-\mu}k^{*1-\mu}}{k^{*-\mu}k^{1-\mu}}\right)\left(1+\frac{k}{k^*}\right)}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}$$

$$g = H\delta \frac{\left(\frac{k^*}{k}\right)^{(1-\mu)}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} - r \frac{\frac{\alpha}{(\alpha+\beta)(1-\alpha-\beta)}\left(\frac{k^*}{k}\right)\left(1+\frac{k}{k^*}\right)}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}$$

$$g = H\delta \frac{\left(\frac{k^*}{k}\right)^{(1-\mu)}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} - r \frac{\frac{\alpha}{(\alpha+\beta)(1-\alpha-\beta)}\left(1+\frac{k^*}{k}\right)}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}$$

From equation (25) it can be derived that: $\left(\frac{k^*}{k}\right) = \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}$

This is substituted in the above equation:

$$g = H\delta \frac{\left(\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)^{(1-\mu)}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}} - r \frac{\frac{\alpha}{(\alpha+\beta)(1-\alpha-\beta)}\left(1+\left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}\right)}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}$$

$$g = H\delta \left(\frac{\left(\frac{\delta}{\delta^*}\right)^{\frac{1-\mu}{\mu+\mu^*-1}}}{1 + \left(\frac{\delta}{\delta^*}\right)^{\frac{1}{\mu+\mu^*-1}}}\right) - \frac{\alpha}{(\alpha+\beta)(1-\alpha-\beta)} r \qquad (35)$$

A.2. Description and Discussion of Variables and Data Sources

A.2.1. Model Abbreviations

Abbrev.	Definition and source in parentheses
A	Set of control and policy variables
$AGFCF$	Annual gross fixed capital formation (OECD)
δ	Depreciation rate of the domestic knowledge stock
$DCPS$	Ratio of domestic credit to private sector to GDP (World Development Indicators)
$Educ$	Annual log of average years of total schooling in the total population over age 25 (Barro and Lee 2013)
Exp	Annual growth rate of export of goods and services (IMF)
g	Average annual log growth of R&D expenditures
$GDP(0)$	Log of initial real GDP per capita (UNCTAD)
$GDPGR$	Annual real GPD per capita growth (UNCTAD)
$GFCF$	Annual average share of gross fixed capital formation in GDP (World Development Indicators)
$GovCons$	Ratio of general government final consumption expenditure to GDP (World Development Indicators)
Imp	Annual growth rate of imports of goods and services (IMF)
Inf	Annual percentage change of consumer price index (World Development Indicators)
K	Variable representing reverse knowledge transfer channel
LEB	Logarithm of life expectancy at birth measured in years (World Development Indicators)

$OFDI^{LocCur}$	Growth rate of outward FDI stock in local currency (OECD)
$OFDI^{USD}$	Growth rate of outward FDI stock in US Dollar (UNCTAD)
R	Research and Development expenditures (OECD)
S^D	Domestic stock of knowledge
S^F	Foreign stock of knowledge
SGR^F	Growth rate of foreign stock of knowledge S^F
$SOFDI_{i,j}$	Outward FDI stock of country i in country j

A.2.2. Data Definitions and Sources

Economic Development: GDP per capita growth

The most commonly used measure for economic growth is the real growth rate of a country's gross domestic product (GDP) (Barro and Sala-i-Martin 2004). GDP measures the market value of all final goods and services made within the borders of a country in a year. GPD per capita is commonly seen as an indicator for a country's standard of living. The analysis therefore uses the growth rate of real GDP per capita as the dependent variable. Data is taken from the UNCTAD statistics.

Reverse knowledge transfer channel: Outward FDI

We expect outward FDI to be a channel of reverse knowledge transfer from the host to the home economy. Outward FDI stock data in US Dollar is drawn from the UNCTAD database. According to the UNCTAD statistics, the FDI stock is measured as the value of the share of the capital and reserves (including retained profits) attributable to the parent enterprise, plus the net indebtedness of affiliates to the parent enterprises. Outward FDI stock data denominated in local currency is drawn from the OECD statistics. In the analysis annual percentage changes of outward FDI stock are used.

Human capital: Average years of total schooling

In the empirical literature the most commonly used proxy for human capital stock are educational attainment measures which reflect the level of education completed by an adult (see Section 4.2.1 for a discussion). It is assumed that educated people are more productive and thus positively impact economic growth (Barro and Sala-i-Martin 2004). The analysis uses educational attainment measures in form of the annual log of average years of total schooling in the total population over age 25. Data is taken from the Barro and Lee (2013) data set.

Domestic investment activity: Gross fixed capital formation

The average share of gross fixed capital formation in GDP is a measure of the investment activity of an economy and is assumed to have a positive effect on economic growth (Barro and Sala-i-Martin 2004, Levine and Renelt 1992, Solow 1956). The annual average share of gross fixed capital formation in GDP is used in the analysis. Data is taken from the World Bank's World Development Indicators.

Macroeconomic stability: Inflation

Inflation in form of the annual percentage change of consumer price index provides a measure of macroeconomic stability. Given the high uncertainties and distortions in economic decisions that come along with high rates of inflation, it is expected that inflation rates negatively impact economic growth (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). Data on the consumer price index is drawn from the World Bank's World Development Indicators.

Health conditions: Life expectancy at birth

The number of years of life expectancy at birth gives an indication of the health conditions of a country's population (Barro and Sala-i-Martin 2004). It may be expected that the higher the life expectancy at birth, the healthier and the more productive the working population and the higher the savings. These factors may have a positive impact on economic growth. Newer research, however, indicates that increases in life expectancy may lead to fast population growth which in turn may in some cases negatively affect per capita income due to reduced capital-to-labor and land-to-labor ratios (Acemoglu and

Johnson 2007). The logarithm of life expectancy at birth is used in the analysis. Data is drawn from the World Bank's World Development Indicators.

Financial development: Domestic credit to private sector

Domestic credit to private sector is a proxy for the financial development of economies. It gives an indication on how much financial resources are provided to the private sector, e.g. in form of loans or purchases of non-equity securities. The indicator is expected to have a positive impact on economic growth in various ways, for example if the availability of financial resources increases liquidity and reduces intertemporal risk (Barro and Sala-i-Martin 2004, King and Levine 1993, Levine and Renelt 1992). The ratio of domestic credit to private sector to GDP is used. Data is drawn from the World Bank's World Development Indicators.

Fiscal measures: General government final consumption expenditure

We use the ratio of general government final consumption expenditure to GDP as a proxy for fiscal measures.[151] The value includes all government expenditures for purchases of goods and services. Whether government consumption is growth-promoting or growth-deterring is a matter of perception. On the one hand, governments may provide valuable growth enhancing public goods such as education or infrastructure. On the other hand, the majority of studies predict that government expenditures have a negative effect on economic growth given expectations concerning the waste of public funds and the distortion of private decisions (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). Data is drawn from the World Bank's World Development Indicators.

Trade openness: Imports and exports of goods and services

We use annual growth rates of exports and imports. Openness of an economy in form of import and export activity may positively feed back to economic growth given that trade may contribute e.g. to the improvement of resource allocation and specialization in the home economy (Barro and Sala-i-Martin 2004, Levine and Renelt 1992). Data is drawn from the World Bank's World Development Indicators.

[151] Note that government expenditure is a quantitative measure that does not account for the efficiency of fiscal measures. While recognizing this problem, the analysis focused on reexamining the robustness of past findings.

Convergence: Initial real GDP per capita

The initial level of real GDP is often applied in growth models to test the absolute/unconditional convergence hypothesis (Levine and Renelt 1992). The initial level of real GDP should give us an indication whether less developed economies tend to catch up in absolute terms, i.e., other things equal, grow faster than more developed economies. Accordingly, the coefficient should show the rate of convergence (Barro and Sala-i-Martin 2004, Solow 1956). Here, the logarithm of initial level of real GDP per capita is used. Data is taken from UNCTAD.

A.3. Sample Countries

Model 1

Algeria, Australia, Austria, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Denmark, Ecuador, Egypt, Finland, France, Gabon, Germany, India, Israel, Italy, Japan, Jordan, Kenya, Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Panama, Philippines, Portugal, Saudi Arabia, Senegal, Singapore, South Africa, Spain, Swaziland, Sweden, Thailand, Tunisia, United Kingdom, United States of America

Model 2 and 3

Australia, Austria, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, United States of America

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