INTERNATIONALISATION THEORY AND TECHNOLOGICAL ACCUMULATION –

An investigation of multinational affiliates in East Germany

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SUMMARY

This dissertation applies the theory of technology accumulation to explain the internationalisation of foreign and West German multinational enterprises (MNEs) into East Germany. This theory shifts the focus from technology transfer to the international diffusion of innovation within the MNE. It rejects the position that all MNEs offer the same technological opportunities to host economies. Yet, most of the existing empirical research on post-communist transition economies including East Germany applies the traditional technology transfer perspective. Therefore, this dissertation provides a complementary and novel approach. We assume a dynamic interaction between existing location specific technological capabilities within the host country, MNEs' location choice, their internationalisation of R&D and innovation, and the potential for technological spillover effects from MNEs to the host economy. The dissertation exploits information from the *IWH FDI micro database* on the full population of MNEs that entered East German manufacturing until 2005 and corresponding survey data. Micro econometric estimation results generate a number of novel findings: We can show that existing location specific technological capabilities affect MNEs' general location choice within East Germany. They are not powerful enough to attract MNEs' technological activities. Instead, the location of MNEs' innovation requires the joint presence of technological and industry specialisation within regions, whereas foreign R&D benefits from technological specialisation in combination with a diversified industry structure. Moreover, the location of technological activity differs depending upon the underlying motive for internationalisation. Our findings suggest that the potential for technological externalities from affiliates to local firms is subject to centrally and locally driven technological heterogeneity of MNEs. Existing location specific technological capabilities do not affect the spillover potential. This hints a limited dynamic interaction of ownership and locational advantages in firms' internationalisation. We derive implications for the technology accumulation theory as well as for various fields of science and technology policy.

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Acknowledgments

The submitted dissertation aims to provide an original piece of research that adds to the existing body of theoretical and empirical knowledge in the field. It also formed a formidable challenge for me as a social scientist to prove that I am able to work in accordance with the required scientific standards. Whether this piece of work has any merit or even impact on the research community is for others to judge. However, it is clearly the outcome of my professional development which has been supported in various important ways by a number of people of whom I would like to name at least a few. First of all, I would like to express uttermost gratitude to my parents, Ingrid and Horst Jindra, who supported my education and progress in an altruistic manner over such a long period of time. My academic development was only possible through cooperation and exchange with many colleagues. Most of all I am highly indebted to Dr Jutta Günther and Dr Johannes Stephan who actively encouraged and facilitated my research progress. Academic guidance was also provided by several other colleagues at the Halle Institute for Economic Research (IWH) including Lutz Schneider, Dr Gerhard Heimpold, Dr Mirko Titze, Dr Iciar Dominguez-Lacasa, Andrea Gauselmann, and Muhamed Kudic. I would like to use this opportunity to thank Gabriele Hardt as well as the students Daniel Sischka, Anja Balschbach, Carmen Wopperer, Babette Richter, and Marcel Kirst for their continued support in updating the *FDI IWH micro database*. The University of Sussex and most importantly SPRU were the other source of my academic inspiration. I am most grateful for the diligent PhD supervision provided by Prof. Nick von Tunzelmann and Dr David Dyker. Furthermore, I benefited very much from the constructive critique at my research committees offered by Dr Simona Iammarino and Prof Ben Martin. In addition, I would like to thank Prof Lucia Piscitello and Prof John Cantwell as commenting members of my EIBA Doctorial Tutorial in Catania. Finally, Tina Hilbert is the one who made sure that my motivation did not run out of steam and, in the process of doing so, endured so many of my ups and downs with great patience.

1. Introduction

The relation between internationalisation of firms, technology transfer, and possible host country effects has long been a concern in economic research. It is traditionally assumed that foreign firms possess a centrally accumulated technological advantage over domestic firms which can be exploited abroad. Given a sufficient level of absorptive capacity and human capital, domestic firms are believed to be able to benefit from technological externalities stimulated by the mere presence of multinational enterprises (MNEs). However, more recently the emphasis shifted from the traditional technology transfer perspective to one of global generation and diffusion of knowledge and innovation within the MNE. It is suggested that not every MNE provides the same knowledge opportunities for domestic firms. The spillover potential crucially depends on the technological heterogeneity of MNEs as well as existing location specific technological capabilities within the host economy.

With the integration of post-communist countries into the European and global economy after 1990, there was a strong research interest into the role of MNEs for economic restructuring and technological catching-up. However, most of the existing research applied the traditional technology transfer perspective. By and large, the evidence shows that MNEs had a positive direct effect in terms of restructuring; however, empirical results for spillover effects to domestic firms are mixed. Despite the fact that there was increasing trend in empirical analyses to use firm level data, the heterogeneity of MNEs remained largely ignored.

This dissertation provides a complementary research approach to the analysis of firms' internationalisation by drawing from the technology accumulation approach. The theory suggests a cumulative relation between existing location specific advantages within the host country, multinationals' location choice, their internationalisation of research and development (R&D) as well as innovation, and the potential of technology related externalities to the host economy. The empirical research of the dissertation analyses each component of this relation in turn. To our knowledge, this is the first time that the technological accumulation approach is applied in such a comprehensive way to explain the internationalisation of firms into East Germany as a post-communist region of Central and East Europe.

Most of the existing empirical studies in the field did not take account of East Germany. This might be for different reasons: *First,* theoretical and empirical difficulties derive from the fact that East Germany became a region subsumed in a larger and more mature economy. This implied a very distinct transition pattern characterised by rapid institutional change and considerable public transfer payments in contrast to other transition economies. *Second,* East Germany received private investment from foreign as well as West German firms. Only the first can be considered as foreign direct investment (FDI). However, West German investors played a considerable role too, and we find MNEs in both groups of firms. *Finally,* there had long been a lack of micro data to analyse the activities of corresponding firms from a production as well as technological perspective adequately. This leaves us still today with the question: What drives multinational enterprises to invest in East Germany and to what extent do they actually contribute towards technological development in terms of their own R&D and innovation as well as through spillover effects to other firms located in East Germany?

1.1 Setting the scene

Before we unfold the main propositions of the technological accumulation approach, derive the research questions, and introduce the adopted research strategy of the dissertation, it is important to set the scene regarding the macroeconomic context of the East German transition crisis, the role of foreign and West German investors in the privatisation process, as well as the alignment of MNEs with the East German innovation system. With the start of economic transition, the production as well as science and technology (S&T) system of the former German Democratic Republic (GDR) broke down due to a lack of international competitiveness. In contrast to other transition economies, the currency union induced a massive real wage appreciation which led to a virtual collapse of industrial production and high and persistent unemployment. During the privatisation process, industrial R&D and innovation largely disappeared. In this context, strong expectations were related to foreign as well as West German investors in respect to the renewal of fixed capital stock as well as to knowledge transfer and spillovers to foster innovation and technological catching-up.

1.1.1 The East German transition crisis

On the 1st of July 1990 the German monetary, economic and social union took effect and turned the GDR into a region subsumed within the economy of the Federal German Republic (FGR). The monetary union implied an exchange rate of 1:1 for salaries, pensions, rents, leases as well as private savings up to 4.000 Mark. As a results of the monetary union, East German labour costs jumped from 7 per cent to about one half of the West German level in 1991 (Franz and Steiner 2000, Sinn 2002). With productivity in the East German manufacturing industry running at an estimated 20 percent of the West German level in 1991, it rendered the bulk of East German enterprises effectively insolvent (IWH 2009).

In response, unemployment jumped. From 1991 to 1993, employment in the East German manufacturing sector plunged by two thirds from 132 employees per 1,000 inhabitants to 47 (Nolte and Ziegler 1994). Since then, labour costs have fallen steadily in relation to productivity, but the employment rate has remained low (Snower and Merkel 2008). Labour productivity in the East German manufacturing sector increased to 78 per cent of the West German level by 2007 (IWH 2009). This productivity growth was initially related to labour shedding and, in later stages, to massive public and private investment as well as a cautious wage policy. De facto East German wage level in manufacturing stands at more or less two thirds of the corresponding West German level since 1996 until today (ibid.).

Burda (2006) argues that with the start of privatisation, East Germany experienced a dramatic factor reallocation with massive cross-regional movements of goods and services in trade, as well as capital flows and labour migration. Considerable transfer payments[1] from West to East Germany were intended to facilitate a speedy reunification. Hall and Ludwig (2007) hold that it is the exceptional pattern of East German privatisation in combination with substantial investments leading to dramatic jumps in levels of capital intensity in manufacturing that caused a quick shift to capital intensive production, inducing a rapid and massive shedding of labour at levels not experienced in other transition countries (ibid).

1.1.2 Foreign and West German investors in the privatisation process

According to the privatisation law passed in June 1990, priority was given to a de-concentration and a quick privatisation of enterprises instead of restructuring before privatisation. The privatisation process had no elements of mass privatisation implemented in Poland, the Czechoslovakian Federation, Hungary, or Poland. State owned enterprises were handed over to the privatisation agency (‘*Treuhandanstalt*’), a public authority at the Federal Ministry of Finance, responsible for the implementation of privatisation. The privatisation agency divided the 434 existing large combined enterprises (‘*Kombinate*’) of the former GDR in order to adapt to new market structures and to make privatisation more feasible.

[1] In 2003 about 25 per cent of East German effective demand was supported by transfer payments of which three thirds are related to social transfers that bolster private consumption and one third at investment (Lehman et al. 2005).

The so-called big privatisation took place through re-privatisation to the former owners, transfer of ownership to local authorities (‘*Kommunalisierung’*), management buy outs and management buy ins (MBO/MBI), as well as privatisation to foreign and West German owners until the end of 1994. In 1990, the privatisation agency had registered a company stock of 8,300 enterprises for privatisation. Due to the division of enterprises as well as outsourcing of single entities and departments, the number of firms under administration grew steadily. Therefore, the stock of enterprises subject to privatisation stood at 12,354 in 1994 (see Table 1).

Table 1 Stock of state-owned-enterprises and privatisation mode

		Stock of enterprises in 1994			
Privatisation mode	Number	%	Ownership	Number	%
Liquidation	3,718	30.57			
Municipalisation	310	2.55	Municipality	310	3.67
Re-privatisation	1,588	13.06	Former owner	1,588	18.81
Privatisation	6,546	53.82	MBO/MBI	2,983	35.33
			West German	2,703	32.01
			Foreign	860	10.18
Net total	12.162	100	Total	8,444	100
	192		Agency	192	
Gross total	12,354				

Source: Bundesanstalt für Vereinigungsbedingte Sonderausgaben (2003)

After subtraction of liquidations, about 35 per cent of the enterprises were subject to MBO/MBI with a presumably large part of East German owners; 19 per cent were re-privatised, also mostly to East German owners; about 32 per cent were sold to West German and only ten 10 per cent to foreign investors. West German and foreign investors were given priority especially in larger privatisation projects in order to support the modernisation of fixed capital as well as knowledge transfer. In this respect, West German and foreign investors were regarded equally effective (Leiner 1998, Zuk 1998). In terms of absolute numbers of privatisation projects, foreign investors did not play a major role. However, in terms of employment and investment promises, foreign investors accounted for 10 per cent and 12 per cent respectively, because they took over rather big and capital intensive enterprises (Bundesanstalt für Vereinigungsbedingte Sonderausgaben 2003, Leiner 1998).

Over time, foreign and West German firms became important shareholders in the East German economy. In 2001, the share of foreign and West German majority owned establishments accounted for 48 per cent of employment, 65 per cent of turnover, as well as fixed capital investment of East German manufacturing sector (Günther 2005). In order to compare the penetration of foreign firms in East Germany and other post-communist countries adequately Günther (2005) argues that it is misleading to consider aggregate FDI data as it says nothing about the actual fixed capital investment and because it excludes West German investment in the case of East Germany. She finds that in 2001 the fixed capital investment by foreign and West German majority owned establishments in East German manufacturing stood at 351 Euro per head and 8,643 Euro per employee. This is way above corresponding fixed capital investment by foreign owned firms in Poland (85 Euro and 1,252 Euro respectively), the Czech Republic (194 Euro and 1,521 Euro respectively), and Hungary (225 Euro and 2,393 Euro respectively).

The massive differences in terms of fixed capital investment per employee are explained by a higher capital intensity of East German manufacturing in comparison to other post communist transition economies (ibid). Fixed capital investment per employee in the East German economy exceeds corresponding West German rates since 1992 (IWH 2009). As a result, the capital intensity of manufacturing has been above the West German level since 2002 (ibid.). Therefore, it can be argued that investment by foreign and West German investor contributed considerably to the renewal of the East German capital stock during transition process.

1.1.3 Aligning MNEs with the East German innovation system

The participation of foreign and West German investors in the restructuring process of the East German economy can not only be assessed from the production, but also the technological side. Over the last 20 years the S&T system of the former GDR underwent considerably transformation, in which foreign and West German investors arguably also had a role to play.

In the S&T system of the GDR pre-1990, central planning entrusted the generation of technologies mainly to R&D institutes of the Academy of Sciences and the research institutes embedded in the large industrial conglomerates, whose targets were to create defined quantities of new technologies. These new technologies were then meant to be the main source of technological diffusion in the enterprises that were responsible for actual production. In principal, central planning in combination with its customary linear technology-push approach failed to motivate the spread of economies of scope even in a non-dynamic way, and so generated a number of kinds of network failures with regard to industrial R&D (von Tunzelmann et al. 2010).

For example, the S&T system of the GDR suffered from a relative weakness of global networks which limited knowledge flows and spillovers from foreign to East German firms. Trade and payment links with non-socialist countries were severely restricted as international flows were predominantly within the Council for Mutual Economic Assistance (CMEA). The international exchanges in the CMEA became increasingly inferior to the potentialities of Western commerce, leading ultimately to intense pressures for change (von Tunzelmann 2004). In response to lack of original domestic innovation activities and arguably weak global networks, industrial research in the GDR turned to reverse engineering and imitation of Western products from the 1980s. This has often been identified as a major weakness of the socialist systems, even though the absorption of external technology and imitation is not a costless task and requires its own technological competencies (Mansfield et al. 1981).

The offsetting element to weak global networks was the great power of national structures under central planning, which set nationwide targets for output and technology as well as the scale and scope of operations. National structures acted as – or instead of – networks in the broad definition, since they effectively determined the interrelationships among elements of the national system, through the rather unbalanced mixture of hierarchies, 'markets' and networking (von Tunzelmann 2004). Local networks were intended to be subservient to national targets, but in practice the production enterprises were left to their own devices to make many of the required managerial decisions, and indeed the system depended on their doing so (von Tunzelmann 1995).

The institutional transformation of the socialist S&T system created the starting point for the regeneration of the East German innovation system, which today can be regarded as constituting a distinct regional innovation system within the national German system. As a historical legacy and a consequence of the privatisation process, the agents faced a number of challenges in the private sector such as overcoming weak industrial R&D and low innovative capacity, as well as re-aligning global and local networks (von Tunzelmann et al. 2010).

The German monetary, economic and social union forced East German enterprises to cut all expenditures that were not immediately necessary to maintain running production (Meske 1994). Therefore, many industrial R&D units disappeared in the course of privatisation since companies had to reduce expenditures even at the cost of medium- and long-term innovation potential. Smaller-sized firms privatised through MBO or MBI were usually not able to retain their own R&D capacities. In turn, most foreign and West German investors had little interest in the existing R&D departments and R&D institutes of the former large combined industrial conglomerates (EFI 2010). Instead, their main investment motives related to access to markets and production sites (Belitz eat al. 1999) As a result, the number of industrial R&D personnel declined sharply by about 63 per cent from 86,000 in 1989 to 32,000 in 1993 and remained more or less on that level until today (Meske 1993, Günther et al. 2009b). Furthermore, state owned enterprises cancelled all contractual relationships with the institutes of the Academy of Sciences, higher education institutions, as well as research institutes that formed part of the large industrial conglomerates (Meske 1993). This loss of R&D and innovation potential has often acted as a key element in the critique raised against the quick privatisation policy (Grabher 1992, Meske 1993, 1994).

Whereas in the early stages of transformation foreign and West German investors bypassed existing private and public R&D infrastructure in East Germany and followed non-technological investment motives, there is emerging evidence for later stages of the transformation that foreign and West German owned firms implement R&D and innovation activities way above levels of East German owned firms (Günther and Lehmann 2004, Günther and Gebhardt 2005, Günther and Peglow 2007). Yet, these performance differentials have been partially related to the structural effects (Günther and Gebhardt 2005). In addition, recent evidence indicates that access to local technology in terms of higher education and public science infrastructure matters apart from advantageous production conditions as investment motives for foreign affiliates based in East Germany (Thum et al. 2007). Yet, it has also been argued that in the context of global location choice multinationals requirements for regional innovation systems can only be rarely fulfilled by the current East German innovation system (Koschatzki et al. 2006). Moreover, there is conflicting evidence on knowledge spillovers from foreign and West German firms in East Germany. There seems to be evidence that East German owned firms benefit in terms of productivity spillovers from the presence of foreign and West German firms within the same sector of activity (Peri and Urban 2006), however, this does not seem to apply to inter-sectoral productivity spillovers (Lehmann and Günther 2004).

Therefore, the verdict on the extent to what foreign and West German owned firms were able to rebalance the formerly weak structural role of global networks in the East German innovation system is still open. Further empirical research seems required in order shed light on the relation between the activities of foreign and West German investors and the East German innovation system.

1.2 Research questions, strategy, and outline

The overarching objective of this dissertation is to enhance our understanding of the internationalisation process of foreign and West German multinational firms into East Germany from a technological point of view. Thereby, we draw from the technology accumulation approach (Cantwell 1989, 1995) towards explaining the growth of international firms. It is based on the assumption that there is a 'complex dynamic interaction of the ownership advantage of groups of firms and the locational advantages of the sites in which they produce' (Cantwell 1989, p. 207). The theory suggests that the geographical dispersion of technological development enhances innovation in the MNE as a whole (Cantwell 1989, 1995). This is founded on the belief that innovation is location specific as well as firm specific. Internal economies of scale in innovation can be achieved across the MNE due to the transfer of knowledge and innovation from affiliate to affiliate and from location to location. MNEs invest in innovation activities in several sub-national centres across countries to benefit from a favourable technological environment. As they do so, their investment generates spillover effects to the location and the industry, which reinforces existing agglomeration economies. The theory implies that locational advantages are endogenously created by the innovation and location strategies of firms combined with spillover effects of their activities (ibid).

From our point of view, the technological accumulation approach suggests a cumulative relation between location specific advantages in multinationals' location choice, the location of multinationals' R&D and innovation, and the generation of technology related externalities from the presence of MNEs to the host economy. The empirical research of the dissertation, therefore, analyses each component of this cumulative relation in turn.

From the technology accumulation perspective, existing spatially distinct capabilities play an important role in the location choice of multinational firms (Cantwell 1989). This argument refers to agglomeration economies in general and technology related externalities in particular (ibid.). However, most of the existing studies (Beyfuß 1992, Barnder et al. 1992, Haas 1996, Belitz et al. 1999, Bochow 2007, Thum et al. 2007) on location choice by MNEs in East Germany do not inform us about the role of location specific agglomeration economies. Spies (2010) put forward the first study that looks at MNEs' location choice at a regional level. She teaches us that foreign investors perceive regional location choice for East German federal states differently from West German states. Yet, she does not provide any further insights as to how locational factors differ between East and West Germany and whether locational factors apply uniformly across investors. Furthermore, Spies (2010) does not differentiate between technology related externalities and other agglomeration economies associated with labour or industry structure. Therefore, this dissertation addresses the following first set of research questions:

(1) *Do location specific agglomeration economies in general and technology related externalities in particular play a significant role for the general location choice of foreign and West German multinationals in East German regions? Does the significance of locational determinants apply uniformly across investors?*

It is the first study to apply a micro-econometric estimation approach to MNEs' regional location within East Germany using data for the total population multinational affiliates in manufacturing. We model the choice of foreign and West German investors to locate their affiliate in a particular East German region taking into account location specific characteristics of all possible alternative regions within East Germany at the time immediately preceding firms' entry in order to investigate the first set of research questions.

Furthermore, the technological accumulation approach holds that the localisation of MNEs' technological activities depends upon the interrelationship between their corporate strategy and location specific characteristics (Cantwell and Piscitello 2005). So far, existing empirical studies from East Germany show that foreign and West German affiliates operate at a higher level of technological activity in terms of R&D and innovation compared to domestic owned firms (Günther and Lehman 2004, Günther and Gebhardt 2005, Günther and Peglow 2007). Yet, there is a paucity of evidence on the underlying motives of MNEs' to internationalise their technological activities into East German locations. Furthermore, there is a lack of knowledge on the role of spatially distinct capabilities in terms of technology related externalities and other agglomeration economies as locational determinants of MNEs' technological activities. Therefore, this dissertation poses a second set of research questions:

(2) *What is the extent of and motive for R&D and innovation undertaken by foreign and West German multinationals in East German regions? Do agglomeration economies in general and technology related externalities in particular impact on the location choice of MNEs' R&D and innovation? Does the significance of locational determinants differ depending upon the underlying motive for the internationalisation of R&D and innovation?*

We model the choice of foreign and West German investors to locate their affiliate in a particular East German region taking into account location specific characteristics of all possible alternative regions within East Germany at the time immediately preceding firms' entry. In contrast to the first investigation we now use survey data from foreign and West German multinational affiliates to test for statistical differences in location choice depending on the existence of and motive for technological activities.

Finally, the technological accumulation approach suggests that technological heterogeneity of MNEs as well as existing spatially distinct capabilities within the host country matter for the potential of spillover effects to the host economy (Cantwell 1989, 2009). The empirical evidence on spillover effects from the presence of foreign and West German affiliates within East Germany is scarce and ambiguous. Peri and Urban (2006) show evidence for intra-industry productivity spillover effects from firms with foreign or West German ultimate ownership in German manufacturing at the level of federals states. Günther and Lehman (2007) find contradictory evidence for inter-industry spillovers from the presence of majority owned foreign and West German establishments in East German manufacturing at different level of regional aggregation. Both studies apply a traditional technology transfer model and neglect the role of technological heterogeneity of MNEs as well as existing spatially distinct capabilities when searching for knowledge spillover effects. Thus, this dissertation focuses on a third set of research questions:

(3) What is the extent of technological spillover potential from the presence of foreign and West German multinationals for other firms in the East German economy? Do centrally accumulated ownership advantages, locally driven technological heterogeneity, and spatially distinct technological capabilities affect the technological spillover potential?

In contrast to existing applications that use a production function approach, we estimate the potential for technological spillovers from MNEs to other firms in the East Germany economy within a maximum likelihood framework applied to survey evidence from foreign and West German multinational affiliates.

This dissertation is able to investigate the research questions by exploiting for the first time data from the total population of foreign and West German multinational affiliates that entered East German manufacturing between 1995 and 2005. The population is available from the *IWH FDI micro database*[2]. This data source overcomes some of the limitation of other existing micro datasets: First, it provides information on both foreign and West German investors. According to the criteria applied in the *IWH FDI micro database* both groups of firms can be considered as multinational. West German investors are only included if they are multinational i.e. have at least one foreign affiliate in addition to the East German affiliate listed in the database. The *IWH FDI micro database* is so far the most comprehensive and only data source for multinational affiliates based in East Germany. Second, the *IWH FDI micro database* was the basis for a survey finalised in 2007. It offers detailed information on representativeness and non-respondent bias not available for this group of firms from alternative datasets. It provides a rich source of affiliate level data on production and technology related aspects.

Thus, the technological accumulation approach is applied to a rich source of data in a comprehensive way to explain the internationalisation of firms into East Germany. The adopted research strategy tries to address the complexity of a possible dynamic interaction of the ownership advantage of groups of firms and the locational advantages of the sites in which they produce. However, the approach is subject to a number of limitations.

First, the research strategy treats East Germany as de facto separate country. East Germany is characterised by a distinct pattern of economic and technological structure and has not yet converged to West German income levels (IWH 2009). Therefore, one can take the view that East Germany is still a region in economic and technological transformation that can be compared to other post-communist transition economies of Central and East Europe, despite the fact that it has became part of the mature economy of West Germany.

Second, in line with the technological accumulation approach investors might consider locating in a specific sub-national region on the basis of cross-country comparison i.e. comparing possibly region A in country B with region C in country D. Thus, there might be different variables that affect the location choice at the country and the regional level. However, we only model MNEs' regional location choice against the background of all possible regional alternatives within East Germany rather than on a cross-country-cross-region basis. Therefore, the adopted research approach is only a partial. This is related to the fact that there is a lack of

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[2] Since 2006 the *IWH FDI micro database* is maintained by a project group at the Halle Institute for Economic Research (IWH) in which the author participates. In 2007 a corresponding survey was undertaken within a FP7 EU project entitled U-know under coordination of Dr J. Stephan.

cross-country time series variables on a level of regional disaggregation that would match the information available for East Germany.

Third, the model of location choice of technological activities builds on the assumption that the decision to implement specific technological activities was already taken at the time of entry. This is based on the argument that the intended orientation of research influences the choice of location to a degree that is very costly to reverse (Kuemmerle 1999). However, this assumption might be challenged as the decision to implement specific technological activities might develop over time rather than being taken ex ante to market entry (see for example Ronstadt 1978, Fisher and Behrman 1979).

Fourth, in the technology accumulation approach, ownership advantages become endogenous by the active strategic role of firms in using innovation and technological accumulation. In turn, location advantages become endogenous via the innovative activity of companies and their technological spillover effects to the industry and locality. The adopted research approach uses cross-sectional data and lagged exogenous variables in order to deal with the implied endogeneity. However, a truly dynamic investigation would require a panel data structure and a multiple equation system that accounts for the simultaneity of existing location specific capabilities, multinationals' investment in R&D and innovation, and subsequent impact on location specific technological capabilities.

Finally, the research analyses the internationalisation of foreign and West German owned multinational firms. The inclusion of West German investors could be challenged as their location does, in fact, not constitute an act of internationalisation of activities. However, given their considerable role in the privatisation process, it is accepted that they should be included in any analysis on 'foreign' investment in East Germany (Günther 2005).

Despite these limitations, the adopted research strategy is one of the first that applies the technological accumulation approach in such a comprehensive way to explain the internationalisation process of firms. Therefore, it is able to generate implications from a theoretical, empirical, and policy perspective.

The theoretical implications address some of the main propositions of the technological accumulation approach. *First,* the theory holds that MNEs take advantage of externalities in foreign locations which stimulate the internal learning process of the multinational firm (Cantwell and Immarino 1998, 2001, 2003). This in turn facilitates MNEs to maintain profits in oligopolistic competition (Cantwell 1989). From our perspective, this argument applies not only to the location of technological but location choice in general. This is the first study to test the impact of location bound technological externalities controlling for other standard variables including agglomeration economies related to employment and industry structure on MNEs' sub-national location choice. *Second,* the technological accumulation approach proposes that the localisation of MNEs' technological activities depends upon the interrelationship between their firm strategy and location specific characteristics (Cantwell and Piscitello 2005). In contrast to existing empirical applications (Cantwell and Piscitello 2005, 2007), we account for other agglomeration externalities associated within the region when analysing the impact of location specific technology related externalities on MNEs localisation of technological activities abroad. In addition, we investigate interaction effects between the two types of externalities and differentiate between the location of R&D and innovation by MNEs.

Third, the technological accumulation approach rejects the hypothesis that innovation and R&D primarily takes place in the home country of the MNE and that the technological role of affiliates is restricted to the adoption and diffusion of an existing centrally accumulated technological advantage (Cantwell 1995). We generate evidence on the prevalence of different underlying motives internationalisation of technological activities and tests for corresponding differences in MNEs' sub-national location. *Fourth,* the technology accumulation theory holds that spillover effects from multinational affiliates to the host economy depend on local evolution of affiliates towards competence creating capabilities (Cantwell 2009), whereas alternative approaches (Chung 2001, Driffield and Love 2007) assume that spillover effects to be conditional upon a centrally accumulated technological advantage. Both hypotheses are tested in the dissertation. *Finally,* Cantwell (1989) argues that locational advantages are endogenously created by MNEs' innovation and location strategies combined with spillover effects of their activities. He points to existing sector specific technological strength of the host country location as a condition for spillovers to develop (Cantwell 1989, 1995). These propositions are tested and allow us to derive conclusions with regard to the assumed complex interaction of ownership and locational advantages in MNEs internationalisation.

The dissertation generates a number of contributions to the existing empirical research on the internationalisation of firms into East Germany and probes into possible generalisation of results for other post communist transition economies. In particular, we pay attention to the role of spatially distinct capabilities in MNEs' sub-national location choice, regions' capability to attract MNEs' R&D and innovation, as well as the extent and conditions for technological spillovers from MNEs to the host economy.

In addition, the research allows us to derive policy implications for East Germany. *First,* we discuss the empirical results on public investment grants as a factor that affects MNEs' general location choice, the localisation of their technological activities, as well as the potential for technological spillovers. We evaluate to what extent the existing design of the public investment grant scheme is able to stimulate the appropriate affiliate behaviour in order to maximise spillover effects from multinational investment in East Germany. *Second,* against the background of our findings we derive conclusions with regard to the role of investment promotion agencies for the enhancement of production and technological linkages between multinational affiliates and other firms in the East Germany economy. *Third,* we evaluate to what extent the design of R&D and innovation policy has lived up to the challenge to re-align MNEs with the East German innovation system. *Fourth,* we ask whether the current public science and higher education policy is able to contribute to the very same policy objective.

The dissertation is structured as follows: The following *second chapter* introduces the technological accumulation approach to the internationalisation of firms and derives the research questions from the core propositions of the approach in the context of existing empirical research. The *third chapter* gives a rationale why the research draws from the *IWH FDI micro database* and corresponding survey evidence. We provide here information on representativeness and non-respondent bias in the survey data. *Chapter four* offers a descriptive overview of multinational affiliates in East German manufacturing. Thereby, we look at sectoral and regional composition and specialisation patterns as well as size structure of the total population. The following three chapters contain the empirical investigations. *Chapter fives* consist of the analysis on the location choice of multinationals. *Chapter six* holds the research on the localisation of MNEs' technological activities. *Chapter seven* is dedicated to scrutinising technological spillover from MNEs. Each of the three empirical chapters has the same structure in principal: First, we introduce the research question and approach; second, we review theoretical considerations and corresponding international evidence, discuss the empirical evidence from East Germany, and contextualise the existing findings in the light of the theory; third, we develop the research hypotheses; fourth, we present corresponding descriptive evidence; fifth, we develop the theoretical and econometric estimation model; and sixth, we present and discuss the estimation results. In *chapter eight,* we summarise briefly the research results from all three empirical investigations and derive corresponding implications from a theoretical, empirical, and policy perspective; before we articulate the limitations of the research approach adopted in the dissertation and highlight possible future research directions.

2. General theoretical framework

This chapter introduces the technological accumulation theory towards explaining the internationalisation of firms as the general theoretical framework for the empirical analysis of foreign and West German firms based in East Germany. We start from capability based view of the firm, which can be regarded as the fundamental basis of the approach. This is followed by an explanation of the core elements of the theory as developed by John Cantwell including capital and technological accumulation, technology accumulation and firm location, and the role of international intra- and inter-firm networks. The subsequent sections discuss the technological accumulation approach in the context of alternative theoretical explanations of firm internationalisation that are dominant in the field of international business including the eclectic paradigm (Dunning 1977), the product life cycle (Vernon 1966), the internalisation theory (Buckley and Casson 1976), and the market power approach (Hymer 1960). Thereby, we critically appraise the propositions of the technological accumulation approach towards ownership, location, and internalisation advantages; the location of R&D and innovation in the MNE; and the role of competition in final product markets. This chapter concludes with a section that relates the main propositions of the technology accumulation approach to the research questions posed by this dissertation and briefly acknowledges differences from previous analytical approaches.

2.1 The capability based theory of the firm

Building on Penrose (1959) who developed the idea of intra-firm differentiation to explain endogenous growth processes within individual firms, the competence or capability based theory of the firm considers the firm as an institution that constructs capabilities through internal learning processes in the form of evolutionary experimentation (Cantwell and Piscitello 2000).

Firms' competences or capabilities are central in this school of thought. Richardson (1972) coined the term 'technological capabilities' to describe the appropriate knowledge, experience and skills needed by firms and organisations to introduce new products, processes and forms of organisation (ibid.). Winter (2003) suggest the concept of 'organisational capability' as a high level routine or collection of routines that together with its implementing input flows, confers an organisation's management a set of decision options for producing significant outputs of a particular type. The term 'routine' relates to a behaviour that is learned, highly patterned, repetitious, founded in part in tacit knowledge and specific to objectives (Nelson and Winter 1982). The process of acquiring ‘organisational capabilities’ is non-linear and depends very much on bounded rationality of the learner (Winter 2003). Teece et al. (1997) incorporated some of these elements into the concept of ‘dynamic capabilities’, which represents ‘the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments’. In turn, von Tunzelmann and Wang (2003) differentiate firm’s ‘competences’ which resemble the stock of accumulated knowledge from ‘capabilities’ that refer to the ability to carry out specific tasks. From their point of view, ‘dynamic capabilities’ of firms represent the extent to what the changes in their own capabilities in production influence or are influenced by changes in the capabilities of consumers and/or suppliers, in ‘real time’ (ibid).

Cantwell and Fai (1999) hold that the outcome of firm specific learning processes in production is the creation of tacit capability or corporate technological competence, that requires the generation of specially tailored knowledge inputs, the composition of which inputs reflects the company’s distinctive fields of technological specialisation, and the focus of its learning activity. The positive impact of the technological accumulation of firms on their rate of profit, and hence on their growth rate, can be modelled as a process by which lower production costs and enhanced product quality or attractiveness raise productivity ahead of increases in wage rates (Cantwell 1989).

Technological learning occurs within firms but is sometimes facilitated through inter-firm cooperation. In developing their capabilities to learn and in their problem solving activity, firms draw on their interaction with other local institutions, downstream markets, and the local science base (Nelson 1996). Because each firm’s technological learning is to some extent particular to the problems encountered in its own production facilities, products, or processes, each firm tends to follow a distinctive path or technological trajectory (Dosi 1988). Since corporate learning is gradual and path dependent, it provides the basis of institutional stability and continuity in evolution, even though it promotes change and differentiation in markets (Cantwell and Fai 1999). In this evolutionary perspective, the firm organises and initiates economic development in interaction with the growth of markets (Chandler 1990, Teece 1993). The firm becomes a repository of competence or productive expertise, and an institutional devise for learning and accumulating such (Winter 1988).

2.2 Technological accumulation and firms' internationalisation

2.2.1 The theoretical core of the approach

The technological accumulation approach towards firms' internationalisation builds upon the dynamic and evolutionary perspective of the capability based view of the firm described above. In addition, to the existing theory it provides a link between the growth of the firm and the changing international location of production. Cantwell (1989) sets out to explain why – within a given industry – some firms become more successful at international activities compared with rival firms. Thus, he is not concerned with a theoretical explanation of the existence but the growth of the multinational firm. The technological accumulation approach addresses the question of why it is that technology is developed in international networks, rather than a series of separately owned plants. It is a theory of international production and changing technology of production rather than exchange (Cantwell 1989).

Capital and technological accumulation

Cantwell (1989) traces back the theoretical roots of his analysis to the approach of the classical school of political economy (most notably Adam Smith, David Ricardo and Karl Marx). According to them, the mainspring of a capitalist economy is the process of capital accumulation. Cantwell (1989) holds that in the case of expansion of manufacturing industry, which has been central to capitalist development since the time of industrial revolution, capital accumulation has been bound up with technological accumulation. Cantwell (1989) refers to the term 'technological accumulation' as originally coined by Pavitt (1987). It encapsulates the idea that the development of technology within the firm is a cumulative process. That is, the creation of new technology within is to be understood as a gradual process of continual adjustment and refinement as new productive methods are tested and adapted in the light of experience. In any firm there is a continual interaction between the creation of technology and its use in production. For this reason a group of firms in a given industry are likely to have similar lines of technological development, yet the technological path of each is to some degree unique and differentiated.

Cantwell (1989) argues that the notion of technological accumulation is consistent with the ideas of Rosenberg (1976, 1982), Usher (1929) and the earlier work of Marx on technological change through systemic adaptation. Similarly, he draws parallels to the work of Atkinson and Stiglitz (1969), Nelson and Winter (1977, 1982) and Stiglitz (1987) on 'localised' technological change in the context of previous technological evolution and learning experience of the firm.

Cantwell (1989) reverts to the classical terminology in speaking of technological accumulation and capital accumulation, rather than simply innovation and investment to emphasise that they both continues and interlinked processes, and not just a series of discrete actions.

Cantwell (1989) considers technology to be both embodied in new items of capital equipment, and disembodied in improvements in the way it is used. Hence, technology is defined with reference to the production process as a whole, and encompasses productivity improvements that are due to both scientific and organisational factors. This entails a broad definition of technological innovation to cover everything in the production process itself that over time raises productivity. Thus, it does not include productivity growth that is due to changes in the scale of output or the size of the plant, using a given technology at a point in time. The gradual accumulation of technology generates dynamic rather than static economies of scale, associated with the changing conditions in production. Technology of this definition encompasses organisational capacity, managerial skills, as well as R&D, but excludes the advertising part of marketing. The accumulation of technology involves the gradual building of largely intangible assets, and is reflected in the skills of the workforce and the design of capital equipment.

Cantwell and Fai (1999) hold that while on the surface innovation is commonly observed through the market phenomena of the emergence of new products and differentiation of existing products, the underlying capacity to change what markets receive is provided by the corporate capability to create and refine to a viable point new products and processes, which rests on the cumulative generation of technological competence in firms. Learning in production creates the capability base of firms that is better captured by diverse fields of technological expertise of a company than it is by the firm’s product area (ibid).

Within this perspective, the accumulation of technology and innovation gives cumulative advantage, whether the innovation is in products or processes and whether it accumulates in the same product/processes or is diversified (Cantwell and Piscitello 2000). The acquisition of new skills, and the generation of new technological capacity, partially embodied in new plant and equipment is a condition for every firm in an oligopolistic industry to maintain or increase profits (Cantwell 1989, 1995, 2000).

Technological accumulation and firm location

For Cantwell and Piscitello (2000) in the capability based view of the firm the major issue is not so much how the firm exploits a given capability, but rather how it establishes a spatially and sectorally diffuse system for the creation of new competence (Cantwell and Piscitello 2000). They argue that the firm is able to benefit from the dynamic economies of scope that derive from the technological complementarities between related fields of activity, and the complementarities between related paths of innovations or corporate learning in spatially distinct settings (ibid).

In the technological accumulation approach 'the use of technology in new environments feeds back into fresh adaptation and new innovation depending on the state of local scientific and technological capability' (Cantwell 1989, p. 9). When production is located in an area that itself is a centre for innovation in the industry concerned, the firm may gain access to research facilities which allow it to extend technology creation in untried directions (ibid). International expansion of production brings gains to the MNE as experience from adapting its technology under new conditions feeds back into the technological development path of the MNE as a whole. Given a sufficient level of technological strength, firms are keen to produce in locations from which there major international rivals emanated which offers them access to complementary innovation (Cantwell 2000).

The notion that the geographical dispersion of technological development enhances innovation in the network of the MNE as a whole is founded on the belief that innovation is location specific as well as firm specific (Cantwell 1989, 1995). Internal economies of scale in innovation activity can be achieved across the multinational corporation due to the transfer of knowledge and innovation from affiliate to affiliate and from location to location rather than just one country. Cantwell (1989, 1995) argues that successful innovators tend to invest in innovation activities in several sub-national centres across countries. As they do so, their investment generates spillover effects to the location and the industry, thus encouraging more investment and innovation activities by other firms. Each innovating firm brings external benefits to the locality in which it invests. Conversely, investors benefit from a favourable technological environment that develops in the locality. Agglomeration economies are generated and they further strengthen the location and the ownership specific advantages of firms operating within them (Cantwell and Iammarino 1998, 2001, 2003). Thus, locational advantages are considered as endogenously created by the innovation and location strategies of firms combined with spillover effects of their activities (Cantwell 1989, 1995). What emerges is a complex 'dynamic interaction of the ownership advantage of groups of firms and the locational advantages of the sites in which they produce' (Cantwell 1989, p. 207).

Intra- and inter-firm international networks

In Cantwell's technological accumulation theory there is a role of international intra-firm and inter-firm networks. Intra-firm or internal networks established between various production and R&D units of the multinational firm spread in the home as well as host country. From Cantwell's (2003) point of view such internal networks are the logical outcome of the shift by MNEs away from local market oriented investments towards internationally integrated strategies that began in the late 1960s (Hedlund 1986, Bartlett and Goshal 1989, Dunning 1992). External or inter-firm networks in which MNE affiliates increasingly participate include a growing number of strategic alliances between MNE competitors, and a greater variety of local networks that link MNEs' affiliates with suppliers, distributors, competitors, consumers as well as local institutions. Cantwell (2003) holds that perhaps the most prominent motive prompting MNEs to enter into them has been that joint learning processes are believed to be a means of raising the rate of innovation of the MNE, and hence its technological accumulation.

The emergence of this so called 'double-network' organisation of innovative is favoured by two interrelated evolutionary forces (Zanfei 2000). First, context specific knowledge can be more effectively generalised and transferred through multinationals' internal networks, and made available for use in different and distant areas. Secondly, the generalisation of context specific information increases the importance of gaining access to abilities to utilise this knowledge creatively. Therefore, external networks become key assets in the competitive arena, as a means to gain privileged and timely access to user experience and skills, and to extract economic value from the growing generic knowledge basis. Works stressing dynamic efficiency considerations come to the conclusion that an expansion of firms' international internal networking will increase firms' exploration potential to search and absorb external knowledge and hence favour the recourse to external networks of international collaborations rather than hierarchical linkages (Castellani and Zanfei 2006).

2.2.2 Ownership, locational, and internalisation advantages

In the 'eclectic paradigm' as developed by Dunning (1977) it is contended that MNEs have competitive or 'ownership' advantages vis-à-vis their major rivals, which they utilise in establishing production sites that are attractive due to their 'location' advantages. According to Dunning, two types of ownership advantage can be distinguished, the first is attributable to the ownership of a particular unique intangible asset, and the second is due to the joint ownership of complementary asset. Based on transaction cost considerations (Coase 1937), MNEs retain control over their network of assets because of ‘internalisation’ advantages of doing so. The latter develop the greater the ease with which an integrated firm is able to appropriate a full return on its ownership advantage as well as directly from the coordination of the use of complementary assets, subject to the costs of managing a more complex network (ibid.)

Cantwell (1989) makes explicit references to the ‘eclectic paradigm’ as developed by Dunning (1977) by referring to ownership and locational advantages as essential ingredients of the technological accumulation approach. However, his own position differs on at least two accounts. First, he identifies an overlap between those ownership advantages which are due to joint ownership of complementary assets and those internalisation advantages that derive from the coordinated use of such assets. While ownership advantages that derive from a particular asset such as firm specific technology can in principle be sold, for example, by licensing of technology, there is no market for the kind of collective ownership advantages. For example, the ability of the firm to generate new technology cannot be sold outside the firm but is only usable within it.

Second, in Cantwell’s (1989, 1995) theory the ownership advantages become endogenous because of the active strategic role of firms in using innovation and technological accumulation to develop their competitive edge. He does not suppose that typically a foreign parent begins with an individual act of technology creation which is then diffused abroad through the operations of its foreign affiliate. Thus, firm specific ownership advantages are not considered as static ex ante characteristics of the foreign parent. In turn, location advantages become endogenous via the innovative activity of companies, their technological spillover effects on the industry and locality and the resulting localised agglomeration effects. Economic geographers based Marshall’s (1962) and Jacobs (1969) point to the role of knowledge, employment, and industry structure within regions as three distinct factors in agglomeration economies. Cantwell (1989, 1995) focuses primarily on the aspect of knowledge if he speaks of technological spillovers or spillovers resulting from MNEs foreign investments in R&D and innovation.

The perception of the MNE as a network for geographically dispersed innovation stresses the dynamic connectedness between local knowledge creation and exchange. From Cantwell’s (2009) point of view, an integrated interactive network for the generation of ownership advantages relies on the interrelatedness between specialised activities conducted in particular locations, each of which takes advantage of spatially specific resources or capabilities through relationship with other local actors. Consequently, spillovers must be analysed in a two way setting, since the local evolution of subsidiaries towards competence creating capabilities matters to the capacity of subsidiaries and indigenous firms to interact, and hence for the presence and absence of local spillovers in either direction (Cantwell and Piscitello 2007, Marin 2006).

Cantwell's (1989, 1995) main criticism is directed at the internalisation theory (Buckley and Casson 1976, McManus 1972, Rugman 1981, Hennart 1996) which tends to dismiss the role of ownership advantages as an unnecessary element in the explanation of internationalisation decision of firms. From their point of view, existence and growth of the international firm is due to market imperfections of the transactional type and the outcome of firms' drive to minimise transaction costs. The most important areas for internalisation are markets for intermediate products and knowledge. If an initiating firm is to appropriate a full return on its firm specific technological advantage, and if it is to coordinate the successful introduction of its technology elsewhere, then it must exercise direct control over the network as a whole. However, Cantwell (1989) argues this may be not so much a feature of the market for technology which is the focus of internalisation theory, as a feature of the very nature of technological development in itself.

Buckley and Casson (1976) treat technology as analogous to knowledge or information having some characteristics of a public good. In particular, it has been argued that once created technology is easily transferred between different locations. In this view there is no particular association for between technology creation and use within the firm. They are linked through the market for technology (external or internal), and not through the conditions of production and technology adaptation and creation. Buckley and Casson (1976) argue that internalisation of the knowledge market will generate a high degree of multinationality because knowledge is in principal a public good within the firm. In contrast, Cantwell (2000) treats technological knowledge not as an immediately usable intermediate product, but rather an input into the collective corporate learning process by which tacit capability and hence technology as a whole is generated. As such, it is an input that normally has its greatest relevance to the firm that created it (Cantwell 2000). Thus, in contrast to the technological accumulation theory the internalisation approach is based on exchange and not production elements. Firms' managers simply react to market conditions and their imperfections rather than having a strategic role.

2.2.3 Internationalisation of R&D and innovation

In his product life cycle approach, Vernon (1966) placed innovation at the centre stage as the most important dynamic force underlying multinational expansion. Two hypotheses are associated with the product life cycle approach. The first hypothesis states that innovations are almost always located in the home country of the parent company, and usually close to the technological headquarters. Three theoretical justifications were provided for this hypothesis: First, there are economies of scale in the R&D function, and if they are strong enough R&D will be concentrated in a single centre. Second, there are locational economies of integration and agglomeration in innovation. Third, innovation is viewed as demand-led process and thus, high income countries are prone to generate innovations (Cantwell 1995).

Vernon (1966), Kindleberger (1969) and Stopford and Wells (1972) theorised a tight relationship between the parent company and foreign subsidiaries, wherein the latter are in charge of replicating the former's activities abroad, with strategic decisions—including R&D and innovation strategies—being rigidly centralised. Vernon (1966) emphasised that coordinating international innovative activities would be too costly, owing to the difficulties of collecting and controlling relevant information across national borders. Having established a new product or production process in the home market, firms would subsequently export and/or locate production facilities abroad (ibid). This would inevitably involve some foreign technological activity concerned with adapting and production processes to suit foreign markets needs (Patel and Vega 1999). From this perspective, foreign subsidiaries would then play a role almost exclusively in the adoption and diffusion of centrally created technology (Zanfei 2000). This type of strategic behaviour has also been termed as asset (Dunning and Narula 1995), home-base (Kuemmerle 1996), or competence exploiting (Cantwell and Mudambi 2005).

Cantwell (1995) rejects this hypothesis as the creation of new technological competences is facilitated through the international dispersion of corporate activities. Also Zanfei (2000) holds that the traditional organisational model, based on the vertical, unidirectional transfer of knowledge from the headquarter towards foreign units, is being gradually replaced by a model wherein foreign units are not only able to absorb passively knowledge generated elsewhere, but are also able to generate and circulate new information. From Cantwell's (2003) perspective, the R&D function is one particularly important contributor to the learning process that characterises innovation, and leads to the creation of technology in the sense of new production systems. In the formation of a network for technological learning and research the location of R&D may be subject to centralisation and decentralisation forces. On the one hand, R&D is increasingly drawn to the major centres of excellence in which best researchers and most skilled production teams are clustered centralisation in the home country. On the other hand, as part of the same process some R&D projects may be moved out of the home country to important foreign centres of excellence (ibid).

Thus, in addition to competence exploiting, investment in foreign R&D and innovation could be motivated by the desire to overcome technological weakness in the home country or could represent a diversification into new or related technological fields that leverage knowledge from the host country to augment MNE’s technological advantage (Cantwell 1995, Cantwell and Piscitello 2007). This motive to undertake investment into foreign technological activities has been labelled as strategic asset (Dunning and Narula 1995) or home base augmenting Kuemmerle (1996) and competence creating activity (Cantwell and Mudambi 2005).

The second hypothesis of Vernon (1966) is that international investment is led by technological leaders, as a means by which they increase their share of world markets and world production. The theoretical justification for this hypothesis is that the most technologically competent companies enjoy lower operating costs than their competitors and provide higher product quality, which generates higher profits and rising international market share (ibid.). Cantwell (1995) agrees with this hypothesis. Because from an evolutionary point of view, different degrees of technological competence are a consequence of the firm specific and path dependent characteristics of technological change. The greater the capability of the most competent or technological leading firms enables them better to expand their activity in new fields or environments, and higher profits provide them with the financial resources to offset the costs of doing so. However, in contrast to the product cycle model the technological accumulation approach cannot be simply extended from the firm to the country level as Cantwell (1989) assumes in innovation a hierarchy of firms but not of countries.

Ietto-Gillies (2005) differentiates Cantwell’s (1989, 1995) approach from Vernon (1966) with regard to two additional accounts. The first point is that Vernon’s innovations are principally demand and consumer driven as high income per capita is an essential ingredient of his theory on the generation and adoption of new technologies. In contrast, Cantwell (1989, 1995) links innovation to production rather than consumption. Nonetheless, his view is that firm specific learning processes interact with the growth of demand as well as supply conditions within the firm and industry. Innovations lead to high productivity and growth, thus to high incomes per capita and high demand for new products in a cumulative causation process (Ietto-Gillies 2005). The second point is linked to the fact that Cantwell (1989, 1995) sees innovation spilling in a variety of ways including spillage from product to product in a multi-product firm and industry. No spillover mechanisms are present in Vernon's (1966) theory which is a model based on product and not the firm. Thus, here innovations refer to a new product, not to a general activity involving a variety of products and processes within the firm.

2.2.4 Competition in final product markets

Cantwell (2000) argues that on the face of it, the unresolved debate between different schools of thought on international production concerns the place of ownership advantages in the growth of the MNE. However, this disguises disagreements over the role of efficiency considerations in the organisation of the firm in their final product markets. From Cantwell's point of view, ownership advantages that raise the efficiency of the firms are a necessary condition vis-à-vis its rivals in an oligopolistic market. Internalisation theorists have instead examined the efficiency of firms in terms of how the exchange of intermediate products is organised, in which process ownership advantages and inter-firm competition in final product markets are secondary issues.

The market power approach as originally advanced by Hymer (1960) also takes the view that ownership advantages associated with greater efficiency need not be regarded as a necessary condition for the existence of MNEs, but for different reasons. The market power approach emphasises the conditions prevailing in final product rather than intermediate product markets, but denies that firms necessarily raise efficiency. Moreover, oligopolies are thought in terms of gradual extension of collusion, with the establishment of ownership advantages as barriers to entry. Therefore, the view that MNEs steadily monopolise and reduce competition in their industries also exists (Cowling and Sudgen 1987).

Instead, Cantwell (1989) suggests two major reasons why the growth in international production has been associated with competition between MNEs in manufacturing rather than increasing entry barriers: Firstly, internationalisation has supported technological diversification since the form of technological development varies between locations and firms. By locating production in an alternative centre of innovation in its industry the MNE gains access to a new but complementary avenue of technological development, which it integrates with its existing lines. Cantwell (1989) argues that by increasing the overlap between firms' technological profiles competition raises in each international industry. Yet, at the same time cooperative agreements increase due to the higher incident of technological spillovers between firms. Spillovers occur where technologies are created by a firm which lie outside its own major lines of development, but which may be of greater use within the main tradition of another firm.

Secondly and partly related to the first factor, today there are a growing number of connections between technologies that were formerly quite separate. This increased technological interrelatedness and has brought more MNEs into competition with one another. These two elements have been brought into connection with the growth of so called 'technological systems' in MNEs (Dunning and Cantwell 1989). Where MNEs in a competitive industry are all attracted to certain centres of innovation to maintain their overall strength, research related activities may tend to agglomerate in these locations (Cantwell 1987).

In principal, Cantwell (1989) argues that the technological accumulation approach allows for cooperation and collusion between firms as well as an intensified competition for local firms as a consequence of MNE expansion under certain circumstances. Thus, inward FDI may have competitive and anti-competitive effects on host countries (Cantwell 1987, 1989). Where indigenous firms enjoy a strong technological tradition in the sector in question, the growth of international production provides a competitive stimulus which encourages an increase in local research related activity. In this case, a strong indigenous technological tradition is associated with beneficial knowledge and hence productivity spillovers between foreign-owned and local companies. However, while where such tradition is weaker, the research of local firms may be displaced by simpler assembly types of production organised by foreign MNEs. The faster growth of upgrading of activity in one location is then achieved at the direct expense of the downgrading of another, as different stages of the production become geographically dispersed. Thus, a competitive impact from MNE growth in one location and an anti-competitive effect in another are two sides of the same coin (ibid.).

2.3 Research questions in the light of the technological accumulation theory

From our point of view, the analytical application of the technological accumulation approach to the internationalisation of multinationals into East Germany has several implications: First, we need to test whether existing spatially distinct capabilities within East Germany attract multinationals in general. Second, we need to scrutinise the nature of technological activities of multinational affiliates within East Germany as well as the effect of existing spatially distinct capabilities on the localisation of specific technological activities in East Germany. Third, we need to analyse the potential for technological spillovers from the presence of multinationals within East Germany as a function of existing spatially bounded capabilities as well as multinationals' heterogeneity with regard to technological activities implemented locally.

General location choice of MNEs

The technological accumulation approach holds that foreign location specific agglomeration economies in general and technology related externalities in particular play an important role in explaining the internationalisation of firms. From Cantwell's (1989, 1995) point of view, the acquisition of new skills, and the generation of new technological capability, partially embodied in new plant and equipment is a condition for every firm in an oligopolistic industry to maintain or increase profits. It is important to underline that existing spatially distinct capabilities of foreign locations do not only constitute a pull factor for the internationalisation of technological activities but production as well. Thus, the general location choice of multinationals should be responsive to various forms of agglomeration economies at the sub-national level of host economies. These theoretical considerations are also in line with the new economic geography that highlights the spatial concentration of economic activities through increasing returns, local externalities, and economic integration (Fujita et al. 1999, Fujita and Thisse 2002).

There is a growing empirical literature on multinationals' regional location choice (Basile 2004, Basile et al. 2008, Barrios et al. 2006, etc.) that shows the relevance of location bound specialisation and diversification advantages on multinationals location choice. Furthermore, Chung and Alcácer (2002) show that the valuation of various components of the locational utility function does not apply uniformly across multinational firms. Yet, existing international studies do not attempt to isolate technology from other agglomeration related externalities in their effect of MNEs' location choice, which could be regarded as important from the technological accumulation perspective on location choice. Most of the existing empirical studies on East Germany (Beyfuß 1992, Brander et al. 1992, Haas 1996, Belitz et al. 1999, Bochow 2007, Thum et al. 2007) do not take account of location specific agglomeration economies when analysing location choice. So far, only Spies (2010) models foreign firms' regional location choice for the united Germany. From this investigation, we learn that foreign investors perceive regional location choice for East German federal states differently from West German states. However, it provides no further insights as to how locational factors differ for regions within East Germany. Furthermore, Spies (2010) does not isolate technology related externalities from other agglomeration economies in her analysis on MNEs location choice. However, from the technology accumulation perspective existing spatially distinct capabilities in terms of knowledge or technology play an important role in the explanation firm internationalisation.

Therefore, it seems appropriate to investigate in this dissertation whether other things equal location specific agglomeration economies in general and technology related externalities in particular play a significant role for the general location choice of foreign and West German multinationals in East German regions. Furthermore, we explore how MNE heterogeneity affects the valuation of technology related externalities as locational factors.

Internationalisation of technological activities

The technological accumulation approach suggests that locational choice of MNEs' technological activities depends upon the interrelationship between their corporate strategy and location specific characteristics (Cantwell and Piscitello 2005). In principal, it is suggested that MNEs not only exploit existing technological competence, but also acquire new or complementary asset from abroad that augment the existing firm specific ownership advantage (Cantwell 1989, 1995). Drawing from the literature on the spatial organisation of R&D (Malecki 1985, Howells 1990) as well as geography of innovation (Feldmann 1994, Audretsch and Feldmann 1996, Carrincazeaux et al. 2001) it is assumed that geographic proximity, localised knowledge spillovers, and agglomeration related externalities are highly relevant for the location pattern of foreign R&D and innovation. Furthermore, it is suggested that locational determinants for MNEs' foreign R&D and innovation differ according to their competence exploiting or augmenting nature (Cantwell and Mudambi 2005, Cantwell and Piscitello 2007, Narula and Zanfei 2005). This is based on the principal assumption that competence augmenting is more supply oriented than competence exploiting, and so depends more upon the quality of regionally available human capital, knowledge resources, and technological opportunities (ibid).

Recent evidence confirms that knowledge spillovers related to technological specialisation, diversification, as well as science and education infrastructure within and across regions affect MNEs' localisation of technological activities positively (Verspagen and Schoenmakers 2004, Cantwell and Piscitello 2005, 2007). Cantwell and Piscitello (2007) confirm that competence augmenting activities are more sensitive to local supply related conditions such as regional technological specialisation as well as science-industry spillovers. However, existing international empirical applications do not control for other agglomeration related effects when testing the impact of technology related externalities. Furthermore, they do not look at possible interactions between the two types of externalities. The existing empirical evidence from East Germany established only that foreign and West German affiliates operate at a higher level of technological activity in terms of R&D and innovation compared to domestic owned firms (Günther and Lehman 2004, Günther and Gebhardt 2005, Günther and Peglow 2007). However, there is a paucity of evidence on the effect of spatially distinct capabilities as drivers of the localisation of MNEs' technological activities within East Germany. Similarly, we have no knowledge about extent of competence exploiting and augmenting implemented locally as well as any differences in the localisation pattern of such technological activities.

Therefore, this dissertation sets out to investigate first the extent of and motive for R&D and innovation undertaken by foreign and West German multinational affiliates in East German regions. Second we analyse how technology related spillover potentials and other agglomeration related externalities impact on MNEs' location choice for R&D and innovation. Further, we would like to find out whether locational factors differ significantly depending upon the underlying motive for the internationalisation of technological activities.

Technological spillover effects from MNEs

The technology accumulation approach proposes that each *innovating* firm brings external benefits to the locality in which it invests (Cantwell 1989, 1995). Thus, spillovers from the presence of foreign firms cannot be treated as following a unidirectional pipeline of knowledge transfer simply trickling down from the parent company through subsidiaries and on to other actors (Marin 2006). If foreign firms are heterogeneous with regard to their technological activities, not every foreign firm provides the same knowledge opportunities or spillover potential for domestic firms. Furthermore, Cantwell (1987, 1989) holds that a strong indigenous intra sector technological strength is associated with beneficial knowledge and hence productivity spillovers between foreign-owned and local companies. Thus, spillover effects from FDI are not only subject to foreign affiliates' investment in innovation but also existing intra sector technological strength of the host country location.

In fact, existing evidence from international studies shows that spillovers effects on the productivity of domestic firms from the presence of foreign firms depend on the centrally driven technologically MNE heterogeneity (Chung 2001, Driffield and Love 2007). More specifically, the evidence indicates that only asset or competence exploiting FDI is a source of positive productivity spillovers. However, models that account for locally driven technological

MNE heterogeneity find that the extent of affiliates’ R&D and innovation and the propensity to establish technological cooperation impact positively on the potential for spillovers to the domestic firms (Todo and Miyamoto 2002, Marin and Bell 2006, Castellani and Zanfei 2006). So far, it is not clear if this applies independently from an ex ante technological ownership advantage as proposed by the technological accumulation approach. The existing empirical evidence on East Germany (Peri and Urban 2006, Günther and Lehman 2007) neglects the centrally or locally driven technological heterogeneity of MNEs as well as the impact of existing spatially distinct capabilities of the host country location when searching for knowledge spillover effects from foreign and West German multinationals.

Therefore, the final set of research questions of this dissertation is concerned with the extent of technological spillover potential from the presence of foreign and West German multinationals in East Germany. The emphasis is on the question whether a centrally accumulated ownership advantage, locally driven technological heterogeneity, and intra sector technological strength affect technological spillover potential for vertical and horizontal spillover effects.

In sum, the dissertation applies the technological accumulation approach in a comprehensive way to explain the internationalisation of foreign and West German multinationals into East German manufacturing since the start of transition. Thereby, we proceed in three separated analytical steps, which according to the theory are interrelated in a dynamic perspective. However, this theoretical endogeneity between spatially distinct capabilities and corporate location and technological behaviour is empirically adequately dealt with. To our knowledge, this is the first time that the technological accumulation approach is applied in such a comprehensive way to explain the internationalisation of firms into a post-communist region of Central and East Europe. It remains to be seen whether firms’ internationalisation into such a region characterised by rapid institutional adaptation and protracted structural change can be explained from a capability based view of the MNE.

3. Data

The correct application of statistical methodology is crucial for the collection and analysis of firm level innovation data. This chapter discusses and provides information on central elements of the collection and analysis of data used. We provide the rationale why the dissertation exploits the *IWH FDI micro database* instead of other existing data sets. Furthermore, we describe the genesis of the total population, survey method, sampling criteria as well as representativeness and non-respondent bias in the 2007 survey.

3.1 Existing micro databases on foreign and West German investment

In principle, there exist three different firm level data sources for the analysis of firms with foreign and/or West German ownership based in East Germany. First, in accordance with the provisions of the Foreign Trade and Payments Regulation the Federal Bank of Germany ('Deutsche Bundesbank') collects annual statistics on FDI stocks in its Microdatabase Direct Investment (MIDI). Companies with direct investment report their international capital links if their balance sheet total exceeds €3 million. Shares and voting rights held by affiliated investors[3] from foreign economic territories are consolidated. Reports are submitted by German enterprises, if on the balance sheet date a non-resident or several economically linked non-residents hold a total of 10 per cent or more of the shares or voting rights in the enterprise. Indirect participating interests must be reported if a "dependent" investment enterprise[4] has a stake of 10 per cent or more in another enterprise. The database also includes German branches and permanent establishments of non-residents having operating assets total more than € 3 million. Two or more resident branches and permanent establishments of any one non-resident are to be regarded as a unit (Lipponer 2008). Due to the registration of companies above the total balance sheet/operating assets threshold as well as the consolidation of different units the database creates systematic distortions with respect to firms' size and regional disaggregation. As a result, the number and volume of foreign investment is underestimated for East Germany (Günther 2005, Votteler 2001). The MIDI contains only data on firms with non-residential i.e. foreign participation and does not

[3] Non-residents are to be regarded as economically linked if they pursue economic interests jointly; this also applies if they pursue economic interests jointly with residents.

[4] A direct investment enterprise is classed as "dependent" if the investor holds more than 50% of the shares or voting rights. If a "dependent" enterprise holds a 100% participating interest in another enterprise, then this enterprise and any additional enterprise fulfilling the condition of a 100% participating interest are also regarded as "dependent".

provided any information on West German ownership. Thus, the MIDI is not suitable for the purpose of our analysis.

A differentiation into foreign, West German, or East German ownership is possible with the Mannheimer Innovation Panel (MIP), which is the German contribution to the Community Innovation Survey (CIS). The MIP offers a wide range of technology and innovation relevant indicators in a panel structure. It is representative for the target population in terms of firms' size, industry, and region (East and West Germany) (Peters 2006). Yet, firms' ownership is not used as a stratifying variable for the random sample from the total population. Therefore, the MIP is representative for East Germany manufacturing as such, but not necessarily for the subgroups of firms with West German or foreign direct investment. We encounter the same issue with the IAB Establishment Panel that also offers firm level data with ownership information and selected technological indicators. However, it uses firms' size, industry, and federal states as stratifying variables for the random sample drawn from the establishment file of the Federal employment agency ('Bundesanstalt für Arbeit') (Fischer et al. 2008). Thus, the MIP as well as the IAB Establishment Panel can only be used in our analysis as a reference for comparisons of selected indicators for East German manufacturing as a whole. These micro level data are not ideal for statistical analysis of foreign and West German owned multinationals within East Germany.

3.2 The IWH FDI micro database

Given the above described limitation, the envisaged research requires a novel micro database that satisfies the representativeness criterion for firms with foreign or West German ownership in East Germany. This requires building a new database and starting off with a cross-sectional dataset. This approach has also clear disadvantages in comparison with existing databases offering data in a panel structure for East Germany. However, it constitutes the first attempt to consolidate various information sources in order to build a comprehensive population of firms with foreign or West German multinational equity in East Germany to date. This forms not only a solid basis for a refined structural analysis of this population within the East German economy but also allows us to assess representativeness of a sample with regard to size, industrial composition, or regional distribution of firms.

The Halle Institute for Economic Research (IWH) decided to build such a micro database on foreign direct investment and West German multinational firms in East Germany (short: IWH FDI micro database). The *IWH FDI micro database* is generated from an annual survey (2007 to

2011). The survey covers structural, organisational, and technological indicators and every second year an extended version is implemented that covers particular themes. In 2007, the first extended instrument was implemented and was dedicated to the topic of internal and external organisation of R&D and innovation. This survey was limited to the population of East German manufacturing. In 2008, the second phase extended the coverage to selected trade and service sectors by implementing the short version of the survey. If the survey continues as planned until 2011, the *IWH FDI micro database* would also offer data in a panel structure, although only for a fairly small sample of firms due to the limited size of the respective total population within East Germany. For the time being two cross sectional datasets (1^{st} spell 2007, 2^{nd} spell 2008) can be exploited. Although, the 1^{st} spell of the *IWH FDI micro database* (2007) as a long version of the survey offers a richer dataset for the purpose of this dissertation.

3.2.1 The total population

Although 10% ownership of the voting power held jointly by one or more foreign entities is recommended as the lower threshold for FDI statistics, the Handbook on Economic Globalisation Indicators (OECD 2005) as well as the OECD Benchmark Definition on FDI (OECD 2008) recommend that statistics on MNEs' activities should be compiled, as a first priority, for the controlled subset of foreign affiliates. The OECD Benchmark Definition on FDI (OECD 2008) and Systems of National Accounts (2008) refer to a foreign-controlled enterprise by ownership by a single investor or single investor group. This approach is followed not only for consistency with other international guidelines, but also because it is only through a single investor or associated investor group that control can be systematically exercised. Majority ownership is suggested as an appropriate selection criterion for such foreign control. However, the relevance of other criteria for selection is acknowledged, and countries that can do so may wish to provide supplemental statistics covering cases in which foreign control may be present, even though no single foreign direct investor holds a majority stake (see OECD 2008). Furthermore, it is recommended that statistics on foreign affiliates should include all controlled foreign affiliates, irrespective of whether the affiliate is held directly or indirectly and irrespective of whether the direct investor in the compiling economy is the ultimate investor or is, instead, an intermediate investor in an ownership chain (ibid.). Following these international guidelines the IWH-FDI-Micro database adopted a fairly broad and inclusive concept of control.

The total population underlying the survey consists of firms located in East Germany (including West Berlin), that have a foreign or West German multinational direct shareholder with a minimum of 10 per cent equity or that have a foreign or West German multinational ultimate owner (with a minimum of 25 per cent indirect ownership). The firms located in East Germany are either legally independent affiliates/subsidiaries (de jure independent person) or an independent branch (no de jure independent person), yet both types of firms have an own business register entry. In some instances also dependent plants, operating sites, or branches have been included without an own business register entry. Shareholders or ultimate owners are not limited to multinational enterprise groups headquartered abroad or in West Germany, but also include physical persons, foundations, financial investors located abroad or in West Germany. This inclusive approach tries to address the complexity of ownership structure. For example, by excluding family ownership or indirect holdings from the population one could miss some of the biggest multinational firms present in East Germany.

The 1st spell (2007) of the *IWH FDI micro database* is restricted to manufacturing i.e. firms in industries 15 to 37 at NACE 2-digit level (Revision 2). In the 1st spell (2007) of the *IWH FDI micro database* no minimum restriction in terms of firm size was applied. In terms of regional coverage, the *IWH FDI micro database* includes firms located in the federal states of Brandenburg, Mecklenburg-Pomerania, Saxony, Saxony-Anhalt, Thuringia, and Berlin (including West Berlin). Despite the fact that West Berlin underwent a different economic development than the former East, it is by now accepted standard to include this territory into statistical economic analysis of East Germany.

In 2006, the original total population was drawn from four partially overlapping firm level data sources: Creditreform, European Investment Monitor, Industrial Investment Council, and R&D Scoreboard. Creditreform (Verband der Vereine Creditreform e.V.) is a German credit-rating agency that maintains the Markus database, which contains about 97 per cent of all German firms that have a business registry entry and are economically active. This includes firms of the following legal forms: AG, GmbH, KG, OHG, GmbH & Co.KG, and one-man company[5]. Amongst other information, the Markus database includes name and address of the company, contact person, industry classification, region, and number of employees. The firm level information stems from the German business registry, is self reported, or researched. Crucially, the Markus database forms part of the international firm level Amadeus database (Bureau van Dijk) that offers elaborate and unique information on related firms and ownership structure.

[5] The also the MIP draws its information on the population of German firms from this source.

The Markus list of East German firms drawn was cross-checked and complemented with three other information sources. A list drawn in 2006 from the European Investment Monitor (EMI) which is jointly operated by Ernst & Young and Oxford Intelligence served as a second source. In addition, the 2005 European Union industrial R&D investment scoreboard was used. Here the list of non-German manufacturing companies was searched for any affiliates or subsidiaries based in East Germany using company information available on the internet. Correspondingly, the list of German based manufacturing companies was searched for West German multinationals with affiliates or subsidiaries based in East Germany. The third and final source of information to build the total population was a hand selected list of foreign investors in East Germany that employed services of the Industrial Investment Council (IIC) [6], which was the responsible investment promotion agency for East Germany from 1994 until 2006. The IIC list also includes foreign investment projects linked to the 'Treuhandanstalt' as former privatisation agency in East Germany which was dissolved in 1994. The resulting list from the four sources described above was cleaned from entries that encountered a change in ownership, insolvency, and closure.

3.2.2 Survey method

The *IWH FDI micro database* survey is implemented by means of computer-assisted telephone interview (CATI) technique. A variety of methods can be used to conduct a survey of firms, including postal surveys and personal interviews. Many of the problems with postal surveys such as several reminders and low response rates can be avoided when data are collected by personal interview such as CATI. The quality of the results is in general expected to be higher and item non-response rates are expected to be lower (Oslo Manual 2005). One drawback of CATI is related to collecting quantitative data. This generally takes time to calculate, so that respondents may not be able to answer the entire questionnaire in a single call. Additionally, in large units such as multinational corporations, questionnaires can only be answered jointly by different offices or branches.

Therefore, the telephone interviews were implemented by Zentrum für Sozialforschung Halle e.V.[7] as a professional non-commercial provider specialised in scientific research. All interviewers received an interview guide as well as intensive training on the questionnaire

[6] In 2007 the Industrial investment Council (IIC) joined forces with the investment promotion agency in charge of West German and was named Invest in Germany (IIG). In 2009, Invest in Germany (IIG) was merged with the German Office for Foreign Trade and formed Germany Trade and Invest.

[7] Zentrum für Sozialforschung Halle e. V. an der Martin-Luther-Universität Halle-Wittenberg, Emil-Abderhalden-Str. 6, 06108 Halle, Germany

provided by the IWH. Interviewers were instructed to contact first a member of the East German subsidiary/affiliate management team personally. In the event that a question could not be properly answered by the person interviewed at first stage, interviewers made additional calls at a later stage or called another person in charge of the issue in the firm (for example R&D management or finance administration). If the respondents refused to answer the questionnaire via telephone, it was alternatively offered to answer the questionnaire via post or fax.

Before the survey went under way the questionnaire was tested internally with selected experienced interviewers. This was followed by a pre-test of the questionnaire with a number of selected firms from the population. This pre-testing phase resulted in a number of revisions in terms of questionnaire structure as well as phrasing of questions. The total interview time of the long instrument used in the 1st spell of the *IWH FDI micro database* was around 30 minutes. Despite this considerable length the interview provider was confident to achieve satisfactory rates of return based on the results of the pre-test.

The 1st spell of the *IWH FDI micro database* survey was implemented in two rounds from the 30th October 2006 to 25th January 2007 and 21st of Mai to the 14th of June 2007. This time lag was related to the fact that the provider received the total population of firms in two tranches. Interviewers contacted every firm in the total population. During the implementation, it was assured that the sample follows the distribution of two stratifying variables. The first was size of companies in terms of number of employees (4 different size classes: 1 to 9; 10 to 49; 50 to 249; and above 250 employees). The second stratifying variable was the nature of firms' principal activities (based on the NACE 2-digit manufacturing classification).

3.2.3 Representativeness and non-respondent bias

From the total population of 1,412 firms with foreign and West German multinational ownership 295 firms participated in the 1st phase of the survey in 2007. This corresponds to an overall response rate of 20.9 per cent in terms of number of firms. The response rates for the sub-groups of firms with either foreign or West German multinational ownership are 20.4 per cent and 22.7 per cent respectively. In terms of employment, firms in the sample account for 39.946 employees which represents 15 per cent of employment in the total population. The shares of sample employment to total employment for the sub-groups of firms with either foreign or West German multinational ownership are 16.4 per cent and 11.1 per cent respectively.

According to the Chi-square test result, the distribution of firms in the sample across sectors at 2 digit level (NACE Rev. 1.1) (see Annex A1, p.216) does not differ significantly from the distribution in the total population[8] (see Annex Table A1.1, p. 215). The average size of firms in the total population measured in terms of number of employees is 200. The average number of employees in the sample is 135 (see Annex Table A2, p. 216). The Mann-Whitney test shows that this is a significantly smaller average size compared to the population (see Annex Table A2.1, p. 216). If we take a look at the distribution of firms across four different classes of firm size (1 to 9, 10 to 49, 50 to 249, and above 250 employees) (see Table A3, p. 216), we realize that the sample has fewer firms in the category of micro firms (1 to 9 employees) as well as large firms (above 249 employees). Yet, the distribution of firms does not differ significantly from the population[9] (see Annex Table A3.1, p. 216). In terms of regional distribution of firms across the six federal states (NUTS 1) in East Germany, the sample does differ significantly from the total population (see Annex Table A4 and A4.1, p. 217). Whereas 15.5 per cent of firms in the population are located in Berlin, this share amounts only to 7.1 per cent in the sample. Thus, firms from Berlin are underrepresented in the sample. Also, at a lower level of regional disaggregation of '*Raumordnungsregionen'*[10] (ROR) the result is unchanged (see Annex Table A5 and A5.1, p. 218).

The survey results show that from the total population of firms about 12 per cent could not be contacted by interviewers by means of telephone. In most cases this was related to an incorrect telephone number (see Table A6, p. 219). About 67 per cent of firms refused to participate in the survey and can be classed as non-respondents. Non-response was motivated by explanations such as no interest, time constraints, refusal to be interviewed by means of telephone, and postponement of a possible interview to a later stage. Finally, about 21 per

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[8] The chi-square test statistic should be carefully interpreted as in three industries we expect less than five observations. Therefore, I repeated the test using a higher sectoral aggregation as used by the IAB and found the results confirmed. Therefore, it seems reasonable to the authors to assume that the sectoral distribution of the sample does not differ significantly from the population.

[9] The chi-square test statistic is not significant only at the 10 per cent not at the 1 per cent level.

[10] From the level of federal states (NUTS 1) the next lower level of disaggregation is '*Regierungsbezirke'* (NUTS 2). However, this is a purely administrative unit. The next lower level is 'Kreise' (NUTS 3). However, at this level we have too few observations in order to assess representativeness. In between NUTS 2 and NUTS 3 there are 23 '*Raumordnungsregionen'* (ROR) within East Germany. They are constructed as administrative-functional units that take into account the commuting movements of workers' between residence and work. Each ROR consist of two to six counties ('*Kreise'*). Therefore, my choice for an appropriate regional unit to assess representativeness was ROR.

cent of firms agreed to participate in the survey (this includes the interviews during the pre-test). The latter group of firms can be classed as respondents. I repeated the tests for significant differences in the distribution of firms across sectors, regions, and firm size categories comparing respondents to non-respondents. This gives us an indication to what extent the survey suffers from a non-respondent bias.

In terms of sectoral distribution, the group of respondents differs significantly from non-respondents[11] (see Annex Table A7 and A7.1, p. 220). Responding firms are more frequent in chemicals and chemical products (NACE 24), non-metallic-mineral products (NACE 26), and basic metal (NACE 27) (see Annex Table A7, p.220). In contrast there are fewer than expected respondents from fabricated metal products (NACE 28), electrical machinery (NACE 31), and motor vehicles (NACE 34). The group of non-respondents shows a higher average number of employees (216) in contrast group of respondents (135) (see Annex Table A8, p. 221) however, the difference is not significant (see Annex Table A8.1, p. 221). The distribution across size categories also differs significantly due to fewer than expected respondents in the micro (1 to 9 employees) as well as large (above 249 employees) category of firm size (see Annex Table A9 and Table A9.1, p. 221). In terms of regional distribution, there are fewer than expected observations among respondents in compared to non-respondent for firms from the federal state of Berlin (see Annex Table A10 and A10.1, p. 222) as well as significant deviation in the distribution across the lower level '*ROR'* regional units (see Annex Table A11 and A11.1, p.223).

Beyond sectoral, regional, and size distribution the sample is characterised by firms that entered between 1990 and 2005 (see Annex Table A12, p. 224). In the distribution over this period, there is a higher entry rate of firms in the sample during the privatisation period until 1994. After a decline in the second half of the 1990s, the entry rate only picks up again from 2000 onwards. At the time of the survey implementation (2006), about 70 per cent of the affiliates are fully, about 23 per cent are majority, and only about 7 per cent are minority foreign or West German owned (see Annex Table A13, p. 224). The survey offers also information on the type of owner. From this we learn, that about 67 per cent of affiliates belong to multinational enterprise group, about 10 per cent belong to a national enterprise group located abroad, about 12 per cent are part of a foreign enterprise (single entity), and 11 per cent have foreign individual or family ownership (see Annex Table A14, p. 224). These ownership structures represent various stages or forms of firm internationalisation into East Germany. The sample supplies also information on the mode of entry. From this it becomes

[11] Chi-square test statistic is significant at 5 per cent level.

clear that 39 per cent entered East Germany by setting up a completely new enterprise (Greenfield), whereas the majority of 61 per cent chose a form of acquisitions (see Annex Table A15, p. 225). The latter group contains acquisitions of a stated owned enterprise as part of the privatisation process (17 per cent), acquisitions of a domestic privately owned enterprise (28 per cent), as well as acquisitions of an enterprise from another foreign investors (16 per cent).

From the distribution of home countries in the sample, we see that about 25 per cent of affiliates belong to multinationals headquartered in West Germany the rest are part of enterprises located abroad (see Annex Table A16, p. 225). The set of foreign home countries in the sample is fairly dispersed. The highest share of foreign firms stem from the Netherlands (11 per cent), Austria (11 per cent), the United States (8 per cent), and Switzerland (8 per cent). In principal, from foreign firms in the sample about 80 per cent originate from EU-27 (plus Norway, Lichtenstein, and Switzerland) and about 20 per cent from overseas.

In sum, the sample is representative at the sectoral level but differs significantly from the total population with regard to regional and size distribution. The regional deviations are mainly related to an underrepresentation of firms from Berlin and firms with 10 to 249 employees are overrepresented. Moreover, there are indications for a non-respondent. An additional limitation applies as representativeness was evaluated looking at each criterion (sector, region, size) separately and not jointly. Beyond these criteria, the sample is characterised by affiliates that entered throughout the period between 1990 and 2005. It is dominated by multinational enterprise groups as owners, full ownership as well as acquisition as mode of entry. On the one hand, empirical results using the 1st spell of the IWH FDI micro database should be interpreted having in mind the above limitations. On the other hand, the substantial sample available is drawn from a comprehensive population that allows us to assess representativeness for the first time so thoroughly.

4. Descriptive overview

This section offers a descriptive overview of the sectoral, regional, and size composition of the population of foreign and West German multinational affiliates located in East Germany. It should demonstrate to what extent foreign and West German investors differ with regard to their structural characteristics and specialisation patterns from the East German manufacturing as a whole. Any descriptive evidence related to the survey drawn from the *IWH FDI database* is separately presented in the subsequent empirical investigations.

4.1 General overview

According to the total population underlying the 1st phase (2007) of the *IWH FDI micro database,* the number of firms that have either a direct foreign shareholder or West German multinational shareholder (with a minimum of 10 per cent equity), or that have a foreign or West German multinational ultimate owner (with a minimum of 25 per cent indirect ownership) totalled to 1,412. From this total population 1,090[12] firms have foreign ownership and 322 firms belong to a multinational company headquartered in West Germany. The total population has a total employment of 266,406 of which 195,429 employees (73.4 per cent) work in firms with foreign and 70,977 employees (26.6 per cent) with West German multinational ownership. The total population accounts in terms of number of firms for only 3.6 per cent of all firms in the East German manufacturing, yet it accounts for 28.6 per cent of East German manufacturing employment. In other words, more than every fourth person in the whole East Germany manufacturing works for a firm with foreign and West German multinational ownership.

4.2 Sectoral composition and specialisation

With respect to the sectoral composition of foreign and West German multinational investors in terms of number of firms, we find most firms in manufacturing of electronics (NACE 30-32), machinery and equipment (NACE 29), and fabricated metal products (NACE 28) (see Annex Table A17, p. 226). The sectoral composition in terms of number of firms of the total population differs significantly from the distribution we find for East German manufacturing in

[12] Just to illustrate, the German Central Bank identifies only 360 companies with foreign participation in the East German manufacturing industry in 2006. The IAB establishment panel counts 828 firms (with majority foreign ownership) in the East German manufacturing industry in the year 2005.

total[13]. Foreign and West German multinational investors tend to specialise their investment in electronics (NACE 30-32), chemicals (NACE 23, 24) and motor vehicles (NACE 34) (see Annex Table A18, p. 226).

Table 2 Sectoral employment distribution of population and total East German manufacturing

Foreign and West German MNEs	Employment		Number of firms	
	absolute	% in	absolute	% in total
Industry (NACE Rev. 1.1)		total EG M.		total EG M.
Chemicals (23, 24)	40.413	92,28	117	13,75
Other transport equipment (35)	19.930	83,28	38	8,98
Motor vehicles and trailers (34)	28.746	67,11	72	15,19
Electronics (30, 31, 32)	47.088	59,63	169	8,72
Non-metallic mineral products (26)	14.965	34,45	129	6,02
Basic metals (27)	13.370	34,13	44	6,48
Paper, printing, publishing (21, 22)	11.114	19,78	106	7,27
Machinery and equipment (29)	22.401	19,70	170	4,80
Medical, precision, optical instr. (33)	8.934	16,67	103	2,94
Food, beverages, and tobacco (15, 16)	23.833	16,38	94	1,46
Recycling (37)	1.831	15,76	24	2,74
Wood and wood products (20)	3.443	14,70	33	2,19
Rubber and plastic products (25)	7.102	14,24	75	5,15
Furniture and other manufacturing	3.094	13,49	48	1,78
Textiles, clothing and leather	5.353	11,25	40	1,31
Fabricated metal products (28)	14.789	10,59	150	1,83
Total	266.406	28,46	1.412	3,60

Source: IWH FDI micro database (2007) and Institute for employment research (2007)

If we assess specialisation patterns in terms of employment we find investment is concentrated in electronics (NACE 30-32), chemicals (NACE 23, 24), motor vehicles (NACE 34) and other transport equipment (NACE 35) in comparison to the overall sectoral composition of East German manufacturing (see Annex Table A18, p. 226). These four industry groups combined account for 51.2 per cent of employment in the total population of foreign and West German multinational firms and account for 71.9 per cent of total East German employment in these four industry groups. The penetration of foreign and West German multinational investors in terms of employment share per sector differs quite a lot (see Table 2). It ranges between 10.59 per cent in the manufacturing of fabricated metal to 92.28 per cent in the chemical industry. In general one could say that the foreign and West German penetration is particularly high and dominating in high-tech and medium-high-tech industries. An exception

[13] Chi-square test is significant at 1 per cent level.

to this general rule is a fairly low penetration of foreign and West German investors in the medical, precision, and optical instrument industry (NACE 33) as well as in machinery and equipment (NACE 29). When we compare the sectoral distribution of foreign vs. West German multinational investors different specialisation patterns emerge (see Table 3). In terms of relative employment shares foreign investors tend to specialise in manufacturing of electrical machinery & apparatus (NACE 31), food products and beverages (NACE 15), transport equipment (NACE 35), and basic metals (NACE 27). In contrast, West German multinationals tend to concentrate on the manufacturing of motor vehicles & trailers (NACE 34) as well as machinery and equipment (NACE 29). Apart from textiles and clothing (NACE 17), the latter two industries (NACE 34; 29) are also the only ones in which West German multinational investors show an employment that is higher in absolute numbers compared to foreign investors'. In general, it seems that the sectoral specialisation of foreign investors is more diversified in comparison West German multinationals.

Table 3 Sectoral employment distribution of foreign and West German affiliates

	Foreign Investors		West German MNEs		Difference
NACE 2 digit	Employment	in %	Employment	in %	in % shares
15	19.365	9,9	2.588	3,6	6,30
16	1.880	1	0	0	1,00
17	2.421	1,2	2.603	3,7	-2,50
18	75	0	104	0,1	-0,10
19	150	0,1	0	0	0,10
20	2.762	1,4	681	1	0,40
21	4.897	2,5	841	1,2	1,30
22	2.495	1,3	2.881	4,1	-2,80
23	4.033	2,1	1	0	2,10
24	28.105	14,4	8.274	11,7	2,70
25	5.845	3	1.257	1,8	1,20
26	11.521	5,9	3.444	4,9	1,00
27	11.857	6,1	1.513	2,1	4,00
28	10.975	5,6	3.814	5,4	0,20
29	10.733	5,5	11.668	16,4	-10,90
30	4.212	2,2	115	0,2	2,00
31	20.133	10,3	2.659	3,7	6,60
32	13.654	7	6.315	8,9	-1,90
33	5.994	3,1	2.940	4,1	-1,00
34	14.264	7,3	14.482	20,4	-13,10
35	16.920	8,7	3.010	4,2	4,50
36	2.085	1,1	1.009	1,4	-0,30
37	1.053	0,5	778	1,1	-0,60
Sum	195.429	100	70.977	100	

Source: IWH FDI micro database (2007).

4.3 Regional distribution

In terms of regional distribution across the six federal states within East Germany, we see that most foreign and West German multinational employment has been attracted to the federal state of Saxony followed by Berlin (includes West Berlin), Thuringia, Saxony-Anhalt, Brandenburg, and Mecklenburg-Vorpommern (see Table 4). The share of foreign and West German multinational firms in total manufacturing employment is with more than half highest in Berlin and lowest in Thuringia with only a fifth of total manufacturing employment.

Table 4 Regional employment distribution of population and total East German manufacturing

	Total EG manufacturing*		Total Population			Share of total
Federal States	Employment	In %	Employment	In %	Deviation in % shares	population in total EG M.
Berlin	103.674	11,1	56.439	21,2	10,11	54,44
Brandenburg	115.037	12,3	32.701	12,3	-0,01	28,43
Mecklenburg	67.162	7,2	16.483	6,2	-0,99	24,54
Saxony	318.963	34,1	84.565	13,2	-2,33	26,51
Saxony-Anhalt	135.984	14,5	35.126	31,7	-1,34	25,83
Thuringia	195.334	20,9	41.092	15,4	-5,44	21,04
Sum	936.153	100	266.406	100		28,46

*Source: *Institute for employment research (2007), IWH FDI micro database (2007).*

The distribution of employment as well as number of firms of the total population across federal states differs from the distribution of total East German manufacturing[14]. This result is mainly related to a concentration of employment of foreign and West German firms in Berlin. When we compare the distribution of employment of foreign vs. West German investors in East Germany different regional specialisation patterns emerge. Foreign employment is concentrated stronger in Berlin and Saxony, where as West Germans have larger relative shares of employment located in Saxony-Anhalt and Thuringia (see Table 5). If we assess the regional distribution of the total population of foreign and West German multinational firms at a lower level of regional aggregation (ROR; see footnote 8 above for a definition) a much stronger differentiation in terms of regional concentration patterns emerges compared the level of federal states (NUTS 1). The share of employment of the total population in total manufacturing employment per ROR region ranges between 11 and 58 per cent (see Annex

[14] The Chi-square test for the distribution of the number of firms of the total population vs. total East German manufacturing is significant at the 1 per cent level.

Table A19, p. 227). Four regions (Oberes Elbtal/Osterzgebirge, Oderland-Spree, Berlin, Halle/S.) show a share of above 40 per cent of total manufacturing employment within the region.

Table 5 Regional employment distribution of foreign and West German affiliates

	Foreign		West German		Deviation in %
Federal States	absolute	in %	absolute	in %	shares
Berlin	52.007	26,6	4.432	6,24	20,36
Brandenburg	23.557	12,1	9.144	12,88	-0,78
Mecklenburg-VP	13.946	7,1	2.537	3,57	3,53
Saxony	52.932	27,1	8.966	12,63	14,47
Saxony-Anhalt	26.160	13,4	31.633	44,57	-31,17
Thuringia	26.827	13,7	14.265	20,10	-6,4
Sum	195.429	100,0	70.977	100	

Source: IWH FDI micro database (2007).

If we take a look at differences in the relative distribution of firms across regions of the total population compared to total East German manufacturing, we find four regional units that show a relative concentration in terms of number of firms as well as employment: Berlin, Oberes Elbtal/Osterzgebirge, Halle, Havelland-Fläming, and Oderland Spree (see Annex Table A20, p. 228 and Table A21, p. 229). Foreign and West German multinational firms in these four regions account for about 50 per cent of the total population as well as about 15 per cent of total East German manufacturing. In principal this high regional concentrations could be linked to economic agglomeration in and around the cities of Berlin and Dresden as well as the conurbation of Halle and Leipzig.

When we compare the relative distribution of employment of foreign vs. West German multinational firms across regional units of 'ROR' it emerges that foreign firms show a higher concentration in the northern and north-eastern regions including Berlin as well as a in the South-West, whereas West German multinational firms tend to concentrate employment in regions stretching from the South of Berlin to the South and South-West (see Annex Table A22, p. 230).

4.4 Sectoral specialisation at the regional level

Given the fact that we find strong sectoral as well as regional differentiation in the distribution of the total population of foreign and West German multinational companies in East German manufacturing, we are likely to observe particular underlying sectoral specialisation patterns at the regional level. If we consider the employment distribution of foreign and West German multinational firms across federal states in comparison to the employment distribution of total East German manufacturing (see Table 6), it emerges a specialisation of foreign and West German multinational firms in chemicals (NACE 23, 24), electronics (NACE 30-32), and other transport equipment (NACE 35) in the federal state of Berlin.

Table 6 Sectoral employment specialisation of population across East German federal states

IAB Code (NACE 1.1)	Berlin	Brandenburg	Mecklenburg West-Pommerania	Saxony-Anhalt	Saxony	Thuringia
3 (15, 16)	4,4	-11,6	2,8	-4,1	-11,3	-14,0
4 (17-19)	-4,1		-4,6	-4,7	-2,7	1,3
5 (21, 22)	-0,3	3,8	9,6	1,0	0,2	3,0
6 (20)		-3,1	-2,8	-5,5	-5,6	-2,5
7 (23,24)	**24,3**	6,3	-0,4	**35,7**	0,5	-1,8
8 (25)	-4,9	-3,0	3,1	-3,7	-3,1	0,2
9 (26)	1,8	5,0	-3,2	1,6	-1,5	2,9
11 (37)	-14,9	-14,5	-14,2	-14,8	-13,3	-14,6
12 (28)	-7,3	-8,4	-9,7	-7,3	-7,1	-1,3
13 (29)	-3,1	-1,8	-7,8	2,3	5,0	-3,6
14 (34)	-3,7	5,7	-0,5	0,1	9,3	**14,4**
15 (35)	5,9	**10,0**	**21,8**	-4,0	-1,3	0,2
16 (30-32)	10,5	3,5	2,0	4,0	**32,6**	9,6
17 (33)	-0,2	-2,1	2,7	-0,3	0,1	6,8
18 (36)	-0,5	-0,6	1,1	0,4	-0,2	0,3

Source: IWH FDI micro database (2007), Author's calculations.

Similarly, we find a relative concentration in other transport equipment (NACE 35), chemicals (NACE 23, 24), and motor vehicles and trailers in Brandenburg. In Mecklenburg-Vorpommern foreign and West German investors are relatively concentrated in other transport equipment (NACE 35), paper, printing and publishing (NACE 21, 22), and rubber and plastic products (NACE 25). Investment in Saxony-Anhalt is characterised by a high concentration in chemicals (NACE 23, 24) and to a lesser extent electronics (NACE 30-32) as well as machinery & equipment (NACE 29). In Saxony we find a very substantial focus of employment in electronics (NACE 30-32) and to a lesser extent in motor vehicles and trailers (NACE 34) as well as machinery & equipment (NABE 29). Finally, in Thuringia foreign and West German multinational firms show a relative concentration in terms of employment compared to the l employment distribution for the total East Germany manufacturing in the manufacturing of motor vehicles and trailers (NACE 34), electronics (NACE 30-32), and medical precision, precision and optical instruments (NACE 33).

Now the question could be to what extent are these regional-sectoral specialisation patterns also related to different types of ownership i.e. foreign or West German multinational. Therefore, we compare the relative employment distribution of foreign to West German multinational owned firms per sector across federal states (see Annex Table A23, p. 231). As we saw above in Berlin there is a high concentration of employment in the chemical industry (NACE 23, 24), which seems to be linked to a higher relative share of foreign employment in this sector. West German multinational employment shares tend to be higher than foreign shares for Berlin in machinery & equipment (NACE 29), motor vehicles and trailers (NACE 34), and fabricated metals (NACE 28). In Brandenburg we saw above (Table 6) a high concentration in the manufacturing of other transport equipment (NACE 25), where we find again a higher relative share of foreign employment. Interestingly, in Saxony-Anhalt the high concentration in the chemical industry (NACE 23, 24) is associated with a relatively higher employment share of foreign firms vs. West German multinational owned firms for chemicals & chemical products (NACE 24) and vice versa for the manufacturing of coke, refined petroleum products, nuclear fuel (NACE 23). For Saxony we detected a comparatively high importance of electronics (NACE 30-32), here we find a relatively higher share of foreign over West German multinational employment in manufacturing of office, accounting & computing machinery (NACE 30) and electrical machinery & apparatus (NACE 31). The opposite is the case for manufacturing of radio, TV, communication equipment (NACE 32). Thuringia was characterised by a relative high concentration of employment in manufacturing of motor vehicles and trailers (NACE 24), which is associated with a relatively higher share of West German multinational over foreign employment. Having in mind that this comparison in based on the relative sectoral distribution of foreign or West German employment in a particular sector, and mot absolute employment shares, we can see indications for the hypothesis that regional-sectoral specialisation patterns are linked to ownership patterns.

4.5 Size structure

Due to data restriction we focus on the number of employees as a measure of firm size in this analysis. The average firm size in the population of foreign and West German multinational owned firms is 200 employees (see Annex Table A24 p. 232). This is about 13 times as much as the average number of employees for the East German manufacturing which stand at about 16 employees. Within the total population we find that the average West German multinational firm has about 223 employees in comparison to 193 employees that work on average in firms with foreign equity participation. The distribution of firm size in terms of employees of the total population is right skewed and the positive kurtosis indicates a peaked distribution. This deviation from the normal distribution seems to be even more pronounced if we consider East German manufacturing as such (ibid.).

If we take a look at the distribution of firm size across four intervals of number of employees (micro, small, medium, and large firms) in the total population, we observe that most firms are in the medium sized (50 to 249 employees) and small group (10-49 employees) with about 39 per cent and 29 per cent, respectively (see Table7).

Table 7 Size distribution of population and share in total East German manufacturing

Size group	No. of firms	In %	% of EG Manufact.	Employment per group	In %	% of EG Manufact.
Micro (1-9)	206	15,4	0,88	874	0,33	0,84
Small (10-49)	383	28,7	3,21	9.677	3,63	3,89
Medium (50-249)	515	38,6	14,57	62.419	23,43	17,56
Large (250 - over)	230	17,2	51,57	193.436	72,61	84,81
	1.334	100	3,40	266.406	100	28,46
Missing values*	78					

** No information on the number of employees available for respective number of firms.*
Source: IWH FDI micro database, Author's calculations.

We find about 15 per cent of firms in micro sized firms (1 to 9 employees) and about 17 per cent in the group firms with over 250 employees. We know that the number of firms in the total population constitutes only about 3.4 per cent of the total number of firms in East German manufacturing. However, foreign and West German multinational firms account for more than 51 per cent of firms and 85 per cent of employment in the group of large firms (over 250 employees) in the East German manufacturing (see Annex Table A25, p. 232). In terms of differences between foreign and West German multinational owned firms, we find more firms and employment of the latter in medium and large firms (see Annex Table A26, p. 232).

5. Empirical Part I: Location choice of multinationals

5.1 Introduction and research questions

Aim of the chapter

This first empirical part of the dissertation investigates whether, other things equal, location specific agglomeration economies, in general, and technology related externalities, in particular, play a significant role for the general location choice of foreign and West German multinationals in East German regions. Furthermore, we analyse whether the valuation of technology related externalities in the location choice of applies uniformly across all foreign and West German multinational affiliates in East Germany.

Internationalisation theory and location choice

From Cantwell's (1989, 1995) point of view, the acquisition of new skills, and the generation of new technological capability, partially embodied in new plant and equipment is a condition for every firm in an oligopolistic industry to maintain or increase profits. However, the strength of the technological capability of an internationalised firm does not only depend on home but also host country characteristics. It is argued that the international dispersion of technological development enhances innovation in the network of the MNE as innovation is considered as location specific as well as firm specific (ibid). Therefore, multinational investors benefit from a favourable technological environment in foreign locations (Cantwell and Immarino 1998, 2001, 2003). More precisely, through internationalisation the firm is able to benefit from spatially distinct capabilities within the host economy by absorbing location specific external economies. In other words, agglomeration economies in foreign sub-national regions as well as the diversity of the environments in which firms operate become sources of learning, innovation, thus, ownership advantage of each firm (Cantwell and Immarino 1998, 2001, 2003). From this perspective, it can be assumed that other things equal agglomeration economies in general and technology related externalities in particular should be significant components of the locational utility function of multinationals internationalising into East German regions.

Empirical evidence on location choice

Most of the existing literature on location choice of multinational companies is concerned with the national level determinants (see for an overview Bloningen, 2005). However, more recently location choice of multinational firms has been analysed at the sub-national level (Basile 2004, Basile et al. 2008, Barrios et al. 2006, Chung and Alcácer 2002, Crozet et al. 2004, Guimarães et al. 2000). Here, firms' location decision is modelled as a choice between a given set of sub-national regions within one or across many countries.

This stream of research is closely related to the 'new economic geography' that argues that the presence of increasing returns, local externalities, and economic integration leads to the spatial concentration of economic activities (Fujita et al. 1999, Fujita and Thisse 2002). Following this literature, small incidents or some natural advantages may foster the birth and rise of an industry in a particular location. The location of production may follow a cumulative process if agglomeration economies are to arise since new firms may tend to locate in existing industrial centres, increasing, in turn, the relative attractiveness of these through a circular process. However, not all industries are subject to the same economies of agglomeration, nor do such agglomeration forces determine industries' location identically (Henderson 1974).

In fact, the existing evidence from international studies at the sub-national level indicates that external economies associated with industry specialisation/diversification as well as foreign firm agglomeration affect the location choice of multinational firms (Basile 2004, Basile et al. 2008, Barrios et al. 2006, Chung and Alcácer 2002, Crozet et al. 2004, Guimarães et al. 2000). However, none of the existing studies isolates the technology related externalities from other agglomeration economies associated with labour or supplier structure. However, from the technology accumulation perspective such technology related external economies form a crucial element in explaining the internationalisation of firms.

Empirical evidence from East Germany

The new economic geography and the literature on sub-national location choice of multinational firms provides a suitable framework for the analysis of the relevance of technology related externalities in the location choice of foreign and West German multinational affiliates within East Germany. So far there is a paucity of such evidence in existing studies (Belitz et al. 1999, Thum et al. 2007 etc.) on locational choice from East Germany. The only exception forms a recent study by Spies (2010) who estimates the locational choice at the level of federal states by employing a utility maximisation estimation framework to a sample of foreign investors in Germany drawn from the micro level data supplied by the central bank ('Bundesbank'). The study comes to the conclusion that East German federal states form closer substitutes in location compared to West German peers, which could signal that foreign investors pursue different strategies entering East and West Germany. However, the study does not identify which locational determinants drive regional location choice in East Germany.

Research approach and contribution

This is the first systematic micro econometric investigation of locational determinants for investment at the regional level of East Germany. Thereby, we place the focus on agglomeration effects in general and technology related externalities in particular which could explain the entry of multinationals from the technological accumulation approach towards firm internationalisation. We exploit the total population of foreign and West German multinational firms that entered East German manufacturing between 1995 and 2005 drawn from the *IWH FDI micro database*. We apply a conditional logit estimation approach to model the likelihood of an investor to locate in one out of 23 East German regions ('Raumordnungsregionen'). Thereby, we account for standard exogenous variables such as market size, production cost, infrastructure, public policy, and focus on six main variables related to various forms of agglomeration effects.

More specifically, in line with existing international studies (Basile 2004, Basile et al. 2008, Barrios et al. 2006, Chung and Alcácer 2002, Crozet et al. 2004, Guimarães et al. 2000) we test for the effect induced by localisation, urbanisation, and intra-industry foreign firm agglomeration. As an addition to existing approaches we isolate knowledge externalities related to intra-industry technology specialisation, technology diversification, and science infrastructure from other agglomeration effects. This follows the proposition of the technological accumulation approach that spatially distinct technological capabilities form an important pull factor for the location of MNEs (Cantwell 1989). By interacting, region specific fixed effects with firm characteristics we are also able to show the impact of investors' heterogeneity on the valuation of agglomeration related locational determinants. This is in line with recent contributions arguing that locational factors do not uniformly apply to all investors (Basile et al. 2008, Chung and Alcácer 2002, Crozet et al. 2004). In particular, we focus on the effect of technological intensity of the industry, firm size, ownership, single vs. multiple entry, and time of entry.

Structure of the chapter

The following section of this chapter reviews the recent international studies with regard to theoretical thinking about locational determinants at the sub-national level and corresponding empirical evidence. The review is structured in market and demand related aspects, agglomeration factors, production costs, public policy, and firm heterogeneity. Section three provides an overview on the existing empirical evidence on locational determinants of foreign and West German multinationals based in East Germany and summarises the findings in the light of the international state-of-the-art. The fourth section spells out the research hypotheses of this chapter. The fifth section introduces the theoretical and econometric model applied as well as data used. Section sixth presents and discusses briefly the estimation results in the context of the theory and existing evidence.

5.2 Theory and international empirical evidence

In principal, region specific locational determinants of firms can be grouped into market, agglomeration, production, and public policy related factors. Market size and income of the region itself as well as neighbouring regions signal potential demand for the investor. Production factors affect the cost side and are related to the supply, price, and quality of regional input markets such as labour, transport, land, capital, and technology. The existence of agglomeration economies in turn affects production factors through technological and pecuniary externalities, such as access to a more stable labour market, availability of intermediate goods, production services, skilled manpower, and knowledge spillover between adjacent firms. Thereby, one can discriminate effects related to the regional agglomeration of domestic and foreign firms. Finally, location choice might be also be affected by public policy in from of investment incentives as well as taxation.

5.2.1 Market and demand related factors

The size of the regional market should make multinational firms' location relatively more profitable, as larger sales would allow investors to recover the fixed set-up cost of foreign production (Devereux et al. 2007, Basile et al. 2008). Head et al. (1999) argue that market size matters for foreign manufacturer even more, if the transport cost of the good produced are high. However, regional units can be of relatively small size and multinational investors might target consumers far beyond the frontier of the region. Following Harris (1954) or the theory of export-platform FDI (Neary 2002), a number of authors consider in addition to the regional market size the market potential measured by a distance-weighted matrix of market size of all other regions (Crozet et al. 2004, Basile et al. 2008, Head et al. 1999, Head and Meyer 2004,).

The existing empirical evidence with regard to market size and potential seems not to reject the hypothesis of a positive effect on location choice. In a study of Japanese FDI into US states Head et al. (1999) confirm the positive effect of regional market size and adjacent market potential using an income measure. Yet, once they control for industry level agglomeration effects the effects disappear (ibid). Crozet et al. (2004) find support for the positive impact of market potential in their study of FDI in French departments which also takes into consideration agglomeration effects. The estimations of Head and Mayer (2004) for Japanese FDI in 57 regions of the EU shows a positive result for regional market size, measured in regional GDP, as well as market potential of adjacent regions. Similarly, Basile et al. (2008) find a positive impact of market size and potential in a study of FDI in 50 regions across eight EU countries. Head and Mayer (2004) conclude that this result reflects the attractiveness of central regions i.e. the ones with a combination of high local demand and proximity to other important sources of demand.

5.2.2 Agglomeration factors

Crozet et al. (2004) argue that the agglomeration effect of domestic and foreign firms depends upon from a trade-off between agglomeration and dispersion forces. On the one hand, a long strand of papers in location theory insists on the fact that geographic distance isolates firms from competition. A rise in the number of firms in a given location shifts prices down in that location and, therefore, reduces incentives to locate there. On the other hand, positive externalities between firms can emerge from technological spillovers or other mechanisms as argued by economic geography literature (Krugman 1991, Venables 1996). The relative strengths of the two forces shape the extent of geographical clustering of firms.

Guimarães et al. (2000) hold that agglomeration economies play a special role in site selection by foreign investors. Generally, information and search costs weigh higher for foreign investors' decisions than for those of domestic investors (Caves 1996). FDI also often involves substantial risk and coordination costs, especially for Greenfield investments (ibid.). There are potential fixed and variable administrative costs which increase when a plant is being managed across borders. Agglomeration economies can potentially offset these costs (Guimarães et al. 2000). It would seem likely that the presence of other firms in the industry, other foreign firms, and services can help service communications, transport, and other needs and will be important location considerations (ibid).

Localisation and Urbanisation

Agglomeration externalities are one of the factors that may influence where economic activity locates. From Marshall's (1962) point of view knowledge spillovers, labour market risk pooling, and vertical linkages are the main sources of so called localisation economies. Benefits derived from increasing returns to scale and learning-by-doing cause industries to concentrate in particular regions (Glaeser et al. 1992). It suggests that firms that use similar technologies, inputs, and types of workers may have incentives to co-locate (Devereux et al. 2007). For example, firms that require similarly skilled labour, and workers that possess those skills may locate together in order to insure themselves against hiring and firing costs (ibid). Empirical evidence exists in support of all three potential sources of localisation economies (see for an overview Rosenthal and Stange 2004). If agglomeration externalities are industry specific, then foreign firms may benefit from localisation i.e. a high specialisation at the region-industry level (Barrios et al. 2006).

In contrast to localisation externalities, Jacobs (1969) argues that firms may benefit from externalities arising in regions with a diverse industrial structure, or from so called urbanisation economies. For example, innovative firms may benefit from technological developments in industries other than their own, or from a local, varied science base (Devereux et al. 2007). This may make diversified regions more attractive than specialised regions. Firms may also benefit from locating in areas where the mass or density of economic activity is high (ibid). If externalities related to urbanisation exist, then foreign firms are more likely to locate in regions with a diverse industry structure (Barrios et al. 2006, Devereux et al. 2007).

Looking at the empirical evidence on agglomeration effects, Head et al (1999) find that Japanese investors cluster within specific region regardless of industry, which indicates the importance of urbanisation effects. In addition, they find also support for industry specific localisation effects. Similarly, other authors such as Guimarães et al. (2000), Barrios et al. (2006), Devereux et al. (2007) provide consistent evidence for the existence of both, localisation and urbanisation effects in locational choice of foreign investors. What can be said about the magnitude of both effects? Guimarães et al. (2000) in their study of FDI into Portuguese regions find that urbanisation economies exert a larger impact compared to industry-specific localisation. They observe that urbanisation economies of major cities exert an additional detectable pull. In their study on FDI into Irish regions, Barrios et al. (2006) find a stronger urbanisation effect for multinationals in high-tech industries compared to low-tech industries. In contrast, localisation externalities are only significant for multinationals in low-tech. Crozet et al. (2004) underline that the magnitude of agglomeration effects differs quite strongly across industry. In addition, the empirical literature shows that the adjacent-state agglomeration effects are found to be of lower magnitude or not significant compared to the within region agglomeration effects (Head et al. 1999, Basile et al. 2008).

Foreign firm agglomeration

Important for our analysis is the argument that agglomeration economies derive not only from the generic number of local incumbents, but also from the number of other foreign firms operating in the same geographical area. As suggested by Head et al. (1999) foreign investors may have less initial knowledge about regional characteristics than their domestic counterparts and interpret the presence of other foreign firms in a given region as a signal of profitability of a given location. Being less knowledgeable as to the general conditions of the region, investors may emulate the decisions of other foreign firms to reduce uncertainty (Guimarães et al. 2000). Mariotti and Piscitello (1995) think that locations within the host country with a high FDI accumulation have lower observation costs as already existing subsidiaries become accumulating points for information on the local economy and environment. This information is partially transmitted through business networks to other international investors who thus enjoy a positive externality (ibid.). This effect has also been related to the presence of foreign firms of the same nationality (Head et al. 1995, 1999, Crozet et al. 2004). Yet, Guimarães et al. (2000) also suggest that there may be advantages for foreign firms independently of their nationality to locate where foreign presence is high if foreign presence reduces uncertainty.

Considering the empirical evidence Guimarães et al. (2000) find that foreign-specific agglomeration does not seem to matter once services and the locational pull of the major cities is accounted for. In contrast, Mariotti and Piscitello (1995) detect a positive effect of the agglomeration of large foreign multinationals on the attraction of foreign firms into Italian regions. Similarly, Devereux et al. (2007) find a positive effect of multinational firm agglomeration for UK regions. Here, a greater foreign presence makes a location even more attractive for Greenfield plants set up by foreign-owned multinationals, compared to those that are part of UK groups. In their study of foreign firm location in France, Crozet et al. (2004) find a positive effect of agglomeration of other foreign firms as well as foreign firms of same nationality. It is noteworthy that co-location seems to be stronger with domestic rather that foreign firms. Basile et al. (2008) put forward evidence that foreign firm agglomeration has positive effects on the locational choice.

Technology and knowledge related externalities

Following Cantwell (1989), in addition to localisation and urbanisation effects from labour market pooling and vertical linkages, the potential for knowledge spillovers in a particular region is an important determinant of firms' location decision. As distance hampers the exchange of tacit knowledge, proximity becomes relevant in order to be able to absorb spillovers (Jaffe et al. 1993, Audretsch and Feldman 1996). Fagerberg et al. (1994) suggest that a regions' capacity to adapt and implement new external knowledge determines the degree of its locational attractiveness. The existing knowledge base plays a particularly important role in the decision of foreign firms as to where to locate their technological activities (Cantwell and Iammarino 2001, 2003). Along with the pre-dominantly market oriented variables, such knowledge related motives becomes increasingly important motivation for multinational enterprises to set up their R&D activities in foreign affiliates (Mariotti and Piscitello 1995, Pearce and Singh 1992, Zanfei 2000). For these reason, the technological efforts of foreign firms tend to be strongly agglomerated at a regional level (Braunerhjelm and Svennsson 1998, Barrel and Pain 1999). The literature on the relative attractiveness of regions for foreign firms' location of technological activity argues that knowledge spillovers can be generated from three sources: specialisation externalities associated with the agglomeration of knowledge in the same sector; diversity externalities associated with the co-presence of knowledge in other sectors; and science–technology externalities stemming from the presence of a munificent scientific and educational infrastructure (Cantwell et al. 2001, Cantwell and Piscitello 2002, 2005). Inter-industry knowledge spillovers are more likely to occur in locations that has accumulated relatively high level of innovative activities and which tend to have a broad profile of technological specialisation (Cantwell and Janne 1999, Cantwell and Iammarino 2001).

In the empirical literature of location choice at the sub-national level only three studies (Chung and Alcácer 2002, Basile et al. 2008, Mariotti and Piscitello 1995) test for the effect of knowledge spillovers. Chung and Alcácer (2002) find a negative impact of regions R&D

intensity in the US whereas Basile et al. (2008) find a positive impact for European regions. Mariotti and Piscitello (1995) who look at location decisions of foreign firms in Italy in general and not the location of R&D find no support for science–technology externalities. However, the measure applied is fairly crude and not differentiated according to the sources of potential knowledge spillovers. Much more differentiated approaches can be found in the literature of R&D location by multinationals. One of the most comprehensive studies in this strand of research has been published by Cantwell and Piscitello (2005). They show support for the positive effect of intra-industry and inter-industry knowledge spillovers. Yet, they find no support for intra- and inter-industry spillovers between regions. Intra-industry effects are positive when the specialisation of the region in a particular industry is essentially due to the presence of other foreign firms already located there. Yet, the effect disappears when the specialisation stems from the presence of domestic owned firms. They argue that this might be related to the fact that indigenous technological specialisation is often concentrated in a few long established major local firms that raise entry barriers. They also find a positive effect of both the public R&D expenditures as well as educational quality within and between regions, which indicates the importance of science–technology externalities for the location of foreign owned R&D.

5.2.3 Production related factors

On the cost side of the profit function, one usually considers production factors such as the cost of labour, transportation, and land (Guimarães et al. 2000). Capital costs are usually assumed to be invariant across regions within one country. For this reason they are generally not included as an explanatory variable in regional location models (ibid.).

Labour and skills

In measuring observed factor prices, most studies focus on labour market conditions characterised by wage, unionisation, or unemployment (Head et al. 1999). In principal, high wages increase production costs and should affect location decisions negatively. High unemployment rates could signal abundant labour and might have the opposite effect. Controlling for wages, the effect of a high unionisation could affect location negatively, if unions insist on restrictive work rules that lower productivity (Head et al. 1999). Following the Marshallian view, another important factor explaining the location of industries may be found in labour market pooling. Firms are more likely to locate in specific areas because they will be more likely to find the labour force with specific skills they need (Barrios et al. 2006).

The evidence for the impact of labour costs is somehow mixed. Head et al. (1999) find that the unionization rate is negatively and the industry level wages are positively related to the location choice of Japanese investors in US states. They suggest that interstate variation in average wages could mainly reflect variation in the skill composition of the work force. High skill intensity of Japanese manufacturing plants would result in the apparent preference for high-wage states (ibid.). Similarly, Barrios et al. (2006) detect a positive effect of the wage level on the likelihood of location of high-tech as well as low-tech industries in Irish regions. Guimarães et al. (2000) also detect initially a positive effect of high wages, yet, once they control for the regional skill level, the effect is rendered insignificant. The share of regional employment of people with only elementary education has a negative impact on location decisions. Devereux et al. (2007) find that firms are more likely to locate in regions with lower wages for unskilled workers, but in regions with higher wages of skilled workers. From their point of view, this result might be related to unaccounted productivity differences between regions i.e. firms are being attracted to regions where the marginal product of skilled workers is higher. The only study to confirm the expected sign for the wage level is provided by Crozet et al. (2004). They find a negative effect, however, with some heterogeneity with regard to the nationality of foreign firms. For example, Italian, Dutch, and Belgium investors are much more sensitive to the wage level compared to the rest of the sample. US investors seem to search for very productive workers despite a very high wage level.

Transport and infrastructure

On the cost side also transport cost and therefore the quality of regional infrastructure plays a potential role. For example, firms might locate close to the nearest airport or port (Barrios et al. 2006, Guimarães et al. 2000). This could be particularly important if multinationals export a large share of their production (Barrios et al. 2006). Transportation cost could also be related to access to and quality of the rail, motorway, or water network within the region. Mariotti and Piscitello (1995) argue that foreign investors might show a preference for regions close to the border for investors coming from neighbouring countries from an information cost perspective. More general it has also been suggested by Basile et al. (2008) and Crozet et al. (2004) that location choice of foreign firms is negatively related to the distance from investor’s home country or market. Although, the reason why investors show a preference for regions that are in relative proximity to their home market might be a trade-off between the access to consumers and transportation cost (Crozet et al. 2004).

With regard to the empirical evidence Guimarães et al. (2000) confirm that the location decision of foreign Greenfield sites in Portugal depends negatively on the distance to Port/Lisbon as the only major international hubs of the country. Mariotti and Piscitello (1995) can show a significant and positive effect of French and Swiss investors to locate in neighbouring Italian regions. The studies by Crozet et al. (2004) as well as Basile et al. (2008) confirm that location of foreign firms seems to be more likely in regions closer to the home country.

Land

Despite the fact that agglomeration economies have been largely proven to arise in urban and regional economies, one may also consider that agglomeration may entail diseconomies, for example, through pollution or higher land rents (Barrios et al. 2006). In particular, the high costs associated with access to commercial land and property might deter foreign entry.

Empirically Guimarães et al. (2000) and Barrios et al. (2006) use population density as a proxy for such diseconomies. Both studies find no robust support of the hypothesis for location decision of foreign firm in Ireland or Portugal respectively. However, Barrios et al. (2006) interprets the result fairly cautiously as population density may in fact also capture demand-side agglomeration economies, that is, firms locating near their potential markets.

5.2.4 Public policy

Investment promotion policies can take various forms: job creation subsidy, temporary exemption from local taxes, low levels of corporate taxation, etc. Other things equal, firms should be positively influenced by this determinant in their regional location choice within a given country (Crozet et al. 2004). This should apply to measures coordinated at the regional as well as national. At the European level, the Cohesion Policy aims at achieving social and economic cohesion, by helping transform and modernise the structure of relatively poor economies. The main instruments of the EU Cohesion Policy are the Structural Funds (SF) and the Cohesion Fund (CF) granted mainly for the provision of public goods, such as building economic and social infrastructures. They should be negatively correlated with plant set-up costs, thus increasing the attractiveness of each location (Kellenberg 2007).

In fact, Devereux and Griffith (1998) show that firms are sensitive to subsidy and tax differential across regions in their location choice. Head et al. (1999) show that labour subsidies are positively related with Japanese investment across US states. However, the inclusion of agglomeration variables lowers the magnitude of the effect. Similarly, Barrios et al. (2006) find that higher public incentives in designated area status increased the probability that a typical multinational chooses this kind of region for investment in Ireland. However, when splitting the sample in high and low-tech industries in turns out that the effect only remains significant for the latter group. Deveroux et al. (2007) find on average Greenfield multinationals entrants are less likely to locate in assisted compared to non-assisted areas in the UK, but are more likely to locate in development compared to intermediate areas. They results seem also to indicate that higher grant offers are needed to attract Greenfield multinational entrants to locations where industry agglomeration or natural resource benefits are weaker. Furthermore, they find that multinational firms are less responsive to government subsidies when there are few other plants in their industry located in the region, but become more responsive as the number of plants already there increases.

Crozet et al. (2004) show that foreign investors are to a large extent sensitive neither to European structural funds nor regional investment incentives in their location decision in France. Even when incentives appear to be statistically significant, the magnitude of the effect seems to be is outweighed by agglomeration or market potential considerations. Basile et al. (2008) find that the amount of EU Structural Funds allocated to a region seems to be a significant determinant of multinationals location decision. Regions within countries that were eligible for the Cohesion Funds are significantly more attractive than others.

5.2.5 Heterogeneity

Chung and Alcácer (2002) argue that multinational firms have heterogeneous firm-specific advantages and investment motives such as market, efficiency, or knowledge seeking. Given that firms invest abroad for different reason, they are likely to value various location factors differently. Therefore, Chung and Alcácer (2002) assume that firms choose a location that maximizes their utility i.e. firm heterogeneity impacts on the relative importance of the various components of the locational utility function (ibid).

Chung and Alcácer (2002) assume that a foreign firm originating from a home country-industry with leading technical knowledge may have unique capabilities, whereas, a firm originating from a country-industry with lagging technical knowledge is less likely to be so endowed. Therefore, they would expect that firms from country-industries with relatively greater technical capabilities will be more attracted to locations with greater market demand and market access, while firms from country-industries with relatively lower technical capabilities will be attracted to locations where more technical activity occurs.

However, Chung and Alcácer (2002) also suggest that overall knowledge intensity of an industry will be another important aspect of heterogeneous investment motives. They argue while firms in mature industries in which standard and well-known technology is used may seek to compete on quality, service, or other less technical dimensions. In contrast, there may be other industries where knowledge is the basis of competition and firms constantly strive to outpace each other through innovation. In such industries all participants will need to be aware of competitors' technical activities. Thus, monitoring at arms' length may be inadequate, leading many industry participants to co-locate. Cantwell and Janne (1999) put also forward the argument that firms from leading technical centres will go to other leading technical centres not to catch up (i.e. to specialise), but to increase their knowledge diversity.

In their study of FDI regional location across US federal states, Chung and Alcácer (2002) are able to confirm that firms from country-industries that have below average R&D intensity are attracted to states with greater R&D intensities. In order to further explore the firm heterogeneity, they interact the proxy with several industry group dummy variables for R&D intensive sectors. They find that knowledge seeking seems to be limited to these industry groups when the interaction measures are introduced. However, within such knowledge intensive industry groups, knowledge seeking occurs for firms with below average country-industry technical level as well as above average country-industry technical level i.e. foreign technical laggards as well as leaders.

Apart from Chung and Alcácer (2002) that address the issue of firm heterogeneity in a very comprehensive way also other studies point into the same direction. Guimarães et al. (2000) and Devereux et al. (2007) differentiate investors by their entry mode and find variance in the relevance of locational factors such as infrastructure, foreign firm agglomeration, and investment grants. Crozet et al. (2004) find that on average, firms tend to follow the choices of competitors from the same country there are large differences with regard to the significance and direction of market potential, wages, agglomeration, and public policy depending on the nationality of the investor. As already described above, Barrios et al. (2006) find differences in the significance and magnitude of effects related to localisation, urbanisation, wages, and investment grants depending on the technological intensity of investors' industry. Basile et al. (2008) suggest multinationals' experience as another possible firm specific factor. The idea is that agglomeration economies could be generated among affiliates belonging to the same business entity in one region. To the extent that multinational firms gain experience with a given context, uncertainty is likely to decrease and the investors will perceive lower risks from further investment. Thus, valuation of locational factors could differ depending on the experience of the multinational firm in the region.

5.3 Empirical evidence on locational determinants from East Germany

There have been several studies on the relevance of locational factors for foreign direct investment in East Germany since the early 1990s. The analyses were conducted at the firm level using survey or interview evidence from foreign subsidiaries and/or headquarters. With regard to regional location we find only one very recent study. The following section is going to review the existing methodological approaches, data sources used and results derived in the light of the theory and international evidence discussed above.

5.3.1 Survey based evidence

Beyfuß (1992) dealt with locational factors of foreign firms in West and East Germany. In a survey, 184 foreign affiliates across 10 industries were questioned about the relative attractiveness of Germany as an investment location. In an open question, foreign affiliates were also asked about their opinion of East Germany as an investment location. The emerging picture was fairly ambivalent. Only a third of foreign affiliates had a positive view on East Germany. Foreign subsidiaries cited factors such as relatively high wages combined with low productivity, poor infrastructure, and unsecured property rights as locational disadvantages.

Brander et al. (1992) conducted interviews with 43 Japanese multinationals headquarters across 12 industries. The interviews revealed that the Japanese multinationals had by and large no interest in East Germany as a potential investment location. This was mainly explained by limited information about East German firms on offer, poor infrastructure, unsecured property rights, insufficient qualification of local professional and management staff, and insecurity about future development of wages as well as prices for real estate.

Haas (1996) probably published the first study that used evidence solely from existing foreign firms based in East Germany. From a list published by the German privatisation agency (‘Treuhand Anstalt’), he identified the population and conducted interviews with 20 foreign investors present in 1994/1995 in East Germany. The foreign investors by and large motivated their investment based on market access arguments. They valued the central geographic position of East Germany in Europe and the availability of investment incentives. In contrast, the foreign firms were critical about the quality of local administration, infrastructure, and the level of qualification of employees.

Belitz et al. (1999) published a more comprehensive study dedicated to the analyses of investment motives and locational factors of foreign companies in East Germany. The authors used survey evidence from East German manufacturing from the year 1998 as well as 25 interviews conducted with large foreign firms. In addition, the study employs evidence from expert interviews conducted with a number of East German regional investment promotion agencies. In the survey, foreign firms evaluated 25 locational factors. First, they were asked to indicate the importance of a particular factor for their location choice. Second, they indicated their satisfaction with regard to the respective factor in East Germany.

Looking at the relative importance foreign investors' location decision seems to be driven by a group of factors including market access, wage level, qualification of labour, energy cost, infrastructure, and public investment incentives. A second group of less important factors is connected to the proximity to suppliers as well as availability and quality of public administrative services at regional and local level. The final group of least important factors includes the availability of commercial land, the level of commercial rents, the proximity to higher education and research institutions as well as quality of local life (local recreation, culture, public transport, housing, medical services). Only about 10 percent of foreign investors consider the access to higher education and research institutions as a very important consideration in their investment decisions. Yet, those who do so also show a high degree of satisfaction with regard to this factor in East Germany. In contrast, foreign investors indicate no satisfaction with regard to the level of energy cost, local taxes as well as the quality of local administration (ibid).

Belitz et al. (1999) conclude in their study that the attractiveness of East Germany for foreign firms during the 1990s can be explained mainly by three factors. First, foreign firms gained direct access to the German and West European markets. Second, foreign affiliates benefited from low capital cost mainly due to investment incentive schemes. Third, foreign investors seemed to benefit from the availability of qualified and motivated personnel at relative low labour cost.

Thum et al. (2007) published one of the more recent and comprehensive studies on locational determinants of foreign investment in East Germany. The authors studied the subject from the foreign affiliate as well as headquarter perspective. The basis for the analysis was a survey of 186 foreign affiliates in East German manufacturing and selected services as well as a survey of corresponding multinational headquarters located abroad. The multinational headquarters were asked to indicate their main investment motive (market access, local production factors) as well as the functions (distribution and sales, R&D, manufacturing) exercised by foreign affiliate across three different international regions: East Germany, Eastern Europe, and (South) East Asia. The majority of headquarters indicated for East Germany 'advantageous local production conditions' (53.9 per cent) as dominant investment motive. Only 26.9 per cent indicated market access as dominant motive and 19.2 per cent said that investment was driven by both, market as well as production related. In comparison to the other two regions the East German affiliates exercise more frequently R&D functions (17 per cent in East Germany, 7 per cent in East Europe, 13 per cent in South East Asia).

Multinational headquarters indicated the general relevance of 40 different locational factors for their investment decisions. From this data, a group of most relevant factors emerged that includes institutional aspects (rule of law, property rights, corruption, and personal security), market size, labour factors (availability of highly qualified personal, the wage level, labour market regulation), infrastructure (communication, transport) as well as taxes and public incentives. Interestingly, two institutional variables (property rights, rule of law) are ranked by foreign investors as most relevant. A second, less relevant, group of factors relates to capital (access to capital, exchange rate risk), cost of land (commercial land, office space), natural resources, transportation cost, red tape, and regulation (trade, environmental). The final group of least relevant locational factors entails competition considerations, research infrastructure, and quality of local life (medical services, training facilities, image of region, recreation, international schooling, local public transport, shopping facilities, and culture).

Also, East German foreign affiliates were asked to indicate the main investment motive. Again, the majority indicated 'advantageous local production conditions' (57.1 per cent) as dominant motive (22.9 per cent market access, 20 per cent both). So far, this confirms very well the answers received by the respective headquarters. Foreign affiliates could also indicate another important investment motive from their point of view. Here, East German affiliates indicated the availability of scientific knowledge of public research and higher education institutions, whereas foreign affiliates in Eastern Europe and Asia gave answers more related to cost advantages and market access. This seems in line with a higher frequency of R&D functions allocated to affiliates based in East Germany.

Foreign affiliates also evaluated their degree of satisfaction with regard to 40 locational factors in East Germany in the context of other international locations. In contrast to unskilled labour, the availability of skilled and highly qualified personal seems to be unsatisfactory. Similarly, affiliates show less than average satisfaction with regard to wages for skilled and highly qualified personnel. They also express dissatisfaction with the level of energy prices, whereas price levels for commercial property and office space seem to be satisfactory. Access to credit as well as the availability of public incentives is judged as satisfactory. East German infrastructure is considered satisfactory with respect to communication and road networks as well as energy and water supply. In contrast, rail, air and water transport networks are rather poorly evaluated. The foreign investors seem to be satisfied with the East German research infrastructure. With respect to soft locational factors, the foreign affiliates indicated by and large satisfaction with the level of perceived personal security as well as local recreation, less so with training opportunities, recruitment of personal with language abilities as well as presence of international schools (ibid).

Bochow (2007) has implemented a very thorough study of foreign direct investment in the East German automotive supplier industry. From a total population of 134 foreign affiliates in East Germany he surveyed 67. In addition, he conducted 18 expert interviews with people involved in the acquisition of an automotive supplier firms in East Germany. He identified as main investment motives for East Germany the availability of investment incentives, qualified personnel as well as wages and production costs. He argues that market access was secondary as this would have been also possible at alternative locations within the European Union. Thus, amongst the given locational alternatives the reigning production conditions were most important.

The foreign automotive suppliers also evaluated the quality of locational factors. Bochow (2007) weights the evaluation for each locational factor by its general importance for international investment decision as indicated by the foreign firm. From this emerges a group that contains 26 out 31 factors that combine a positive valuation with high overall importance (investment incentives, availability of qualified personnel, industrial real estate, proximity to customers/suppliers, taxes, wellbeing of foreign employees etc.). Into the so called problematic category which combines a high importance for the multinational and low evaluation of the locational factor for East Germany fall three locational factors: the supply of management personnel, foreign language skills as well as prices for energy, water, and sewage. The group of so called luxury factors that combine a relatively low importance for general investment decisions with a high degree of satisfaction for East German belongs for example the access to higher education and research institutions. Finally, access to the national rail network as well as local transport are characterised by low general importance and with relatively low evaluation by foreign firms.

5.3.1 Evidence from regional location choice modelling

Spies (2010) puts forward the first study investigating the regional determinants of the location choice of foreign multinationals in the united Germany. She exploits the firm level Microdatabase Direct Investment (MiDi) of the German central bank *('Bundesbank'*), which has certain limitation for East Germany as discussed in chapter 3. Merging the firm level data with information on German federal states (*'Bundesländer'*), she assesses the impact of region specific drivers for location choice using a profit maximisation framework on the full sample of about 8.500 investment projects registered in the MiDi between 1997 and 2005. Of this sample, about 980 investment projects are located in East Germany.

The author derives a theoretical location choice model in line with existing approaches (Head and Mayer 2004) that takes account of agglomeration, production, infrastructure, tax and other institutional effects on the location choice between German federal states. The selection of a particular location depends on the potential profits associated with that location exceeding the potential profits associated with all other available locations. The theoretical model is first estimated using a conditional logit estimation approach, which assumes that all alternative locations have the same degree of substitutability. However, she argues that the motives for undertaking FDI in distinct regions could differ given that investors may take advantage of the persistent gap between Eastern and Western German federal states to pursue different strategies in the two regions. If this assumption is true, the federal states would not be equal substitutes and the standard conditional logit model would produce inconsistent parameter estimates. Therefore, the specifications are also estimated by a nested logit procedure, which divides the regional choice in two a West and East German sub-set of regional choices. The different specifications are estimated for the full sample as well as separately for sub-samples of the most important countries of origin as well as different economic sectors (services, manufacturing, downstream activities of wholesalers and retailers, upstream activities of R&D centres and other headquarter services).

The results of the nested logit estimation show that in fact foreign investors perceive Eastern federal states as more closely substitutable alternatives than Western federal states. From the estimation on the full sample, the author identifies with regard to production related factors a negative effect of local business tax and unit labour costs, however, a positive effect of the price for developed property. The absolute size of the regional market has a positive effect on the location decision, in contrast to market potential from of surrounding regional markets weighted by proximity. The variable on infrastructure is not significant. With regard to agglomeration effects she detects a positive effect from the regional concentration of foreign affiliates of the same home country within the same sector of activity as well as the regional concentration of foreign affiliates in general within the same sector of activity. Similarly, she detects a positive effect if the federal state of choice shares a border with the home country of the foreign investor. With regard to human capital she finds a positive effect of the regional share of university graduates but no effect of the share of school graduates without school leaving certificates. Similarly, the regional public R&D expenditures have no statistical effect on location choice as well as regional population density.

From the sectoral decomposition we learn that in contrast to services in manufacturing the author cannot detect any statistically significant effect of the real estate tax, unit labour cost, land price, and infrastructure. The border effects is also is less relevant compared to services. R&D and education policy does not influence a significant effect on location choice in manufacturing. Finally, it seems that East German federal states are viewed as especially close substitutes in manufacturing. For down-stream activities of wholesalers and retailer, taxes and local infrastructure do not seem to matter, in contrast to the finding of a large positive effect of population density. With regard to upstream activities associated with R&D and headquarter services, the author finds that none of the standard location choice variables exhibit statistical significance apart from market access and border effects. Surprisingly, there is also a negative effect of regional public R&D expenditures.

With regard to differences in locational factors depending on the home country of origin, Spies (2010) takes a look at the five most important investing countries. She finds that the nested estimation structure is only supported for Dutch and French investors, however, not for British, Swiss, and French multinationals. This implies that the latter group perceives East German federal states as equal substitutes to West German federal states. At the individual country level, the author finds that local taxes matter only for Swiss and US investors, while the latter do not respond to unit labour cost. In contrast to the other home countries, US investors tend to invest in federal states characterised by higher land prices. Border effects and network effects (same country or general foreign regional agglomeration within same sector of activity) are important across all five countries. Spies (2010) argues that this has possible implications for East Germany which lacks adjacency to important investing countries, however, policy makers might consider the promotion of industry agglomerations as promising strategy to attract further foreign investors.

5.3.2 Contextualisation of existing findings in the light of the theory

The review of the existing empirical evidence of locational determinants of foreign investment in East Germany shows that only one study takes explicitly into account the considerations related to the new economic geography that hints at the spatial concentration of economic activities through increasing returns, local externalities, and economic integration (Fujita et al. 1999, Fujita and Thisse 2002). Despite the fact that Spies (2010) finds that foreign investors perceive regional location choice for East Germany differently from West Germany, so far no evidence exists the relevance of locational factors for regions within East Germany.

This implies that we have no knowledge to what extent intra- and inter-industry agglomeration effects of various forms affect the location choice of multinationals in East Germany. However, the theoretical perspective on internationalisation and technology accumulation (Cantwell 1989, 1991, 1995) such effects play an important role in location choice and have been empirically validated in other international studies (Basile 2004, Basile et al. 2008, Barrios et al. 2006, Chung and Alcácer 2002 etc.).

Furthermore, most of the existing studies on the relevance of locational factors in East Germany do not take account of firm heterogeneity as suggested by recent studies (Basile et al. 2008, Chung and Alcácer 2002, Crozet et al. 2004). This would imply the assumption that all foreign investors value different components of the locational utility function equally independent of firm characteristics such as the mode of entry, country of origin, technological intensity of industry, size etc. Only Spies (2010) started to investigate heterogeneity with regard to the home country and industry, however, it is constrained by the limited amount of firm level information in the MiDi database of the central bank.

All existing studies employ firm level data. However, size and quality of underlying populations as well as resulting samples differ quite a lot. Early studies (Beyfuß 1992, Brander et al. 1992, Haas 1996, Belitz et al. 1999) have only limited access to information about the population of foreign firms and rely on fairly small samples. More recent studies (Thum et al. 2007, Bochow 2007) are able to draw from well researched populations that generate larger samples.

However, these studies do not supply information with regard to representativeness. Therefore, samples used are potentially not able to reflect industry and firm heterogeneity properly. However, even the existing studies that are able to exploit larger firm level data sets (Belitz et al. 1999, Thum et al. 2007, Bochow 2007) apply only descriptive analysis of the relevance of locational factors for foreign investors in East Germany.

Furthermore, all survey based studies refer to the perceived importance of various locational factors at the time of the survey and/or interview implementation. However, the relevance of locational factors can vary over time similarly as the investment motive (Dunning and Lundan 2008). Therefore, it seems important to relate the relevance of locational factors to the time prior to market entry of each firm. This requires information about the entry of foreign investors as well as time series data on different locational factors.

Therefore, micro-econometric estimation approaches which account for firm, industry and region specific effects might in fact be more suitable as an analytical tool to determine the significance of various locational factors in the regional location choice of multinational firms. In fact, the only study that does so has been put forward by Spies (2010). She exploits the most reliable micro database available for the united Germany supplied by the central bank (‘Bundesbank’). However, as discussed in Chapter 3 due to registration procedures related to a lower limit on total balance sheet/operating assets as well as the consolidation of different units the database creates systematic distortions with respect to firm size and regional disaggregation. As a result, the number and volume of foreign investment is underestimated for East Germany (Günther 2005, Votteler 2001). Naturally the database does not hold information on investment projects by multinational companies headquartered in West Germany, which constitute an important share of investment into East Germany during the transition process.

In sum, the existing studies do not explain location choice of multinational companies in East Germany by taking account agglomeration effects on a regional level of analysis that are crucial from the a technological accumulation point of view on firms internationalisation. Thereby, it would be insightful to separate various forms of specialisation or diversification externalities associated with technology and other spillovers. In addition, we face a lack of evidence on the role of firm heterogeneity in terms of valuation of locational factors when investing in East Germany. Furthermore, the micro level data sources from East Germany employed so far suffer from considerable methodological limitations with regard to representativeness as well as the inclusion of West German multinational investors. This opens several avenues for contributions to the existing body of research on the location choice of multinationals in East Germany.

5.4 Hypotheses

The above review of existing empirical evidence on locational determinants of FDI in East Germany showed that market related factors, availability of qualified personnel, and public investment incentives played a major role in the decision-making process of international investors (Belitz et al. 1999, Thum et al. 2007). Therefore, we need to account for these standard exogenous variables in the subsequent empirical investigation. However, given the lack of investigations at the regional level in East Germany the original contribution of the research is going to focus on intra-regional industry specific agglomeration effects, isolating technology from other agglomeration effects, as well as the impact of firm heterogeneity on the regional location choice within East Germany:

If agglomeration externalities are industry specific, then foreign and West German multinational firms may benefit from a high specialisation at the region-industry level (Barrios et al. 2006). This specialisation refers to a relative advantage of the respective sector and region in question in comparison to the degree of specialisation of the sector across all regions. Thus the following hypothesis results:

(1) Other things equal, a high concentration of a particular industry within a region has a positive impact on the likelihood that foreign and West German multinational affiliates of the same industry locate in this region in East Germany.

Yet, it has been argued that firms may also benefit from locating in areas where the mass or density of economic activity is high. If such externalities related to urbanisation exist, then foreign firms are more likely to locate in regions with a diverse industry structure (Barrios et al. 2006, Devereux et al. 2007). A diversification across sectors within a particular region is independent from a relative specialisation. In other words a region can show a relative specialisation within a particular sector and a high degree of diversification at the same time. They are not two extremes of the same measure. Therefore, the following hypothesis results:

(2) Other things equal, a high diversity across industries within a particular region has a positive impact on the likelihood that foreign and West German multinational affiliates locate in this region in East Germany.

Importantly, for our analysis is the argument that agglomeration economies derive not only from the generic number of local incumbents, but also from the number of other foreign firms operating in the same geographical area (Mariotti and Piscitello 1995, Head et al. 1999, Guimarães et al. 2000). Thus the following hypothesis results:

(3) Other things equal, the number of foreign firms within the same region has a positive impact on the likelihood that foreign and West German multinational affiliates locate in this region in East Germany.

In addition to localisation and urbanisation effects from labour market pooling and vertical linkages, the potential for knowledge spillovers in a particular region is an important determinant of firms' location decision. Recent empirical evidence showed that technology seeking became an important investment motive for foreign firms locating in East Germany (Thum et al. 2007). Therefore, I would like to model explicitly the potential for knowledge spillovers within a region as an important locational determinant in the analysis. In line with existing approaches we can differentiate between intra-industry knowledge spillovers, inter-industry knowledge spillovers, and science–technology externalities (Cantwell et al. 2001, Cantwell and Piscitello 2002, 2005). From this a subset of three hypotheses emerges:

(4) Other things equal, a high concentration of intra-industry knowledge within in a region has a positive impact on the likelihood that foreign and West German multinational affiliates of the same industry locate in this region in East Germany.

(5) Other things equal, a high diversity of knowledge across industries within in a region has a positive impact on the likelihood that foreign and West German multinational affiliates locate in this region in East Germany.

(6) Other things equal, the quality of the scientific and educational infrastructure in a region has a positive impact on the likelihood that foreign and West German multinational affiliates locate in this region in East Germany.

5.5 Theoretical and econometric model

5.5.1 Theoretical model

In line with existing approaches (Devereux and Griffith 1998, Head and Mayer 2004, Basile et al. 2008), we can assume the following simplified decision process of the firm. First, the firm decides whether to serve a foreign market. Second, the firm takes a decision upon the question whether to serve the foreign market by means of FDI rather than exports, licensing, or collaborative ventures. Once it has opted for FDI, the firm finally decides where to set up activity within the foreign market. Our analysis of location patterns of multinational firms at the sub-national level is confined to the final stage in this decision-making process. In our particular case East Germany is a ‘country’. However, this assumption seems to be justified given that Spies (2010) econometrically identifies that East German federal states are closer substitutes to each other compared to West German federal states in regional location choice of foreign investors that locate in Germany. We assume that country level location determinants such as political, legal, and other institutional framework conditions apply uniformly across all regions within East Germany.

Our model assumes that the selection of a particular East German region depends on the potential profits associated with that location exceeding potential profits associated with all other available location in East Germany. The profit of the firm is affected by location specific internal market access, fixed costs, and potential benefits from agglomeration related external effects. The focus of our analysis is on the effect of various technology and other agglomeration related variables in the decision-making process of investors. However, we control for a number of standard exogenous variables in the locational choice theory: First we account for access to the regional internal market. Second we consider production cost related factors across regions in terms of human resources, land, transport, and infrastructure. Third we include public policy effects with respect to investment grants and local business taxes. Finally, we test firm and industry heterogeneity impacts on the relative importance of the various components of the locational utility function.

Following Guimarães et al. (2003), we consider the existence of J spatial choices among East German regions with $j = 1, \dots, J$ and N investors with $i = 1, \dots, N$, then the profit derived by investor i if he locates at area j is given by

$$\pi_{ij} = \beta' z_{ij} + \epsilon_{ij} ,$$

where β is a vector of unknown parameters, z_{ij} is a vector of observed explanatory variables, and ϵ_{ij} is a random term. Thus, the profit for the investor i of locating at region j is composed of a deterministic and a stochastic component. The investor will choose the region that will yield him the highest expected profit. If the ϵ_{ij} are independent and *iid* extreme value distributed, it can be shown that

$$P_{ij} = \frac{e^{\beta' z_{ij}}}{\sum_{j=1}^{J} e^{\beta' z_{ij}}}$$

where P_{ij} is the probability that the investor i locates at region j. If we let $d_{ij} = 1$ in case investor i picks choice j and $d_{ij} = 0$ otherwise, then we can write the log likelihood of the conditional logit model as

$$\log L_{cl} = \sum_{i=1}^{N} \sum_{j=1}^{J} d_{ij} \log P_{ij} \ ,$$

In the basic specification the profit derived by investor i if he locates at region j is given by the following specification

(I) $\pi_{ij} = \beta_1 IS_{jh_i t_{i_{-1}}} + \beta_2 ID_{jt_{i_{-1}}} + \beta_3 FA_{jt_{i_{-1}}} + \beta_4 TS_{jh_i t_{i_{-1}}} + \beta_5 TD_{jt_{i_{-1}}} + \beta_6 HE_{jt_{i_{-1}}} + \beta_7 GDP_{jt_{i_{-1}}} + \beta_8 HR_{jh_i t_{i_{-1}}} + \beta_9 LAND_{jt_{i_{-1}}} + \beta_{10} INV_{jt_{i_{-1}}} + \beta_{11} TAX_{jt_{i_{-1}}} + \beta_{12} INFRA_j + \beta_{13} SIZE_j + \epsilon_{ij}$,

, where $\beta_1 IS_{jh_i t_{i_{-1}}}$approximates the specialisation of region j in the industry h of investor i at t_{-1} as the year preceding the entry of investor i (see Table 8 for detailed description of measurement), $\beta_2 ID_{jt_{i_{-1}}}$ the diversification across industries of region j at t_{-1} as entry of investor i, $\beta_3 FA_{jt_{i_{-1}}}$ the agglomeration of foreign and West German multinational firms in region at t_{-1} as entry of investor i, $\beta_4 TS_{jh_i t_{i_{-1}}}$ the technological specialisation of region j in the industry h of investor i at t_{-1} as entry of investor i, $\beta_5 TD_{jt_{i_{-1}}}$ the technological diversification within region j at t_{-1} as entry of investor i, $\beta_6 HE_{jt_{i_{-1}}}$ public expenditure for higher education infrastructure of region j at t_{-1} as entry of investor i, $\beta_7 GDP_{jt_{i_{-1}}}$ the gross domestic product of region j at t_{-1} as entry of investor i, $+ \beta_8 HR_{jh_i t_{i_{-1}}}$ the share of human resources in science and technology occupations of the region j in the industry h of investor i at t_{-1} as entry of investor i, $\beta_9 LAND_{jt_{i_{-1}}}$ the average price of developed commercial sites of region j at t_{-1} as entry of investor i, $\beta_{10} INV_{jt_{i_{-1}}}$ investment grants per employee of region j at t_{-1} as entry of investor i, $\beta_{11} TAX_{ij}$ the average tax levied by local authorities (counties) of the region j at t_{-1} as entry of investor i, $\beta_{12} INFRA_j$ the average distance to the closest airport of investors located in region j, and $\beta_{13} SIZE_j$ the size of the surface of region j, and ϵ_{ij} a random term.

In this basic specification, the parameters $\beta_1$to β_6 constitute the explanatory variables related to hypotheses (1) to (6) and β_7 to β_{13} constitute standard control variables in sub-national location choice. Apart from β_{12} and β_{13} , all explanatory variables are measured at t_{-1} as the year[15] preceding the entry of investor i. By lagging the respective variables we avoid a possible endogeneity between the investment of foreign and West German firms and the region specific effects. Several studies (Crozet et al. 2004, Head et al. 1995) construct agglomeration variables in a way to take into account neighbouring location sites or introduce inter-regional effects (Cantwell and Piscitello 2005). However, we restrict our analysis to intra-region effects in order to lower the probability of multicolinearity in the specification.

In order to account for heterogeneity across firms we estimate the following second specification that includes interaction terms between selected firm specific effects and the main exogenous variables in line with the hypotheses developed in this chapter:

(I) $$\pi_{ij} = \beta' z_{ij} + \gamma' HTdum_i * v_{ij} + \delta' LARGEdum_i * v_{ij} + \varepsilon' FORdum_i * v_{ij} + \theta' MEdum_i * v_{ij} + \vartheta' Edum_i * v_{ij} + u_{ij} ,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables specified in estimation *(I)*, γ a vector of unknown parameters from the interaction between $HTdum_i$ and v_{ij} a vector that contains a linear combination of all exogenous variables in line with the hypotheses (1 to 6) as defined in specification above, δ a vector of unknown parameters from the interaction between $LARGEdum_i$ and v_{ij}, ε a vector of unknown parameters from the interaction between $FORdum_i$, θ a vector of unknown parameters from the interaction between $MEdum_i$ and v_{ij}, ϑ a vector of unknown parameters from the interaction between $Edum_i$ and v_{ij}, and u_{ij} the error term.

$HTdum_i$ represents a dummy variable that equals to one if investor i belongs to a high- or medium-high technology intensive industry and zero otherwise, $LARGEdum_i$ equals to one if investor i has a number of employees above the mean of the population and zero otherwise, $FORdum_i$ equals is to one if the investor i is foreign and zero if it is a West German multinational, $MEdum_i$ equals to one if the investor i has other affiliates in East Germany and zero otherwise, $Edum_i$ equals to one if the investor i has entered East Germany after the privatisation process ended in 1996 and zero otherwise, and u_{ij} is a random term.

[15] However, reliable data on the regional level is only available back until 1995. Therefore, we need to assume 1996 as earliest possible entry year for all investors that entered before 1996. Thus the entry years range between 1996 until 2006.

5.5.2 Econometric method

For a large class of industrial location studies, the random utility maximization approach offers a particularly promising basis for obtaining reliable empirical results (Guimarães et al. 2004). The random utility maximization framework has served as the paradigm for analysing discrete microeconomic data following McFadden (1974, 1978). Indeed, the random utility maximization framework is the basis for studying many discrete-choice urban and regional problems, including industrial location choice (Guimarães et al. 2004). In this case, the industrial location decision is cast as a discrete choice problem in which profit (utility) maximizing firms select sites from a distinct set of regions and localities. One major advantage of the discrete choice- random utility maximization approach in industrial location research is that it can be tested against an extensive array of spatial data maintained by national and regional governments. Through an application of the conditional logit model (CLM), Carlton (1979, 1983) first demonstrated that industrial location decisions can be modelled in a random utility maximization setting as suggested by McFadden (1974).

The critical assumption of the CLM is that the unobserved factors are uncorrelated over alternatives, as well as having the same variance for all alternatives (Train 2003). This independence of irrelevant alternatives (IIA) assumption, while restrictive, provides a very convenient form for the choice probability. However, the IIA assumption can be inappropriate in some situations. In the context of industrial location choice the IIA assumption might be challenged by unobserved location characteristics that may induce correlation across choices between regions or unobserved individual characteristics that might make some choices closer substitutes for certain investors (Guimarães et al. 2004). Two types of tests are available for the IIA assumption, a Hausman-type specification test (Hausman and McFadden 1984) and a Lagrange multiplier test (McFadden 1978a). These tests can be conducted by eliminating a subset of the choices from choice set and re-estimating the model. If the parameters of the restricted model are not systematically different from the parameters of the full model, then the IIA property holds. However, the number of subset combinations to test can be enormous. Furthermore, these tests do not offer a guideline for selecting the subset of choices to eliminate.

When dealing with small geographical units, this problem may be more important because neglected site characteristics can more easily extend their influence beyond the boundaries of the considered spatial units. Some researchers have recognized this issue and attempted to control for the existence of unobservable correlation across choices by applying a nested logit approach, which models assume that investors follow a hierarchical decision process, initially choosing among a small set of larger regions and, conditional on that initial choice, then selecting a location within that region. The difficulty here is in the identification of the upper levels of the nested logit as they may constitute unrealistic scenarios for the decision maker. Moreover, it is sometimes difficult to conceive of regional characteristics that affect upper-level location choices in ways different from the choice at the lower levels. An alternative strand of empirical research has modelled the firm location decision problem using Poisson (count) models and micro level spatial data sets. The Poisson studies approached the location problem differently than the CLM by relating the number of new plants being opened at a particular site to a vector of area attributes. The Poisson regression is particularly advantageous in dealing with large spatial choice sets since each spatial choice becomes an observation. However, Poisson regression model lacks a theoretical underpinning such as the random utility maximization framework for the CLM (ibid.). A formal link between the CLM and the Poisson regression has been addressed by Guimarães et al. (2003, 2004).

Given that our analysis relates to a choice between 23 '*Raumordnungsregionen'* as functional units within East Germany we have a comparatively small set of choices of small regions. '*Raumordnungsregionen'* consist of two to six NUTS-3 level counties ('Kreise') and their demarcation takes into account commuter movements between peoples' residence and work places. This way '*Raumordnungsregionen'* describe in principal economic centres and their corresponding peripheries. This functional unit lies between the '*Kreis*' (NUTS-3) and '*Regierungsbezirk*' (NUTS-2) level and serves as a basis for statistical reporting and regional planning. '*Regierungsbezirke*' at the next upper level could be used as a reference for a nested logit approach. However, it is very unlikely that these purely administrative units are of any relevance to the investors' choice. Similarly, *'Bundesländer'* (NUTS-1) are fairly large and heterogeneous administrative units and not the relevant unit for the selection of a particular location site, once investors decided to invest within East Germany. Yet, *'Bundesländer'* could be of relevance to investors due to a potential leverage of regional governments in areas such as large scale investment grants, infrastructure, or other public investment decisions. However, German as well as European regulations are at hand to keep such differential treatment of investors at bay.

In sum, it seems appropriate to apply a CLM approach to *'Raumordungsregionen'* under the condition that we observe the availability of federal grants, infrastructure and other public investment as well as control for the size of *'Raumordungsregionen'* as a proxy for the type of region in question (more rural or urban) in order to reduce the possibility of correlation across choices between regions that might make some regions closer substitutes for any investors. In line with Chung and Alcácer (2002), we introduce individual characteristics of investors in order to account for firm heterogeneity that otherwise might make some regions closer substitutes for certain investors.

Table 8 Measurement of variables in estimations of chapter 5

Variable	Measurement	Year	Source
Region specific variables			
Industry specialisation	Number of employees per industry (NACE 2-digit level) and region (ROR) standardised by total employment per region divided by the number of employees per industry (NACE 2-digit level) and region (ROR) standardised by total number of employees in all regions.	2005	Statistik der Bundesagentur für Arbeit (2005)
Industry diversification	Inverse Herfindahl index of employment per industry (NACE 2 digit level) and region (ROR). The Herfindhal index is calculated as squared sum of the shares of employment of each industry (NACE 2) per region in total employment per region (ROR).	2005	Statistik der Bundesagentur für Arbeit (2005)
Foreign firm agglomeration	Share of foreign and West German multinational employment over total employment (including self-employment) in region (ROR).	1995-2005	IWH FDI Micro database (2007), AK VGR der Länder (2009)
Technology specialisation	Revealed technological advantage (RTA) measured in terms of patent applications from industry and natural persons. Number of patent applications per industry (NACE 2-digit level) and region (ROR) standardised by total patent applications per region divided by the number of patent applications per industry (NACE 2-digit level) and region (ROR) standardised by total number of patent applications.	1995-2005	Patentatlas (2001, 2006)
Technology diversification	Inverse Herfindahl Index of patent application of industry and natural persons over industries (NACE 2 digit level) per region (ROR). The Herfindhal index is calculated as squared sum of the shares of patent applications of each industry (NACE 2) per region in total patent applications per region (ROR).	1995-2005	Patentatlas (2001, 2006)
Higher education infrastructure	Annual public investment grants for new and reconstruction of higher education institutions per employee per region (ROR) ('Mittel Rahmen der Gemeinschaftsaufgabe Art. 91a GG').	1995-2005	Bundesminsiterium für Bau- und Raumordnung, Fördermitteldatenbank (2005)
GDP	Annual GDP per region (ROR) in current prices (in Mio. Euro).	1995-2005	Arbeitskreis VGR der Länder (2008)
Human resources in S&T occupations	Share of human resources in science and technology occupations (HRSTO) in total employment per region (ROR) and industry (NACE 2 digit level). Deviation of share in industry and region from industry average across all regions in East Germany.	2005	Statistik der Bundesagentur für Arbeit (2007), author's calculations
Land	Annual average price for developed sites per region (ROR).	1995-2005	INKAR (2007
Investment grants	Annual sum of investment grants per employee per region (ROR). Includes grants for new private investment, investment directed at business expansion or acquisition of a firm that is facing closure (Investitionszuschuss im Rahmen der Gemeinschaftsaufgabe, EFRE cofinancing).	1995-2005	Bundesminsiterium für Bau- und Raumordnung (2005)
Local trade tax	Average of annual trade tax levied by local authorities (Gewerbesteuerhebesatz) (in Euro) in region (ROR).	1995-2005	INKAR (2007)
Airport access	Average distance to closest airport in each region (ROR) (in km).	2009	Own calculations.
Size of region	Size of region (ROR) (in sq km).	2007	Statistisches Bundesamt, Statistik Regional (2007)
Firm-specific variables			
Technological intensity of firms' industry	Firms are classified by industry into the four categories of technological intensity according to the OECD (1995) classification. The hightech und medium-hightech firms form one group and the medium lowtech and low tech firms form the second group.		IWH FDI Micro database (2007)
Size of firms	Based on the number of employees in 2005 we divided the population of firms at the median number of employees (177) into large and small firms.		IWH FDI Micro database (2007)
Origin of firms	We divided the population in firms with West German multinational or foreign ownership.		IWH FDI Micro database (2007)
Entry of firms	We divided the population of firms into those that have more than one affiliate in East Germany (multiple entries) and those that have only one affiliate in East Germany (single entry).		IWH FDI Micro database (2007)
Entry time of firms	We divided the population of firms into those that entered until and after 1996 which indicates the finalisation of the East German privatisation process.		IWH FDI Micro database (2007)

5.6 Results and discussion

5.6.1 Estimation results

We estimate first the basic model specification with robust standard errors (see column 1 and 2 in Table 9). Apart from one variable (technology diversification), all of our main variables show significant coefficient and the expected sign and apply as fixed effects uniformly across all region and firms. The log-likelihood is -3661 and according to the probability value of the Chi-square statistic significantly different from the null hypothesis. The likelihood ration index indicates a Pseudo-R^2 [16] of 0.111 which is fairly high in the context of micro-econometric estimations. Subsequently, the interaction model (see column 3 and 4 in Table 9) is estimated with robust standard errors. Now, only two variables (industry specialisation, foreign firm agglomeration) carry the expected significant sign and apply as fixed effects uniformly across all regions and firms. However, there are a number of significant interaction effects that constitute a combination of region-specific effects with investor-specific characteristics. The log-likelihood of the interaction specification stands at -3621 and is significantly different from the null hypothesis. In comparison to the basic model the Chi^2 statistic as well as the Pseudo-R^2 of the interaction model are higher. If we conduct a likelihood ratio test between the basic specification and the interaction specification, the latter is significantly different from the first. According to the Akaike-criterium (AIC) the interaction model has an improved fit. Thus, there is good indication that the model fit of the interaction specification is improved in comparison to the basic specification. Thus, introducing heterogeneity of investors allows an improved estimation in contrast to a model that takes only account of fixed effects that apply uniformly across regions and firms. However, the second specification does not render the results of the basic specification invalid. It simply is a more differentiated approach. Now let us take a closer look at the estimation results of both specifications.

According to the CLM model, using the basic specification we cannot reject the hypothesis (1) that an intra-regional industry specialisation has a positive impact on the likelihood that foreign and West German investor locate in a region. Here, we measured revealed employment specialisation per industry and region. The higher the relative specialisation of employment in a particular industry of a region is in comparison to all other regions, the higher is the likelihood that investors are attracted into that region. Such intra-regional agglomeration

[16] In non-linear models such as the CLM the Pseudo-R^2 does not provide information on the percentage of variance explained to total variance. As it is not bounded by zero and unity the Pseudo R2 can only be interpreted as absolute value.

effects are mainly related to benefits derived from labour market pooling and vertical linkages as we isolate in the context of the basic specification externalities related to technology or knowledge related spillovers.

Similarly, we cannot reject the hypothesis (2) that an intra-regional diversification across industries has a positive impact on the likelihood that foreign and West German investors locate in a region. Thus, a diverse manufacturing industry structure or areas with dense economic activity across more than one industry increase significantly the likelihood of subsequent foreign and West German investment. It could for example be that innovative firms may benefit from technological developments in industries other than their own (Devereux et al. 2007). Thus, we find support for the relevance of industry specific localisation as well as urbanisation economies as relevant locational determinants in East Germany. This is in line with consistent evidence for both effects from other international studies (Head et al. 1999, Guimarães et al. 2000, Barrios et al. 2006, Devereux et al. 2007). In other words, localisation and urbanisation economies can exists alongside each other as they are not two extremes of the same measure, as a region can show a relative sectoral specialisation in one particular sector in comparison to all other regions independent from the degree of diversification across industries within the region.

In addition to industry specific localisation and urbanisation effects, we test in the basic specification for the impact of existing regional agglomeration of foreign and West German investors on the likelihood of subsequent investment. We find positive evidence that this hypothesis (3) cannot be rejected for East Germany. This positive evidence is consistent with evidence from other countries at the sub-national level (see Devereux et al. 2007, Crozet et al. 2004, Basile et al. 2008) and would support the argument that the presence of other investors independently from nationality lowers observation costs for new entrants (Head 1999 et al. Mariotti and Piscitello 1995).

Apart from Mariotti and Piscitello (1995), Chung and Alcàcer (2002), and Basile et al. (2008) this is one of the first studies to isolate technology related specialisation effects from other agglomeration effects in the context of locational determinants of foreign investment at the sub-national level. All prior studies assess the impact of total regional R&D intensity on the likelihood of foreign investment. Our approach borrows from Cantwell and Piscitello (2005), who actually look at the location of foreign R&D, and differentiate three different sources of regional knowledge spillovers.

Table 9 Estimation results for CLM base and interaction model

VARIABLES	(1) CLM base model		(2) CLM interaction model	
Region specific variables				
(H1) Industry specialisation	0.731***	(0.054)	0.739***	(0.134)
(H2) Industry diversification	0.654**	(0.303)	0.585	(0.753)
(H3) Foreign and WG firm agglomeration	0.284***	(0.058)	0.390**	(0.159)
(H4) Technology specialisation	0.304**	(0.110)	0.285	(0.314)
(H5) Technology diversification	0.498	(0.474)	1.080	(1.301)
(H6) Science infrastructure	0.104***	(0.029)	0.012	(0.048)
GDP	0.324**	(0.135)	0.484***	(0.141)
HR in S&T occupations	-0.015	(0.114)	-0.046	(0.118)
Prices for commercial property	-0.188*	(0.110)	-0.257**	(0.115)
Investment grants	0.230***	(0.057)	0.237***	(0.059)
Local authority trade tax	-0.609*	(0.355)	-0.688*	(0.382)
Distance to closest airport	-0.009	(0.071)	-0.036	(0.073)
Size of region	-0.381***	(0.115)	-0.298**	(0.120)
Interaction of region and firm-specific variables				
High Tech and Medium High Tech Firms				
(H1) Industry specialisation			-0.504***	(0.120)
(H2) Industry diversification			0.545	(0.273)
(H3) Foreign and WG firm agglomeration			0.099	(0.115)
(H4) Technology specialisation			0.874***	(0.260)
(H5) Technology diversification			-1.035	(0.886)
(H6) Science infrastructure			0.040	(0.032)
Large Firms				
(H1) Industry specialisation			0.262**	(0.114)
(H2) Industry diversification			-0.837	(0.598)
(H3) Foreign and WG firm agglomeration			0.272**	(0.122)
(H4) Technology specialisation			0.015	(0.273)
(H5) Technology diversification			-0.134	(0.923)
(H6) Science infrastructure			-0.003	(0.040)
Foreign Firms				
(H1) Industry specialisation			-0.077	(0.115)
(H2) Industry diversification			-0.026	(0.574)
(H3) Foreign and WG firm agglomeration			0.054	(0.133)
(H4) Technology specialisation			-0.322	(0.254)
(H5) Technology diversification			-0.033	(1.050)
(H6) Science infrastructure			0.084**	(0.033)
Multiple Entry Firms				
(H1) Industry specialisation			0.095	(0.111)
(H2) Industry diversification			0.128	(0.561)
(H3) Foreign and WG firm agglomeration			-0.184	(0.124)
(H4) Technology specialisation			-0.083	(0.255)
(H5) Technology diversification			1.529*	(0.899)
(H6) Science infrastructure			-0.038	(0.038)
Post-privatisation Entry Firms				
(H1) Industry specialisation			0.272*	(0.011)
(H2) Industry diversification			-0.404	(0.506)
(H3) Foreign and WG firm agglomeration			-0.191	(0.117)
(H4) Technology specialisation			0.096	(0.235)
(H5) Technology diversification			-1.163	(0.905)
(H6) Science infrastructure			0.072**	(0.035)
Observations	30199		30199	
Number of firms	1313		1313	
Log likelihood (null)	-4117		-4117	
Log likelihood (model)	-3661		-3621	
Chi-square	767.4		853.5	
Prob > chi2	0.000		0.000	
Pseudo R2	0.111		0.121	
AIC	7347		7327	
BIC	7455		7685	
LR-Test[1] CLM Basis vs. CLM Inter chi(30)			80	
Prob > chi2			0.0000	

Robust standard errors in parentheses *** p<0.001, ** p<0.05, * p<0.1 [1]Test without robust standard errors

First, we scrutinised the role of intra-industry technology specialisation. More specifically we test the effect of a revealed technological advantage (RTA) in terms of patenting activity. We find a positive and significant effect. This implies that a region with a RTA in a specific industry over other regions in East Germany increases the likelihood of subsequent investment of foreign and West German multinational investors in this specialised industry. Thus, hypothesis (4) cannot be rejected. Second, we analyse the impact of externalities from technology diversification of a region. In other words, we test whether a regional knowledge production that is diverse across industries increases the likelihood of subsequent investment. Yet, we find no statistical evidence that this is the case uniformly across regions and firms in East Germany. Finally, we isolate knowledge externalities related to a strong scientific and educational infrastructure. More specifically, we tested whether annual public investment grants for construction and reconstruction of higher education institutions within a region increases the likelihood of follow up private investment by foreign and West German multinational firms. In fact, we find a significant and positive effect that hints at the relevance of science-industry spillovers. Therefore, we cannot reject hypothesis (6) for East Germany.

As for the remaining standard exogenous variables in locational choice, the basic specification produced the following results. The regional market size has a positive and significant effect which is in line with the market access or demand related locational aspects (Devereux et al. 2007, Basile et al. 2008, Crozet et al. 2004, Head et al. 1999, Head and Meyer 2004).

Given that we do not expect a great deal of variation in terms of wages or unionisation rates across East German region we focus instead on the skill component of the regional labour force. In line with prior studies (Barrios et al. 2006) we expect a positive effect of the share of human resources in science and technology related occupations (HRSTO) in total employment per industry and region. Yet, we do not find any significant effect. Despite benefits from agglomeration they might also induce diseconomies for example in form of higher prices for commercial land and rents, which in turn might deter foreign entry (Barrios et al. 2006). In contrast to existing studies (Barrios et al. 2006, Guimarães et al. 2000) that use population density, we use annual regional averages for developed commercial sites as measure and find a significant negative effect on the entry likelihood of foreign and West German multinational affiliates.

In terms of public policy factors, we introduced regional variations in investment incentives as well as taxation rates. With regard to the intensity of EU co-financed investment grants (‘*GA*

Investitionszuschuss') for new private investment, investment directed at business expansion or acquisition of a firm that is facing closure, we find a positive and significant impact on the entry likelihood. This evidence is in line with other studies that find a positive effect of EU structural funds or regional development schemes on the location choice controlling for agglomeration forces and market potential (Basile et al. 2008, Barrios et al. 2006, Devereux and Griffith 1998). In contrast, our evidence shows that the level of trade tax levied by local authorities has a significantly negative impact on the location choice within East Germany, which again is in line with other studies that showed that multinationals are sensitive to taxation differentials at the sub-national level (Devereux and Griffith 1998).

We also test for the impact of the quality of regional transportation infrastructure by measuring the proximity to the next airport in line with existing studies (Barrios et al. 2006, Guimarães et al. 2000). In contrast to these studies, we do not find a robust statistically significant negative effect. Finally, we introduce in our basic specification an exogenous variable that accounts for the size of the region in terms of its surface. The results show a significant negative effect. Thus, the smaller the surface of a region is, the higher is the probability of foreign and West German entrants. That could indicate that investors prefer regions of a type that has an urban character i.e. a large central economic agglomeration and a limited periphery. Thus apart from the skill and infrastructure all other exogenous control variables show a significant and plausible effect on the likelihood of foreign and West German investors across East German regions.

Our second CLM specification introduced firm heterogeneity by interacting fixed region specific effects linked to our main exogenous variables with selected firm characteristics. Thus in line with Chung and Alcácer (2002) we are able to use this specification to test investors value components of the utility function significantly different depending on selected firm characteristics. First, we differentiate investors according to the technological intensity of the industry they belong to. More specifically we analyse whether investors in high-tech or medium-high-tech industries value our main exogenous variables differently. The results indicate that high-tech and medium-high tech investors value industry specialisation (H1) positive but less than the control group. In contrast, they place higher value on the technological specialisation (H4) compared to the control group.

Second, we differentiate large from small investors in terms of number of employees. We find that large investors place higher value on industry specialisation (H1) and existing agglomerations of foreign and West German investors (H3) compared to their control group. This evidence could suggest that large investors place higher value on externalities related to labour market pooling, vertical linkages, as well as the presence of other investors. This could be explained by their need for a higher level of external economies of scale in order to reap the full benefits from their large scale investment as well as fixed and variable administration cost (Guimarães et al. 2000). It could also be related to a higher ability or absorptive capacity of large investors to benefit from such externalities.

Third, we differentiate between foreign and West German multinational investor with regard to their valuation of locational determinants in the focus of our analysis. We find that foreign investors place higher value on the regional scientific infrastructure (H6) compared to their West German peers.

Fourth, we differentiate between investors that enter the first time into East Germany and those that have multiple entries. Interestingly firms with multiple entries value technological diversification (H5) of a region higher compared to first time single entry firms.

Finally, the interaction specification of the CLM model allows us to differentiate between investors that entered early during the privatisation process of the East German economy and those that enter at a later stage until 2006. The group of post-privatisation entries places a higher value on intra-industry agglomeration effects (H1) and the quality of the scientific infrastructure (H6).

5.6.2 Discussion

This first empirical part of the dissertation investigated whether other things equal location specific agglomeration economies in general and technology related externalities in particular play a significant role for the general location choice of foreign and West German multinationals in East German regions. This research question is based on the assumption in line with the technological accumulation approach that internationalised firms absorb spillover effects in agglomerations of foreign locations that feed back into the internal learning process of the multinational firm, which in turn contribute to the generation of technological capability as a condition for every firm in an oligopolistic industry to maintain or increase profits (Cantwell 1989).

So far, existing evidence from international studies showed mixed results. Chung and Alcácer (2002) find a negative impact of public R&D spending on location choice of MNEs in the US.

Basile et al. (2008) detect a positive impact of private sector R&D intensity per region for MNEs' location choice in European regions. Furthermore, Mariotti and Piscitello (1995) find no support for science–technology externalities. For East Germany, Spies (2010) analyses foreign investors' regional location choice at the level of federal states for the united Germany from 1997 to 2005. She argues that foreign investors perceive the East German federal states as closer substitutes to each other compared to West German federal states.

To our best knowledge, this is the first study to test jointly for the impact of regional knowledge spillover potential form technological specialisation, diversification as well as science infrastructure controlling for other agglomeration related effects in the context of sub-national location choice of multinationals. The evidence from our basic specification indicates that knowledge spillover potentials from technological specialisation as well as science infrastructure are significant locational determinants of MNEs regional location choice within East Germany. We cannot find a significant effect of technological diversification across industries within the region. Thus, it seems that technological specialisation of a region attracts multinationals across the board, whereas the effect of technological diversification does not apply uniformly across investors.

Existing survey based evidence from Thum et al. (2007) already indicated the access to higher education and research infrastructure forms an important investment motive in East Germany. This finding seems to be reinforced by our analysis. Moreover, we find that science-industry spillovers matters even more for foreign vs. West German multinational affiliates and gained significantly importance over time. Earlier studies from East Germany (Belitz et al. 1999, Thum et al. 2007) argued that the majority of foreign affiliates refer to 'advantageous local production conditions' rather than 'market access' as dominant investment motive in East Germany. Our evidence suggests that, apart from standard locational production costs associated with wages, qualification, and transportation also agglomeration related externalities form an important part of these 'advantageous local production conditions'. It has been argued that foreign investors faced high information costs in East Germany during the start of the 1990s (Brander et al. 1992, Haas 1996). Our evidence could signal that emerging agglomerations of foreign and West German mitigated such costs as suggested by other international studies (Head 1999 et al. Mariotti and Piscitello 1995, Spies 2010). In line with prior evidence (Haas 1996, Belitz et al. 1999, Thum et al. 2007, Bochow 2007) our study underlines the positive impact of investment incentives as well as the negative effect of local taxation on location choice.

So far, our findings would imply that other things equal technology related spillover potentials affect not only the internationalisation of R&D or innovation as demonstrated by Cantwell and Piscitello (2005) but the location choice of multinationals in general. In line with the international state-of-the-art (Basile et al. 2008, Chung and Alcácer 2002, Crozet et al. 2004) we tested whether this applies uniformly across different types of investors.

Our findings suggest that knowledge spillover potential from intra-industry technological specialisation matters significantly more for firms in high-tech or medium-high-tech industries compared investors in medium-low and low-tech industries. The first group, by definition, is characterised by higher R&D intensity within the industry. Therefore, we could argue that location specific technology related knowledge spillover potentials are particularly relevant for industries in which firm competitiveness depends to a large extent upon R&D inputs.

Furthermore, we find that knowledge spillover potential from technological diversification across industries within one region impacts positively on the location probability of investors that pursue a multiple entry or staged acquisition strategy in contrast to MNEs that enter the market the first time. It could be that a diversified technological structure of a region could trigger up-stream or down-stream investment of MNEs already present in the market.

The knowledge spillover potential from science infrastructure is stronger for foreign firms compared to multinationals headquartered in West Germany. This difference could be linked to the role of proximity in science-industry spillovers as the home base of West German multinationals including links to the science infrastructure is not as distant as in the case of foreign investors. Furthermore, science-industry spillover potential seems to be more important to investor that entered East Germany in the second part of the observation period after the finalisation of the privatisation process. This could indicate that in a period of liberalisation and privatisation of a host country FDI might be dominated by market access, whereas in a subsequent period with lower information cost due to existing FDI, location specific technological advantages could gain importance as locational factors.

In sum, our findings suggest that spatially distinct technological capabilities associated with regional technological specialisation of the private sector as well as public science infrastructure affect the utility maximisation of multinationals location choice significantly as suggested by the technological accumulation approach. Moreover, locational factors including technology related externalities are subject to industry and firm heterogeneity.

6. Empirical Part II: Localisation of MNEs' technological activities

6.1 Introduction and research questions

Aim of the chapter

This chapter of the dissertation sets out to investigate the extent of and motive for R&D and innovation undertaken by foreign and West German multinational affiliates based in East Germany. Furthermore, we test whether existing technology and other agglomeration related spillover potentials impact on MNEs' location choice for R&D and innovation. More specifically, we are interested in possible interaction effects of location bound potentials for knowledge spillovers and other agglomeration related externalities on MNEs choice. Furthermore, we inquire whether locational factors differ significantly depending upon the underlying motive for the internationalisation of technological activities by MNEs.

Internationalisation theory

In the internationalisation theory, we find a debate whether the location of technological activities abroad is motivated by the exploitation of an initial technological advantage of firms acquired in the home economy, or by sourcing of the host country's locational advantage in technology. The economics of the multinational firm long viewed technological innovation as being primarily generated in the home economy as an ex ante ownership advantage that could be exploited abroad (Hymer 1960, Vernon 1966, Dunning 1977). Consequently, the competence exploiting motive for FDI in R&D and innovation has long been the dominant view to characterise the nature of expatriate technological activities (Kuemmerle 1999). Yet the technological accumulation approach (Cantwell 1989, 1995, Pearce and Sing 1992a, Kuemmerle 1997) shifts the focus onto the creation of new technological competences through the international dispersion of corporate activities. Cantwell (1989, 1995) proposes a dynamic interaction between technological ownership and locational advantages. In addition to competence exploiting, investment in foreign R&D and innovation could be motivated by the desire to overcome technological weakness in the home country or to leverage new or complementary knowledge from the host country to augment MNE's technological advantage (ibid).

A considerable part of the empirical literature on the internationalisation of R&D and innovation contributed to this debate (see for example Patel and Vega 1999, Le Bas and Sierra 2002). The evidence from the largest and most innovative multinationals shows that by and large firms internationalise in areas where they enjoy an ex ante firm specific technological advantage in the home country/industry. There seems to be little evidence to suggest that firms engage in R&D and innovation abroad to overcome a technological weakness of the home industry. Although, the evidence also shows that a considerable share of foreign affiliates not only exploit but actively augment the technological advantage of the MNE (ibid).

Location choice for technological activities abroad

The technological accumulation approach suggests that locational choice of MNEs' technological activities depends upon the interrelationship between their corporate strategy and location specific characteristics (Cantwell and Piscitello 2005). Drawing from the literature on the spatial organisation of R&D (Malecki 1985, Howells 1990) as well as geography of innovation (Feldmann 1994, Audretsch and Feldmann 1996, Carrincazeaux et al. 2001) it is assumed that geographic proximity, localised knowledge spillovers, and agglomeration related externalities are highly relevant for the location pattern of foreign R&D and innovation.

Most of the existing empirical literature analysed location specific determinants for the internationalisation of R&D and innovation in MNEs at the country level (Hakanson 1992, Fors 1996, Kumar 1996, Odagiri and Yasuda 1996). This approach does not allow accounting for the sub-national dimension of locational characteristics. More recent research produced evidence that MNEs' networks for R&D and innovation conform to a geographical hierarchy of regional centres within and across countries (Cantwell and Immarino 1998, 2000, 2001, 2003, Cantwell 2000, Cantwell and Noonan 2002). The assumption is that regional agglomerations of knowledge and capabilities attract FDI in technological activities to a different extent and with a different sectoral spread, depending upon the position of the region in the geographical hierarchy (Cantwell and Immarino 1998, 2000). The evidence seems to support the hypothesis that so called 'higher order' regions that accumulate a wide ranging technological competence are more likely to attract foreign technology compared to regions that are characterised by a set of specific capabilities in some particular fields (Cantwell and Iammarino 2000).

Only a few studies exists that investigate the direct effect of knowledge spillovers on the location of MNEs technological activities at the sub-national level (Verspagen and Schoenmakers 2004, Cantwell and Piscitello 2005, 2007). Corresponding evidence confirms that knowledge spillovers related to technological specialisation, diversification, as well as science and education infrastructure within and across regions affect MNEs' localisation of technological activities significantly (ibid). In this line of research, only the study by Cantwell and Piscitello (2007) scrutinises whether locational determinants for MNEs' foreign R&D and innovation differ according to the competence exploiting or augmenting motive for technological activities implemented locally. This is based on the principal assumption that competence augmenting R&D is more supply oriented than competence exploiting R&D, and so depends upon the quality of regionally available human capital, knowledge resources, and technological opportunities (Cantwell and Mudambi 2005, Cantwell and Piscitello 2007, Narula and Zanfei 2005). In fact, Cantwell and Piscitello (2007) confirm that competences augmenting technological activities are more sensitive to regional technological specialisation as well as science-industry spillovers.

With regard to existing empirical research on East Germany, so far we find no evidence on locational determinants of foreign and West German multinational affiliates' technological activities or differences in that choice depending on the strategic nature of technological activities implemented. Yet from the technology accumulation perspective this forms an important cornerstone to understand firms' internationalisation into East German regions.

Research approach and contribution

The main contribution of the subsequent research is to test for the relevance of various location bound knowledge spillovers in their impact on the localisation of foreign and West German multinationals' technological activities across East Germany regions. This research approach follows the studies by Cantwell and Piscitello (2005, 2007). Apart from technology related knowledge spillovers we also account for the presence of and interaction with other agglomeration related externalities associated with the availability of labour or supplier structure. So far, this aspect has been largely neglected. However, it seems to be important in order to substantiate the evidence on the validity of the argument that knowledge externalities influence the location of MNEs' technological activities as suggested by the technological accumulation approach.

Furthermore, we differentiate the impact of knowledge spillovers related locational factors according to the asset exploiting or augmenting nature of R&D or innovation. Following Patel and Vega (1999) and Le Bas and Sierra (2002), we differentiate four possible technological strategies depending on a combination of home and host country technological advantages. We assume that the location choice of foreign and West German multinational affiliates is function of location specific exogenous variables at the time of entry. The valuation of specific components of the locational utility function differs according the implementation of R&D or innovation as well as the strategic nature of technological activities. We employ a conditional logit estimation procedure in order to model this location choice. We exploit survey evidence from the IWH FDI micro database 2007 as well as a rich set of secondary region and industry specific data to implement the model empirically.

Structure of the chapter

The first section reviews the theory and corresponding empirical evidence from international research on the locational determinants for technological activities of MNEs abroad. Thereby, we focus on agglomeration related factors but also discuss demand, and other location specific characteristics. We also take a look at the existing evidence on technological activities of foreign and West German multinational affiliates within East Germany and contextualise the existing findings in the light of theory. The next section introduces the research hypotheses of this chapter. The subsequent section offers new descriptive overview of the extent and nature technological activities of foreign and West German multinational affiliates using evidence from the *IWH FDI micro database 2007.* The following section introduces the theoretical model and econometric model as well as variables used to test the hypotheses. The final section presents and discusses briefly the estimation results in the context of the theory and existing evidence.

6.2 Theory and international empirical evidence

The subsequent review of theoretical perspectives on the internationalisation of technological activities takes first a look at the underlying motives for FDI into technological activities. Secondly we scrutinise the literature on location specific drivers of the internationalisation of technological activities. Thereby, we review differentiations of locational effects according to the adopted technological strategy. Each sub-section offers an overview of theoretical arguments as well as corresponding empirical evidence from existing international studies. The empirical evidence from East Germany is going to be discussed in a separate sub-section. Finally we contextualise the empirical findings in the light of the technological accumulation approach in order to set the scene for the hypotheses development of our research.

6.2.1 Motives for the internationalisation of MNEs’ R&D and innovation

A large part of the literature on the internationalisation of R&D and innovation debated the question of the underlying motive for locating technological activities abroad. The competence exploiting motive for FDI in R&D has long been the established view to characterise the nature of expatriate technological activities (Kuemmerle 1999). According to the argument, firms engage in FDI whenever they perceive they possess certain technological advantages over their competitors which are best exploited internally from a foreign location. This strategic behaviour has also been termed as asset (Dunning and Narula 1995), home-base (Kuemmerle 1996), or competence exploiting technological activity (Cantwell and Mudambi 2005).

This perspective is consistent with the predictions of the product life cycle model as proposed by Vernon (1966). He argued that having established a new product or production process in the home market, firms would subsequently export and/or locate production facilities abroad (ibid). This process would inevitably involve some foreign technological activity mainly concerned with adapting products (e.g. to account for differences in consumer taste) and production processes (e.g. to account for differences in the labour market) to suit foreign market needs (Patel and Vega 1999). According to the technology accumulation approach firms' internationalisation can not only be considered as a consequence of an already existing technological ownership advantage to be exploited in foreign markets, but also as the means of improving existing assets, or to acquire and create completely new technological assets (Cantwell 1989, 1995, Narula and Zanfei 2005). This motive to undertake investment into technological activities abroad has been labelled as strategic asset (Dunning and Narula 1995) or home base augmenting Kuemmerle (1996), as well as competence creating activity (Cantwell and Mudambi 2005). Cantwell and Piscitello (2007) suggest that asset or competence exploiting activity represents an extension of R&D work undertaken at home, while asset augmenting represents a diversification into new scientific problems, issues or areas, drawing upon local expertise.

A clear cut dichotomy between the competence exploiting and augmenting strategies of FDI in R&D has also been challenged by a number of authors. Instead, foreign technological investment may follow an evolutionary pattern starting with small investments in technical services evolving into proper R&D units performing global technology work (Ronstadt 1978). Whenever products are multi-technology-based, one firm may be marginally ahead in one technology and its competitors in another. Consequently, technological leadership can change rapidly, which partially could explain why firms often engage in both, asset augmenting and exploiting technological activities (Zander 1999, Criscuelo et al. 2005). Cantwell and Piscitello (2007) agree that any given subsidiary has a need for a variety of technologies and any given host location may possess a relative technological advantage in one area, but be relatively disadvantaged in another. Thus, an MNC in a given region may engage in both technological activities simultaneously.

Table 10 Typology of motives for FDI in foreign technological activities

Technological strength of MNE in home and host country		
	Host country	
Home country	*Strong*	*Weak*
Weak	Technology Seeking	Market seeking
Strong	Home base augmenting	Home base exploiting

Source: Le Bas and Sierra (2002), Table 1, p. 595

Home base exploiting technological activity is a combination of technological strength in the home country combined with relative technological weakness abroad aimed at exploiting the existing firm specific advantage in a foreign environment. In turn, home base augmenting strategy is associated with technological strength both, in home and host country in order to enhance the technological advantage of the MNE actively. Now in addition to the dichotomy of exploiting and augmenting, Patel and Vega (1999) and Le Bas and Sierra (2002) identify two more possible strategies. They also discriminate technology seeking FDI in R&D and innovation which is directed at offsetting home country technological weakness in a given technological field by investing in a host country with proven strength in the desired technology. Finally, the fourth strategy - market seeking FDI in R&D - is characterised by technological weakness both, at home and in the host economy. It corresponds to situations where the investment is not technology oriented but could reflect the reliance on external growth as a method of international expansion.

Attempts to assess the relative importance of the underlying motives for foreign R&D and innovation show that home base exploiting and augmenting strategies are the most important locational strategies, whereas technology seeking and market seeking strategies are rather marginal (Patel and Vega 1999, Le Bas and Sierra 2002). According to the evidence from patenting activities two thirds of foreign affiliates can be attributed to home base exploiting and augmenting strategies (see Table 11). This finding would imply that most affiliates internationalise R&D and innovation activities in areas within they enjoy an ex ante technological strength in the home country and industry. In turn, there is little evidence of affiliates that go routinely abroad to compensate for their technological weaknesses at home (technology seeking strategy) i.e. firms that internationalise without an ex ante home country/industry technological advantage.

Table 11 Motives for FDI in foreign technological activities in existing research

Type of technological activity	Patel and Vega (1999)*	Le Bas and Sierra (2002)**
	Share of cases (in %)	Share of cases (in %)
Technology seeking	10.5	17.0
Home base exploiting	36.9	31.3
Home base augmenting	39.2	35.5
Market seeking	13.4	16.1
Total	100	100

*Based on US patenting activities of 220 of the most internationalised firms in terms of technology creation from 1990 to 1996. ** Based on European patenting activities of the 350 most important MNEs in terms of patenting activity from 1994 to 1996.

Source: Le Bas and Sierra (2002), Table 5, p. 603

The market seeking strategy for FDI in R&D and innovation seems to be the least important (ibid.). Independently from the debate of the relevance of an ex ante technological advantage for the internationalisation of R&D and innovation, the empirical results also suggest that MNEs engage abroad to a considerable extent in asset augmenting technological activities. Although Patel and Vega (1999) argue that asset augmenting is often restricted to small scale centres of excellence mainly targeted at observing the competitive environment abroad.

In respect to major location specific determinants, Patel and Vega (1999) suggest that asset exploiting R&D would be attracted by the scale of the host market, asset augmenting R&D directed at monitoring competitors would be linked to the quality and scale of science and technology of the host country, whereas asset-augmenting R&D targeted at generating new technology would be determined by the quality and scale of science and technology as well as local cost advantages (ibid). Cantwell and Mudambi (2005) and Cantwell and Piscitello (2007) agree that competence exploiting R&D is primarily demand driven, and so depends upon the size and extent of differentiation in local markets, competence augmenting R&D is essentially supply driven, and so depends upon the quality of human capital and institutional knowledge based resources in a location. According to Narula and Zanfei (2005), the development of technologies abroad may benefit from diversity and heterogeneity in the host country knowledge base. Where local technological opportunities are sufficiently high, asset augmenting activities are more likely (ibid). Given this broad differentiation of locational determinants in supply and demand side conditions, we take now a closer look at the role of agglomerations, local market characteristics, and other location specific drivers of foreign technological activities.

6.2.1 Demand as location driver

The purpose of foreign owned technological activities can be theoretically linked with the support of foreign production and servicing the foreign market needs (Buckley and Casson 1976, Dunning 1988, Rugman 1981, Hennart 1996, Vernon 1966). Therefore, the location of this type of R&D will be influenced by the size of host country markets (Kumar 2001). Since adaptation can most efficiently be performed in the immediate vicinity of potential customers, companies will be induced to transfer some of their R&D abroad as soon as adaptive R&D reaches a volume sufficient to employ a minimum scale laboratory (Hakanson and Nobel 1993). A small host country market might not generate sufficient economies of scale in innovative activities related to adaptation processes geared to local market needs (Kumar 2001). Similarly a sufficient level of development of host country markets in terms of income and need for product differentiation may play a considerable role (Zejan 1990).

Cantwell and Mudambi (2005) and Cantwell and Piscitello (2007) argue that the primary function of affiliates with a competence exploiting mandate is to serve the local market. Their role is predominantly demand driven. Hence the higher the level of local demand in a location, the more incentive to undertake process improvements, as well as to differentiate output to bolster profit margins. Both of these activities lead to higher R&D intensity in the adaptation of firm's output to local conditions. Yet the primary function of affiliates with asset or competence creating mandates is principally supply driven. In this case local market characteristics should not affect location choice of R&D intensity.

The bulk of the empirical analysis on overseas R&D finds a positive and significant influence of market size and market characteristics on affiliates' R&D location choice at the national level. Several studies find significant and positive links between foreign R&D intensity or R&D location (Mansfield et al. 1979, Hirshey and Caves 1981, Zejan 1990, Hakanson 1992, Fors 1996, Odagiri and Yasuda 1996, Kumar 1996, 2001) and the size of the market as well as the level of income (Zejan 1990). Local market orientation seems to favour foreign affiliate R&D especially in developing countries (Kumar 1996, Odagiri and Yasuda 1996). Cantwell and Mudambi (2005) find evidence that the scale of local demand has a positive impact on the R&D intensity of competence exploiting affiliates. This is also the case for affiliates endowed with a competence augmenting mandate, however, to a lower extent. Studies at the regional level also confirm a positive impact of market size (Cantwell and Piscitello 2005) as well as per capita income (Cantwell and Piscitello 2005, 2007) on R&D intensity. In contrast, to the hypothesis both, competence exploiting as well as augmenting technological activities are attracted by higher regional income per capita (Cantwell and Piscitello 2007).

6.2.2 Agglomerations as location factors

It has been suggested that foreign technological activities of MNEs tend to agglomerate partly due to a random and cumulative process essentially related to certain natural advantages, but more especially due to location bound spillovers and externalities in foreign locations (Cantwell and Piscitello 2005). Managers are highly cognisant of the phenomenon of inter firm spillovers as well as the fact that a high proportion of spillovers tends to be geographically localised (Saxenian 1994). Accordingly, a number of studies assume that managers are likely to take into account future spillovers potential when making decisions regarding where to locate or to acquire new technological activities (Feinberg and Gupta 2004, Verspagen and Scheonmakers 2004, Cantwell and Piscitello 2005, 2007 etc.).

According to the literature on knowledge creation in the MNE, foreign owned R&D tends to agglomerate depending upon the potential for the three different sources of spillovers and externalities: (1) intra-industry spillovers or specialisation externalities associated with the presence of a wide ranging collection of firms active within the same sector; (2) inter-industry spillovers or diversity externalities associated with the co-presence of firms working in different sectors; and (3) science-technology spillovers and externalities associated with the existence of scientific and educational infrastructure (Cantwell and Piscitello 2005, 2007).

Intra-industry spillovers and specialisation externalities

The spatial concentration of firms engaged in similar activities or within the same sector leads to further local clustering of related firms and the local accumulation of knowledge (Braunerhjelm et al. 2000). Knowledge or technological externalities associated with localised specialisation can be related back to Marshall (1962) as one aspect of the so called agglomeration economies. Nonetheless, a specialised workforce of skilled engineers with experience in a certain field of research and specialised firms that can supply certain types of instruments/services can also constitute important inputs into the R&D process (Saxenian 1994). Therefore, an emerging spatial cluster of R&D activities may provide important advantages to the ‘members’ of such a cluster and thus a self-reinforcing process may set in that leads to strong spatial concentration (Verspagen and Scheonmakers 2004).

The second explanation for the spatial concentration is related to the nature of knowledge itself. While information is rather easy to codify, this is not the case for knowledge due to its tacit dimension (Cowan et al. 2000). According to Polyani (1967) creative acts and in particular acts of discovery depend crucially from personal feelings and commitment. Von Hippel (1994) argues that 'sticky knowledge' cannot be transferred at non-significant costs. Geographic distance hinders the exchange of tacit knowledge (Jaffe 1989, Feldman 1994, Audretsch and Feldman 1996, Jaffe et al. 1993, Jaffe and Trajtenberg 1996). From Cantwell's (1989, 1994) point of view, technological knowledge is not perceived as an immediately usable intermediate input – as in the internalisation school of thought (for example see Buckley and Casson 1976) - but rather an input into the collective learning process of the firm by which tacit capability is generated. Therefore, MNEs need to be on site with their own production and innovatory capacity if they are to benefit from the latest advances in geographically localised technological developments to feed their innovation (Cantwell 1989, Kogut and Chang 1991).

Taking both arguments - specialisation externalities and the tacit nature of knowledge – into consideration, Cantwell and Piscitello (2005) hypothesise that MNEs are more likely to locate their research activities in regions where other firms are technologically active within the same industry. However, when the local technological specialisation stems essentially from a long established presence of domestically owned firms, foreign firms might suffer from a crowding out effect for example due to the limited given stock of human capital. In that case the location of foreign technological activities might be discouraged (ibid).

Cantwell and Piscitello (2007) introduce a variation of their specialisation hypothesis. They argue that existing dominant firms disregarding ownership tend to be well connected insiders in a region. This embeddedness could facilitate the transmission of local knowledge to foreign firms. Yet, this very dominance could also restrict the access to local knowledge to foreign firms as they are new entrants into an established network. Conversely, locally non-dominant firms tend to be less well embedded in a region, but they potentially provide foreign-owned subsidiaries with a greater variety of sources of local knowledge with which to interact (Canina et al. 2005), and so can create a greater diversity of opportunities for spillovers.

Inter-industry spillovers and diversity externalities

A second source of positive spillovers stems from the variety associated to the co-presence of firms from different industries and technological fields. The more diverse the technological activity within the region, the more firms could potentially benefit. Such spillovers relate to diversity externalities which favour the creation of new ideas across sectors, and go back to the concept of 'urbanisation economies' originally suggested by Jacobs (1969). Innovative firms may benefit from technological developments in industries other than their own (Devereux et al. 2007). This may make diversified regions more attractive than narrowly specialised regions. In fact, Cantwell and Iammarino (2001, 2003) argue that inter-industry spillovers are more likely to occur in an all-round 'higher order' regions, which facilitate a more favourable interaction with indigenous firms, and greater opportunities for intercompany alliances for the purposes of technological collaboration and exchange. Here, it is possible that relationships are established between actors in otherwise quite separate alternative fields of specialisation (Cantwell et al. 2000).

Science –industry spillovers

Finally, the efforts of firms to advance technology do not proceed in isolation, but are strongly supported by public research centres, universities, industry associations, an adequate education system, and excellent science base (Breschi 2000, Kline and Rosenberg 1986, Nelson 1993, Nelson and Rosenberg 1999, Rosenberg and Nelson 1996). There is growing evidence that such science-technology spillovers tend to be spatially bounded (Acs et al. 2000, Adams 2001, Audretsch and Feldman 1996, Audretsch and Stephan 1996, Jaffe et al. 1993). This could be especially true for foreign-owned firms, which tend to have a greater degree of locational mobility when locating their corporate research, and so pay for example greater attention to being close to relevant public research facilities (Görg and Strobl 2001).

Spillover effects and the underlying motive for FDI in R&D

Cantwell and Mudambi (2005) hold that the primary function of affiliates with asset or competence creating mandates is to tap into the local knowledge and resource base to augment MNE group's overall technological strengths. This role is principally supply driven; therefore, locational condition related to technological externalities should be more relevant for affiliates engaged into asset augmenting behaviour. Cantwell and Piscitello (2007) hypothesise that knowledge spillovers related to technological specialisation of existing dominant firms (including foreign firms) as well as science-industry spillovers in a region are going to attract especially foreign technological activities characterised by competence augmenting. This is motivated by the argument that dominant firms are as insiders well embedded with sources of local expertise and so facilitate the desired knowledge spillovers to foreign firms that seek to acquire technological assets abroad. In contrast, regions that are highly populated by foreign owned firms and are characterised by a higher technological specialisation of non-dominant firms, are more likely to draw foreign competence exploiting R&D. They do expect for both types of technological activity positive spillovers from technological diversification and negative spillovers (deterrence spillovers) in regions characterised by a combination of a high share of domestic firms and a narrow technological specialisation of dominant firms.

Empirical evidence on agglomeration related factors

Overall, the existing empirical evidence demonstrates that the location of foreign owned technological activities is sensitive to agglomeration potential within regions. Cantwell and Piscitello (2005, 2007) use US patent data granted to the world's largest industrial firms in regions (NUTS-2 level) of Germany, France, the UK and Italy between 1987 and 1995. They approximate the presence of regional externalities by patent measures. Specialisation is measured by the revealed technological advantage of each region and industry in terms of patent output. Diversification has been measured by the inverse coefficient of variation over the profile of regional technological specialisation across technological fields in terms of regional patent activity.

Cantwell and Piscitello (2005) find that intra-industry spillovers have a positive and significant effect on the co-location of foreign owned technological activity. When the specialisation of the region in a particular industry is due to the presence of other domestic owned firms, the effect becomes instead negative or insignificant. Furthermore, Cantwell and Piscitello (2005) find inter-industry or diversity spillovers come out as positive and always highly significant, thus confirming that diversity externalities provide a region with a higher likelihood to attract foreign-owned technological activities. Finally, they find R&D employment in the public sector and the educational base within regions as well as in adjacent regions to constitute significant pull factors for foreign owned R&D. This is taken as evidence for the importance of science-industry spillovers.

Other evidence from regions in the UK and Italy shows that the composition of technological specialisation of foreign owned affiliates follows more closely the equivalent pattern of specialisation of domestic firms in 'lower order' regions than in 'higher order' regions (Cantwell and Immarino 1998, 2000, 2001). From this correlation it seems that in the case of 'higher order' regions diversity externalities are assumed to be the main centripetal forces drawing multinational research activities, in 'lower order' regions localisation economies seem to lead to more focused foreign participation in the overall local research efforts (Cantwell and Immarino 2001).

Finally, Cantwell and Piscitello (2007) test the effects of the various agglomeration related determinants on the location of R&D differentiating competence augmenting or exploiting activities. The authors allow that any affiliate may have some element of each strategy, whereas most previous studies (Kuemmerle 1999, Cantwell and Mudambi 2005) categorised the entirety of the R&D laboratory or the affiliate. Whenever the firm's specialisation in a certain technological field in some region and industry is matched by an absence of specialisation in the equivalent field at home Cantwell and Piscitello (2007) define the relevant patents of the affiliate as representing a diversification i.e. as asset or competence augmenting activity. If there is a positive specialisation in a field of technological activity at home and in the host region, this builds upon and enhances an existing domestic specialisation and is considered as asset or competence exploiting activity.

Cantwell and Piscitello (2007) show that collocation with dominant incumbent companies may confer positive benefits in terms of intra industry knowledge spillovers for subsidiaries with competence augmenting activities. With regard to competence exploiting activities, there seem to be positive effects from the co-location of non-dominant incumbent firms. In line with their hypothesis, they find that foreign affiliates with competence augmenting mandates are more sensitive to science-industry spillovers. For both strategies exists a positive influence of prior foreign technological activities within the region (ibid).

6.2.3 Other location specific factors

Cantwell and Piscitello (2005) suggest that regional conditions such as the availability of skilled labour in a field, financial and fiscal measures, and the regulatory and legal environment might make a region an appealing location for foreign owned MNEs to invest in research. Based on the assumption that the supply side conditions matter relatively more for affiliates endowed with an asset or competence mandate, Cantwell and Mudambi (2005) argue that the quality of general locational conditions in terms of labour skills and employment rates should have a stronger positive effect on competence augmenting vs. exploiting R&D activity.

Due to data limitation on the regional level, we find a paucity of empirical evidence from existing studies on the regional locational choice for foreign technological activities on the effects of local conditions such as human capital, technological skills, or public policy. Cantwell and Mudambi (2005) use the location of affiliates in UK regions that are classified as Assisted

Areas (either Development Areas or Intermediate Areas) as an inverse measure of overall locational quality. In fact, they find a negative effect on the assignment of a competence augmenting mandate as well as corresponding R&D intensity of such affiliates.

6.2.4 Empirical evidence from East Germany

Most of the existing empirical studies focused on differences in technological performance of East German firms depending on ownership using data from the German innovation survey or the IAB establishment panel. For example, Günther and Lehmann (2004) find that foreign owned manufacturing establishments show a higher level of R&D activity (47 per cent) compared with West German (23 per cent) and East German (11 per cent) owned peers in 2001. These differences seem also to translate into innovative performance. From 1999 to 2000, majority foreign owned establishments implemented more frequently innovations in terms of improved products (66 per cent), enhanced product range (40 per cent), as well as market novelties (30 per cent) compared to both West German and East German owned firms (Günther and Lehman 2004). The difference is most striking for innovations that are new to the market and not merely product improvements or enhancement of the products range (Günther and Gebhardt 2005). Furthermore, Günther and Gebhardt (2005) report that foreign investors clearly increased their innovation activities from 1996–97 to 1999–2000, while German owned establishments' innovation and research activities slightly decreased or over the same period.

Thus the descriptive evidence indicates that multinational affiliates perform above East German average with respect to R&D and innovation. If one controls for other firm and industry effects foreign ownership as such has no statistically significant or even a negative effect on the innovation propensity (Günther and Lehman 2004, Günther and Peglow 2007). The explanation could be that foreign affiliates are considerably larger, more prone to R&D, technically better equipped, more likely to provide training, and more export oriented, as these firm specific factors are, in fact, all significantly correlated with the propensity to innovate (Günther and Gebhardt 2005).

Another stream on the existing empirical literature focused on the geography of innovation in East Germany. Günther et al. (2009, 2009b) look at the dispersion and dynamics of innovation activities in East German counties ('*Kreise*' and '*kreisfreie Städte*') between 2002 and 2006. They measure innovative performance with an index that takes account of R&D intensity in terms of expenditure and employment, employment shares of knowledge and technology intensive branches as well as patent intensity across counties. As expected, they find considerable heterogeneity in terms of level and dynamics of innovative performance across counties in East Germany. In particular, there seem to be disparities between the Northern and Southern counties, where the latter take a lead. In the South urban areas such as Jena, Weimar, Leipzig, Dresden, and Chemnitz show an outstanding innovative performance. Nonetheless innovative performance is not restricted to urban areas as 50 per cent of rural areas mostly in the proximity of urban areas could improve their innovative performance over the period considered.

Hornych and Schwartz (2010) analyse whether regional industrial agglomerations promote innovative performance of regions in East Germany between 2000 and 2005. Their results show that industrial agglomeration in absolute terms is associated with higher regional patenting activity in East Germany. However, results using a relative measure indicate an inversely U-shaped relationship between the degree of industry specialisation and innovation. The authors find also support for a positive impact of the extent of business networks, the regional R&D employment, market size, and population density. Hornych (2008) finds in a similar study on regional innovative performance in East Germany indications that urbanisation rather than specialisation economies might play an important role.

In sum, the existing empirical evidence established that foreign and West German affiliates operate at a higher level of technological activities in terms of R&D and innovation compared to domestic owned firms in East Germany. Furthermore, the location of technological activities within East Germany is sensitive to the existence of agglomeration economies. Yet, so far we find a paucity of empirical evidence on region specific drivers of the location of technological activities by foreign and West German owned multinational firms within East Germany. Similarly, we find no evidence on the strategic nature of technological activities implemented by multinationals locally as well as corresponding differences in location choice drivers.

6.2.5 Contextualisation of existing findings in the light of theory

The review of existing empirical evidence shows that firms internationalise technological activities in areas where they enjoy a home bound technological advantage (Patel and Pavitt 1999, Le Bas and Sierra 2002). This finding is in line with the market power (Hymer 1960) or product life cycle (Vernon 1966) approach towards explaining the internationalisation of firms. In turn, there is little evidence of affiliates that internationalise technological activities also without an ex ante home country technological advantage (Patel and Pavitt 1999, Le Bas and Sierra 2002) as suggested by the technological accumulation approach towards internationalisation (Cantwell 1989, 1995).

The empirical evidence also reveals that a considerable portion of firms internationalise R&D and innovation in order to acquire, enhance, or develop new capabilities abroad, and in case of technology seeking FDI also independently from an ex ante technological advantage. In addition empirical evidence supports also the strong path dependent character of technological accumulation (Cantwell and Piscitello 2005, 2007). These empirical insights would lend support to the technological accumulation theory that assumes a dynamic interaction between corporate strategy and location specific technological characteristics as well as cumulative causation (Cantwell 1989, 1995, Cantwell and Piscitello 2005).

Technological accumulation approach (Cantwell 1989, 1995) holds that localised knowledge externalities play a crucial role as a pull factor drawing foreign R&D and innovation. The emerging body of empirical evidence confirms that the location and extent of foreign technological activity is sensitive to spatially bound knowledge spillovers induced by technological specialisation, technological diversity, as well as science infrastructure (Cantwell and Piscitello 2005, 2007).

Most authors agree that, theoretically, the location of asset exploiting technological activities is in principal demand and asset augmenting supply driven (Patel and Vega 1999, Cantwell and Mudambi 2005, Narula and Zanfei 2005, Cantwell and Piscitello 2007). So far, there is only one empirical study that investigates this general hypothesis on the regional level of analysis. In fact, Cantwell and Piscitello (2007) are able to show that competence augmenting is more responsive to science-industry spillovers as well as collocation with dominant incumbent companies within the same industry. In contrast, competence exploiting seems to be positively related to specialisation of non-dominant incumbent firms. Both activities are attracted by externalities from regional technological diversification. In contrast to the assumption, both technological strategies react similarly to local demand characteristics (ibid).

Most existing empirical contributions in this line of research rely on patent statistics to calculate measures to proxy inter firm spillovers (Verspagen and Schoenmakers 2004, Cantwell and Piscitello 2005, 2007). These measures form a good indicator for location specific potential for technology related knowledge spillovers. Nevertheless the models applied to estimate the statistic effect of such spillovers do not explicitly account for the impact of other agglomeration externalities related to labour or industry structure. Although externalities associated with specialisation (Marshall 1962) and urbanisation (Jacobs 1969) could also affect the location choice for technological activities. Due to data limitation on the regional level, current empirical studies (Verspagen and Schoenmakers 2004, Cantwell and Piscitello 2005, 2007) do not also account for the potential effects of other local conditions such as human capital, technological skills, or public policy. The failure to account for their influence could lead spurious findings with regard to the significance of technology related knowledge externalities as locational determinant for MNEs' technological activity.

Furthermore, there could be an important interaction between technology related and other spatially bound externalities in their impact on the locational choice for foreign R&D and innovation. For example, are there any additional effects from the combination of technological and specialised labour within the sector and region? Or, does technological diversification only matter if the firm is based in a sector and region that is characterised by intra-industry specialisation with regard to labour or specialised supplier base?

In addition, existing studies deal conceptually with the location of foreign owned technological activities, but in fact estimate the effect of various exogenous factors on the intensity of patenting (Cantwell and Piscitello 2005, 2007). Patent measures offer clear advantages for example with regard to their international standardisation and time series availability (Grilliches 1990, Pavitt 1985, 1988). It is well known that patents capture only a part of technological activities as not all innovations are patented and not all patents are commercialised (ibid.). Therefore, affiliate level information on R&D or innovation activity might be an alternative measure for technological activity. In addition, existing estimation approaches rely only on location information from patenting firms, the location pattern of non-patenting firms is not considered. This omission could introduce a potential estimation bias into the research. For example, technology related agglomeration externalities might be statistical significant factors for location choice in general, and not specific to the location of technological activities. Therefore, we would suggest an alternative approach, in which we test for differences in the statistical significance of locational determinants for technological active vs. non-technological active affiliates.

From our point of view, such extensions of existing models could enhance our understanding of the impact of the new economic geography in general and technology related knowledge externalities in particular on the location choice for MNEs' foreign R&D and innovation. The adopted approach is able to shed more light on the interaction of corporate strategy and locational advantages as suggested by the technological accumulation approach. In this way we are also able to fill the gap of empirical evidence on location specific determinants of technological activities by foreign and West German multinational firms within East Germany.

6.3 Hypotheses

According to the technological accumulation theory knowledge externalities are central in explaining the location of technological activities by MNEs as well as the expansion of MNEs as such from a dynamic point of view (see for example Cantwell 1989, 1995). The interaction between corporate strategy and location specific technological advantages is facilitated by the exchange of specific knowledge in an environment characterised by agglomerations of other firms as well as a competitive public science and education infrastructure. The emphasis is on knowledge externalities generated from a specialised and heterogeneous knowledge structure available within a specific region[17]. Following Cantwell and Piscitello (2005, 2007), we test for the effect of three principal sources for knowledge spillovers on the location of technological activities by foreign and West German MNEs within East German regions. We hypothesise that:

(1) *Other things equal, foreign and West German multinational affiliates are more likely to locate technological activities in regions, where they are able to benefit from a potential for knowledge externalities from technological specialisation within their sector of activity.*

(2) *Other things equal, foreign and West German multinational affiliates are more likely to locate technological activities in regions, where they are able to benefit from a potential for knowledge externalities from technological diversification across different industrial sectors.*

(3) *Other things equal, foreign and West German multinational affiliates are more likely to locate technological activities in regions, where they are able to benefit from a potential for knowledge externalities from public science and research.*

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[17] It is important to remember that specialisation and diversification advantages are not two extreme ends of the same measure. Instead they can exist next to each other. One region might show a relative technological advantage in one particular field in comparison to all other regions and still by might characterised by a relative high diversity across technological fields within the region.

It has also been suggested that a specialised workforce of skilled engineers with experience in a certain field of research as well as a concentration of specialised supplies of intermediate goods and services can constitute important inputs into the R&D process (Saxenian 1994). Consequently there is good reason to assume that there are positive externalities from intra-industry specialisation that is not directly related to technological sector specific expertise but other more general agglomeration. Therefore, we hypothesise that:

(4) *Other things equal, foreign and West German multinational affiliates are more likely to locate technological activities in regions, where they are able to benefit from a potential for externalities from general specialisation within their sector of activity.*

Similarly, knowledge externalities from technological diversification form part of the so called urbanisation economies a concept that can be related back to Jacobs (1969). He argues that firms may benefit from externalities arising in regions with a diverse industrial structure (ibid). For example, diversified region may offer a critical mass or density of economic activity rather than a narrow specialised industrial specialisation, which could be advantageous for the implementation of multi-technology based R&D and innovation requiring inputs from a variety of sources (labour, supplier) present in the region. This may make regions that are in general industrially diversified more attractive than specialised regions. Therefore, we hypothesise

(5) *Other things equal, foreign and West German multinational affiliates are more likely to locate technological activities in regions, where they are able to benefit from a potential for externalities from a general diversity across different industrial sectors.*

The question now emerges as to whether there are any additional benefits from the interaction of technology related knowledge spillovers and other industrial agglomeration related externalities. For example, if we assume that a firm locates in a region due to general industry specialisation, this environment could be characterised by simultaneous technological specialisation and diversification. If general industrial specialisation is match by technological specialisation or diversification we would expect that the affiliate is more likely to be in the position to exploit technological opportunities

(6) *Others things equal, foreign and West German multinational affiliates are more likely to locate technological activities in a region, where they are able to benefit from a combination of spillover potential from general industry specialisation and technology related knowledge specialisation within their sector of activity.*

(7) *Others things equal, foreign and West German multinational affiliates are more likely to locate technological activities in a region, where they are able to benefit from a combination of spillover potential from general industry specialisation and technology related knowledge diversification across different industrial sectors.*

Similarly, we would expect that a firm reaps additional benefits if it locates technological activities in a region offering externalities from general industry diversification as well as knowledge externalities from technological specialisation. This way it can combine benefits from the presence of heterogeneous labour and supplier structure with a specialised sector specific technological knowledge base within the region. Therefore, we hypothesise:

(8) *Others things equal, foreign and West German multinational affiliates are more likely to locate technological activities in a region, where they are able to benefit from a combination of spillover potential from general industry diversification and knowledge specialisation.*

If benefits from general industry diversification within a region are matched by knowledge diversification, we would assume that this effect could confer additional positive location effects to firms' technological activities. Such a setting could be present in so called 'higher order' regions. It has been argued that in such region inter-firm spillovers are more likely to occur, which facilitate a favourable interaction with indigenous firms, and greater opportunities for intercompany alliances for the purposes of technological collaboration and exchange across sectors in otherwise quite separate alternative fields of specialisation (Cantwell and Iammarino, 2001, 2003, Cantwell et al. 2000). Therefore, we hypothesise:

(9) *Others things equal, foreign and West German multinational affiliates are more likely to locate technological activities in a region, where they are able to benefit from a combination of spillover potential from general industry diversification and knowledge diversification.*

Hypotheses (1) to (3) are a replication of the research implemented by Cantwell and Piscitello (2005, 2007). The hypotheses (4) and (5) are novel and control for the impact of other general agglomeration effects with regard to specialisation or diversification. The potentially most insightful contribution to the existing body of research comes from hypotheses (6) to (9) which test for possible interactions between technology related and other agglomeration externalities on the foreign location choice for MNEs technological activities at the regional level.

6.4 Descriptive analysis

The subsequent section gives a descriptive overview of technological activities in foreign and West German multinational affiliates in terms of R&D and innovation indicators, strategic approaches towards technological strategies implemented, as well as regional distribution and sectoral specialisation of technological activities.

6.4.1 R&D employment and expenditure

In the survey, foreign and West German affiliates indicated the number of R&D employees in the year 2002 and 2005. From all affiliates that participated in the survey, 36 per cent had R&D employment in the year 2002 (see Table 12). This increases to 56 per cent for 2005. In 2002, the affiliates had on average 6.31 R&D employees which equates on average to a share of 8.87 per cent in total employment per firm. For 2005, we observe on average of 8.00 R&D employees per firm which corresponds to a share of 10.98 per cent of total employment per firm. If we calculate the total number of R&D employees across all firms over total employment (in aggregate), the share increased from 5.00 per cent in 2002 to 6.40 per cent in 2005. From all affiliates that participated in the survey about 50 per cent had R&D expenditures in the year 2002. This increased to about 60 per cent in 2005. In 2002 each foreign and West German affiliate spent on average about 733,000 Euro on intra and extramural R&D, which increased to about 846.000 Euro in 2005.

Table 12 R&D employment and expenditure indicators of multinational affiliates

	2002		2005	
All affiliates	*n*		*n*	
R&D employment*				
Share of affiliates with R&D employment (in %)	295	35.59	295	53.56
Average no. R&D employees per firm	209	6.31	281	8.00
Average share of R&D employees in total employment p. firm (in %)	209	8.87	281	10.98
Share of R&D employees of total employment (aggregate) (in %)	209	5.00	281	6.40
R&D expenditures**				
Share of affiliates with R&D expenditures (in %)	295	49,83	295	60,34
Average annual R&D expenditure per firm (in Euro)	168	732.831	198	846.339
Average share of R&D expenditure in turnover per firm (in %)	147	6,01	195	6,89
Share of R&D expenditure in total turnover (aggregate) (in %)	160	3,41	193	3,34

Note: *R&D employment refers to the total number of technical and scientific personnel (headcount) dedicated at all R&D activities undertaken on the affiliate level (see Annex Codebook v11_1a/b). **R&D expenditures refer to all annual intra-mural and extramural expenditures on the level of the affiliate (see Annex Codebook v19_2a/b). n for R&D expenditures varies due to missing values in the reference value (turnover).

Source: IWH FDI micro database – Survey 2007, author's calculations

This corresponds to 6.01 per cent and 6.89 per cent of total turnover on average per firm respectively. If we compute the corresponding aggregates, we find that R&D expenditures stand at 3.41 per cent of total turnover in 2002 and at 3.34 per cent in 2005. In respect to differences in R&D according to ownership, we find that R&D activity in terms of employment as well as expenditures is more frequent in West German multinational compared to foreign owned affiliates (see Annex Table A29 and Table A30, p. 235). Although the share of R&D employees in total employment per firm is similar, in aggregate the share of R&D employees in total employment is almost double for West German multinational affiliates. Yet, the average R&D expenditure per firm absolute and also relative as the share in turnover per firm is higher for foreign owned affiliates.

It should be noted that we observe for 2002 as well as 2005 that the share of affiliates with R&D expenditures is considerably above the share of affiliates with R&D employment. The difference is explained by the fact that the measure used for R&D expenditure refers to intra-mural and extramural expenditures on the level of the affiliate. R&D employment is accounted for by intra-mural expenditures. Thus, there is a certain share of affiliates in 2002 (about 14 per cent) and 2005 (about 7 per cent) that has no R&D employment but extra-mural R&D expenditures for example on R&D services provided by other units of the multinational network or external firms.

If we compare R&D by foreign and West German manufacturing affiliates to indicators for total manufacturing in East Germany, we find for foreign and West German affiliates a much higher frequency of R&D activity in terms of R&D employment as well as expenditures. However, corresponding R&D intensities are considerably lower compared to the total East German manufacturing. According to the IAB establishment panel, only 12 per cent of all manufacturing firms in East Germany reported own R&D activity in 2004. In contrast, R&D intensity in terms of employment (aggregate) for the total East German manufacturing stands 8 per cent (Euronorm 2007), which is clearly above the intensities for foreign and West German affiliates as reported above (5.0 and 6.4 per cent). The picture is very similar if we look R&D intensity in terms of expenditure (aggregate). There we find for the East German manufacturing R&D expenditures of 13 per cent of turnover (Euronorm 2007), which again exceeds by far the values foreign and West German affiliates reported above (3.09 and 3.24 per cent). It has been suggested that the comparatively low R&D intensity of foreign and West German affiliates can partially be explained by differences in the size structure (Günther and Gebhardt 2005). The average firm size in the underlying population of foreign and West

German multinational owned firms is 200 employees (see Annex Table A24, p. 232). This is about 13 times as much as the average number of employees for the East German manufacturing which stand at about 16 employees. It is a typical empirical phenomenon that R&D intensity is higher in small and medium sized firms than in large firms (see e.g. Janz 2003, Kleinknecht 1989). Therefore, our findings with regard to R&D activity and intensities of foreign and West German multinational affiliates are in line with prior research on East Germany (Günther and Gebhardt 2005).

6.4.2 Innovation activity, intensity, and output

In the survey, affiliates were asked to indicate whether they have implemented innovation activities during the period from 2002 to 2005. In line with the Oslo Manual (2005), we differentiated between four different types of innovation activity: product, process, marketing, and organisational innovation. The results show that 70.8 per cent of affiliates were product innovators and 70.2 per cent have introduced new or improved processes (see Table 13). These are fairly high proportions if we compare these indicators to the total East German manufacturing. According to the Mannheim Innovation Panel (MIP), the shares of firms undertaking product or process innovations during the years 2003 to 2005 in total East German manufacturing constitute 47 per cent and 31 per cent respectively. The higher innovation activity of foreign and West German multinational affiliates is partially explained by the differences in the underlying reference period that is in case of the *IWH FDI micro database* four years (2002 to 2005) and for the MIP only three years (2003 to 2005).

Table 13 Share of multinational affiliates with innovation activities

	Share of innovators 2002 – 2005*					
	n	Product	Process	Marketing	Organisation	All
All affiliates	295	70.8	70.2	49.2	61.0	29.8
Foreign affiliates	222	68.9	68.9	50.5	65.8	29.7
West German affiliates	73	76.7	74.0	45.2	65.8	30.1

Note: *Innovations should be new for the affiliate not necessarily for the market. It does not matter, whether the innovation has been developed by the affiliate on its own or in cooperation with other firms or scientific institutions. A product innovation is defined as the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics (see Annex Codebook v18_1). A process innovation is defined as the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software (see Annex Codebook v18_2). A marketing innovation is defined as the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing (see Annex Codebook v18_31). An organisational innovation is defined as the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations (see Annex Codebook v18_4).

Source: IWH FDI micro database – Survey 2007, author's calculations

The results from the IWH survey also show that foreign and West German multinational affiliates engage into marketing innovations (49.23 per cent) and organisational innovations (61.0 per cent) (see Table 13). About 30 per cent of foreign and West German affiliates engaged into all four different types of innovations of the period from 2002 to 2005. With regard to differences between innovation activity and firm ownership, we find that West German multinationals show a higher share of product and process innovators in comparison to the foreign group (see Table 13). The situation is reversed with regard to marketing innovations. In terms of innovation scope we principally do not find any considerable differences between the two ownership groups.

Our evidence compares well with prior research exploiting the IAB establishment on East German manufacturing, which already indicated that West German but especially foreign owned firms implement more frequently product innovations compared to East German establishments (Günther and Lehman 2004, Günther and Gebhardt 2005). However, we cannot confirm considerable differences between foreign and West German ownership from our sample. This is most likely related to the fact that the *IWH FDI micro database* and IAB establishment panel use different definitions of West German ownership. The latter considers majority owned establishments which are headquartered in West Germany. Whereas, the *IWH FDI micro database* considers firms that have a direct or indirect ownership of a parent that is headquartered in West German and a MNE i.e. it has at least one foreign affiliate outside Germany. This 'multinational' sub-group tends to be much larger in terms of average employment and turnover, which could explain a higher innovation propensity.

The foreign and West German multinational affiliates have also been asked to evaluate their intensity of innovation activities in comparison to the competitors in the relevant market for each innovation type. Our results show that about 49 per cent of all affiliates consider their own product innovation intensity above or far above the level of innovation intensity of their competitors in the main market (see Table 14). The share stands at 47 per cent for process innovation, 39 per cent for marketing innovations, and 38 per cent of organisational innovations.

Table 14 Share of innovating affiliates with high innovation intensity

	Product	Process	Marketing	Organisation
All innovators	49.28	47.83	39.31	37.78
Foreign owned innovators	52.94	45.10	40.18	38.64
West German owned innovators	39.29	55.56	36.36	35.42

Source: IWH FDI micro database – Survey 2007 (see Annex Codebook v18_1a, v18_2a, v18_3a, v18_4a), author's calculations

The innovation intensity seems to be higher for foreign affiliates in comparison to their West German multinational peers in all but process innovation. Interpreting this indicator, we have to take into consideration that the competitive environment of affiliates differs considerably across product and geographic markets. Another more common indicator to assess the innovation intensity is the share of new or considerably improved products in annual turnover. The affiliates indicated in the survey the share for 2002 and 2005. From this we learn that the average share of turnover derived from product innovations is about 25 per cent across all foreign and West German affiliates in 2005 (see Table 15).

If we compute this as an aggregate it amounts to 26 per cent of total turnover of all affiliates. It seems that foreign affiliates tend by and large to show slightly higher shares of innovative output for both years. MIP results show that the innovation output of total East Germany manufacturing stands at 22 per cent (ZEW 2007).

Table 15 Multinationals affiliates' share of innovative output in annual turnover

		2002		2005
All affiliates	n		n	
Average share of innovative output per firm (in %)	181	22,83	257	25,19
Share of innovative output in aggregate (in %)	168	14,96	240	25,97
Foreign affiliates				
Average share of innovative output per firm (in %)	131	24,88	193	25,86
Share of innovative output in aggregate (in %)	119	13,55	177	26,28
West German multinational affiliates				
Average share of innovative output per firm (in %)	50	17,46	64	23,17
Share of innovative output in aggregate (in %)	49	23,16	49	23,23

Source: IWH FDI micro database – Survey 2007 (see Annex Codebook v20a/b), author's calculations

Thus, it seems that on a descriptive level not only the level of innovation activity but also of innovation output is higher for foreign and West German multinational affiliates compared to the rest of East German manufacturing firms.

6.4.3 Asset exploiting and augmenting strategies

Apart from standard R&D and innovation indicators, the *IWH FDI micro database* offers also information on the governance and strategic aspects of technological activities that are specific to MNEs. For example, foreign and West German multinational affiliates indicated to what extent technology related business functions are undertaken only by the affiliate, mainly by the affiliate, mainly by the investor, or only by the investor. This seems to us a possible indicator for the degree of centralisation and control over technological activities within the MNE. Thereby, we differentiate between basic and applied research, product, and process development as technology related business functions. If we consider the extent of centralisation for the whole sample, we find that process development is least centralised, followed by product development, and basic and applied research (see Table 16). About 41 per cent of affiliates indicate that they have an exclusive mandate to deal with process development. This applies to 36 per cent and only 28 per cent of affiliates for product development and basic and applied research respectively. Furthermore, we find only fairly low shares of affiliates that indicate that technology related business functions are only undertaken by the investor.

Table 16 Centralisation of technology related business functions in affiliates

Business function exercised by....	only affiliate	mainly affiliate	mainly investor	only investor	Not available
All affiliates (n=295)					
Basic and applied research*	28.47	17.97	16.95	25.08	11.53
Product development**	35.93	20.00	17.63	18.98	7.46
Process development***	40.68	23.73	17.63	11.19	6.78
Foreign affiliates (n=222)					
Basic and applied research	29.73	15.32	17.57	24.77	12.61
Product development	37.39	18.92	16.22	18.92	8.56
Process development	42.34	22.52	18.02	9.91	7.21
West German affiliates (n=73)					
Basic and applied research	24.66	26.03	15.07	26.03	8.22
Product development	31.51	23.29	21.92	19.18	4.11
Process development	35.62	27.40	16.44	15.07	5.48

Note: ***Basic and applied research** comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge to devise new applications (see Annex Codebook v14_3). **Product development refers to product innovations, which are new or significantly improved goods or services with respect to their characteristics (technical specifications, components, materials, incorporated software) or intended uses (user-friendliness etc.). The product must be new to your firm not necessarily to the market! (see Annex Codebook v14_4)***Process development refers to new or improved production methods (e.g. computer-assisted design) or delivery methods (e.g. bar-coded goods-tracking system.) including changes in techniques, equipment and/or software (see Annex Codebook v14_5).

Source: IWH FDI micro database – Survey 2007, author's calculations

This applies to 25 per cent of affiliates in respect to basic and applied research and to 19 per cent and 11 per cent for product and process development respectively. This general order of de/centralisation amongst the three technology related business functions applies equally to foreign as well as West German affiliates.

The survey provides also data on technology related knowledge flows between the MNE group and the affiliate. Affiliates indicated the importance of headquarters and other units of the MNE group as knowledge sources for R&D and innovation for the affiliate in question. This seems to be a suitable indicator to what extent the MNE group exploits its existing technological advantage in affiliates located in East Germany. Firms indicated the importance for the time of the entry of the multinational investor as well as today (time of implementing the survey in 2006). About 40 per cent of affiliates across the sample indicate that headquarters is an important source of technological knowledge for the affiliate at the time of the entry (see Table 17).

Table 17 HQs' importance as source of technological knowledge for affiliates

	Share of affiliates (in %)		
All affiliates (n=295)	Important*	Not important**	Not available
At entry	40.00	46.44	13.56
Today	38.31	48.81	12.88
Foreign affiliates (n=222)			
At entry	36.49	48.20	15.32
Today	31.53	49.55	18.92
West German affiliates (n=73)			
At entry	50.68	41.10	8.22
Today	45.21	46.58	8.22

Note: *Includes responses that indicated: important, very important, extremely important ** Includes responses that indicated: low importance, not important (see Annex Codebook v22_3a/b).

Source: IWH FDI micro database – Survey 2007, author's calculations

Yet, the importance declined over time as the share stands only at 38 per cent today. Furthermore, it seems that the level of headquarter importance is higher for the group of West German multinational firms, but that the trend over time applies equally to both. The level of importance of other MNE-group units seems to be lower in comparison to headquarters. Only about 16 per cent of affiliates indicated that these are an important source of technological knowledge (see Table 18). Yet, the level of importance follows a different trend over time as it increases to about 20 per cent until today. This pattern applies equally to foreign and West German multinational firms.

Table 18 Other MNE units' importance as source of technological knowledge for affiliates

	Share of affiliates (in %)		
All affiliates (n=295)	Important*	Not important**	Not available
At entry	15.93	64.41	19.66
Today	20.00	61.36	18.64
Foreign affiliates (n=222)			
At entry	15.32	63.96	20.72
Today	20.27	60.36	19.37
West German affiliates (n=73)			
At entry	17.81	65.75	16.44
Today	19.18	64.38	16.44

Note: *Includes responses that indicated: important, very important, extremely important ** Includes responses that indicated: low importance, not important (see Annex Codebook v22_4a/b).

Source: IWH FDI micro database – Survey 2007, author's calculations

Thus, there is descriptive evidence that affiliates located in East Germany exploit existing technological assets of MNEs. It seems that a large part but not the majority of foreign and West German multinational affiliates draws on the existing technological advantage that lies with the headquarter of the group but less so from other units of the MNE group. Over time, the importance of headquarters seems on average to decline, whereas the importance of other MNE-group units on average increases.

The survey also holds information about the importance of the affiliate itself as a source of technological knowledge for headquarters and other units of the MNE group. This information could be taken as an indicator to what extent affiliates actively augment existing technological assets of the MNE.

Table 19 Affiliates' importance as source of technological knowledge for headquarters

	Share of affiliates (in %)		
All affiliates (n=295)	Important*	Not important**	Not available
At entry	40.68	51.53	7.80
Today	59.32	32.88	7.80
Foreign affiliates (n=222)			
At entry	43.24	46.85	9.91
Today	58.11	31.98	9.91
West German affiliates (n=73)			
At entry	32.88	65.75	1.37
Today	63.01	35.62	1.37

Note: *Includes responses that indicated: important, very important, extremely important ** Includes responses that indicated: low importance, not important (see Annex Codebook v23_1a/b).

Source: IWH FDI micro database – Survey 2007, author's calculations

Looking at the importance of affiliates as source of technological knowledge for headquarters, we find that 41 per cent consider themselves as an important source already at the time of the entry of the investors (see Table 19). Until today, this share has been increasing considerably to 59 per cent. This increase is even more pronounced for West German multinational affiliates. The level of affiliates' importance as source for technological knowledge for other units of the MNE group is lower in comparison to headquarters as knowledge receivers. However, it follows a similar trend over time. The share of affiliates that consider themselves as an important source for technological knowledge increased from about 23 per cent at the time of entry to currently 39 per cent (see Table 20). Again, we find this trend slightly more pronounced for West German multinationals. Thus, there seems to be descriptive evidence from the survey that multinational affiliates located in East Germany also augment existing technological assets of the MNE group.

Table 20 Affiliates' importance as source of technological knowledge for other MNE units

	Share of affiliates (in %)		
All affiliates (n=295)	Important	Not important	Not available
At entry	23.05	63.39	13.56
Today	38.98	48.14	12.88
Foreign affiliates (n=222)			
At entry	24.32	58.56	17.12
Today	37.39	45.95	16.67
West German affiliates (n=73)			
At entry	19.18	78.08	2.74
Today	43.84	54.79	1.37

Note: *Includes responses that indicated: important, very important, extremely important ** Includes responses that indicated: low importance, not important (see Annex Codebook v23_2a/b).

Source: IWH FDI micro database – Survey 2007, author's calculations

Since entry, the importance of asset augmenting technological activities has been increasing considerably. Today the share of affiliates that implements asset augmenting type of behaviour is higher compared to affiliates which indicated asset exploitation type of activities. The question is now remains what is the relation between asset exploiting and augmenting behaviour in affiliates located in East Germany? Therefore, we select from the sample a sub-group that considers itself as important source of technological knowledge for headquarters today and analyse their asset exploitation behaviour.

Table 21 HQs' importance as source of technological knowledge for asset augmenting affiliates

	Share of asset augmenting affiliates (in %)		
All affiliates (n=176)	Important*	Not important**	Not available
At entry	59,09	34,09	6,82
Today	73,30	19,89	6,82
Foreign affiliates (n=130)			
At entry	60,00	33,85	6,15
Today	71,54	22,31	6,15
West German affiliates (n=46)			
At entry	56,52	34,78	8,70
Today	78,26	13,04	8,70

Note: *Includes responses that indicated: important, very important, extremely important ** Includes responses that indicated: low importance, not important (see Annex Codebook v23_1a/b and v22_3a/b).

Source: IWH FDI micro database – Survey 2007, author's calculations

It turns out that for affiliates with asset augmenting type of technological activities headquarters is an important source of technology. This applies already at the time of entry of the investor for 59 per cent of affiliates (see Table 21), which is considerably above the 40 per cent average for the total sample (see Table 17 above). Furthermore, this share continued to rise. So that today about 73 per cent of affiliates with asset augmenting type of technological activities hold the position that their headquarters is an important source of technological knowledge. Thus, this could indicate that asset augmenting type of behaviour goes hand in hand with increasing technology exploitation type of technological activities. This empirical finding would be in line with authors that questioned the mutual exclusivity of the two technological strategies for an affiliate as a unit (Zander 1999, Criscuelo et al. 2005, Cantwell and Piscitello 2007).

In order to take also account of the relation of home and host technological advantages when differentiating strategic approaches towards technological activities, we use the typology developed by Patel and Vega (1999) and Le Bas and Sierra (2002). They discriminate four types of strategies: technology seeking (type 1), home base exploiting (type 2), home base augmenting (type 3), and market seeking FDI in R&D (type 4). The differentiation of strategies is the result of four possible configurations of technological strength and weakness in the respective sector or field in the home and host country. We use the indicators of the importance of the headquarters as a technological source of knowledge for the affiliate as proxy for the relative corporate technological strength in home country and the importance of the affiliate as a technological source of technological knowledge for headquarters as proxy for relative technological strength of the host country (East Germany) to differentiate the four types of technological strategies empirically.

Table 22 Underlying motives for internationalisation of technological activities

	Share of affiliates (in %)				
	Type 1	Type 2	Type 3	Type 4	Not available
All affiliates (n=295)	32.54	19.66	12.20	21.36	14.24
Foreign affiliates (n=222)	34.68	18.92	9.91	20.27	16.22
West German affiliates (n=73)	26.03	21.92	19.18	24.66	8.22

Source: IWH FDI micro database – Survey 2007 (see Annex Codebook v23_1a/b and v22_3a/b)*, author's calculations*

We find that about 33 per cent of affiliates following a technology seeking strategy (type 1), about 20 per cent implement an home base exploiting strategy (type 2), 12 per cent of affiliates conduct a home base augmenting strategy, and about 21 per cent follow market seeking technological activities (see Table 22). In contrast to the empirical findings of Patel and Vega (1999) and Le Bas and Sierra (2002), we find for East Germany a much higher share of technology seeking especially in the case of foreign affiliates. Given this finding, it could be argued that a sizeable part of firms internationalise technological activities to East Germany in order to overcome technological weaknesses at home. This finding would support the argument made technological accumulation approach (Cantwell 1989, 1995). If we take technology seeking and home base augmenting strategies together, about 45 per cent of multinational affiliates actively draw from the technological strength of East Germany. This is a thin majority over the 41 per cent (type 2 and 4) that predominantly exploit an ex ante technological advantage of the home country. This close balance would be in line with the findings by Patel and Vega (1999) and Le Bas and Sierra (2002).

6.4.4 Regional specialisation of technological activities

In order to analyse on a descriptive level the regional technological specialisation of foreign and West German multinational affiliates in the sample, we calculate two measures. First, we use the revealed technological advantage of each industry (NACE 2 digit level) within a region ('*Raumordnungsregion'*) as specialisation indicator. Second, we use the inverse Herfindhal index as a measure of diversification across industries for each region. We calculate the measures for the incidence of R&D expenditure in the years 2005 as well as for the incidence of product innovation during the period 2002 to 2005 as indicated by foreign and West German multinational affiliates. Thus, we calculate the specialisation patterns using data of a sub-group of affiliates from the total sample that are R&D active or product innovators.

In terms revealed technological advantages (RTA), we find across East German very distinct specialisation patterns across regions. If we look at the top industry with the highest RTA per region, we find for 13 regions the same industry both for the specialisation in R&D or product innovations (see Table 23). In nine regions (Uckermark-Barnim, Oderland-Spree, Oberlausitz-Niederschlesien, Dessau, Südthüringen, Westmecklenburg, Prignitz-Oberhavel, Halle/S., Nordthüringen) the most specialised industry differs depending on the indicators (R&D or product innovation). If we look at the diversification measures of R&D and product innovation activity a North-South division across East Germany emerges (see Table 23).

Table 23 Regional specialisation and diversification of affiliates' R&D and innovation

	R&D expenditure (n = 172)			Product innovation (n=209)		
Region	NACE Top Industry *	No. of specialised industries**	***HF - Index	NACE Top Industry	No. of specialised industries	HF - Index
Westmecklenburg	36	3	0,33	20	5	0,20
Mittleres	20	3	0,33	20	6	0,17
Vorpommern	35	5	0,20	35	5	0,20
Mecklenburgische Seenplatte	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Prignitz-Oberhavel	37	4	0,25	20	4	0,25
Uckermark-Barnim	21	3	0,17	20	4	0,14
Oderland-Spree	26	1	1,00	27	2	0,50
Lausitz-Spreewald	35	3	0,33	35	5	0,20
Havelland-Fläming	35	4	0,14	35	6	0,08
Berlin	22	7	0,05	22	7	0,03
Altmark	24	1	0,25	24	1	0,25
Magdeburg	34	7	0,10	34	6	0,07
Dessau	31	7	0,06	27	8	0,07
Halle/S.	37	5	0,09	26	6	0,04
Nordthüringen	37	3	0,17	31	4	0,14
Mittelthüringen	30	8	0,03	30	7	0,02
Südthüringen	31	6	0,08	28	7	0,08
Ostthüringen	17	8	0,02	17	7	0,02
Westsachsen	21	5	0,02	21	5	0,01
Oberes Elbtal/Osterzgebirge	27	8	0,02	27	7	0,02
Oberlausitz-Niederschlesien	29	5	0,05	21	5	0,05
Chemnitz-Erzgebirge	18	5	0,20	18	7	0,13
Südwestsachsen	18	10	0,07	18	10	0,07

Note: *NACE 2-digit industries with highest value across all industries within the region. **Number of NACE 2-digit industries with RTA value above 1. *** Inverse of the Herfindhal-Index. A high value indicates a high concentration or low diversification of R&D or innovation activity with the respective regions. Please see for a comprehensive overview of RTA values Table A27, p.233 and A28, p.234.

Source: IWH FDI micro database – Survey 2007, author's calculations

The 11 regions in the South and South West (Ostthüringen, Westsachsen, Oberes Elbtal, Mittelthüringen, Berlin, Oberlausitz-Niederschlesien, Dessau, Südwestsachsen, Südthüringen, Halle/S.) tend to be most diversified, whereas the 12 regions mostly in the North of East Germany (Magdeburg, Havelland-Fläming, Uckermark-Barnim, Nordthüringen, Vorpommern, Chemnitz-Erzgebirge, Prignitz-Oberhavel, Altmark, Westmecklenburg, Mittleres Mecklenburg/Rostock, Lausitz-Spreewald, Oderland-Spree) tend to be much less diversified. The most diversified regions consequently show also a higher number of industries that are characterised by a revealed technological advantage.

6.4.5 Summary

Summarising the descriptive findings on technological activities so far, we find in line with prior studies foreign and West German multinational affiliates more frequently active in R&D compared to the total East German manufacturing. However, R&D intensities are low compared to the total East German manufacturing sector. Similarly, we find more innovation activity both in terms of product and process innovation as well as a higher innovation output compared to the total of East German manufacturing firms. Moreover, we find basic and applied R&D to be the most centralised technology related business function followed by product and process development. In general, most affiliates participate in technology related business functions with only a few exceptions. In terms of technology related knowledge flows, we find indications that over time affiliates became less dependent on technological knowledge from the parent, integrated stronger with other MNE-units, and today actively augment the technological advantage of headquarters as well as other MNE units. Furthermore, we are able to show that the exploitation of a technological advantage at home goes hand in hand with technology augmenting technological activities in East German affiliates. Differentiating strategic approaches towards investment in R&D we find a dominance of technology seeking technological activities but a close balance of affiliates that actively draw from the technological strength of East Germany and firms that predominantly exploit an ex ante technological advantage of the home country. The dominance of the technology seeking strategy could indicate that the scale and quality of the regional science and technology base as well as technological opportunities could be important drivers for the implementation of technological activities in East Germany. Furthermore, the evidence seems to indicate that East German regions differ quite markedly in terms of technological specialisation as well as the extent of diversification if we consider the distribution of R&D and product innovation of foreign and West German affiliates across industries and regions simultaneously. This could indicate that investors in technological activities are sensitive to region and industry specific agglomeration effects, both in terms of specialisation as well as diversification. However, in order to substantiate this claim we need to specify an econometric model according the hypotheses developed in this chapter.

6.5 Theoretical and econometric model

6.5.1 Theoretical model

We model the location choice for technological activities by foreign and West German multinational affiliates in East Germany. Country level determinants such as political, legal, and cultural framework conditions are assumed to apply uniformly across all regions within East Germany. We test whether the valuation of region and industry specific locational factors of affiliates implementing specific technological activities differs significantly from other affiliates' valuation in an integrated estimation approach. This allows us to identify the locational factors that are decisive for the implementation of specific technological activities rather than location choice in general. We avoid a potential estimation bias by exploiting the location information from the whole sample of affiliates rather than using only data for the sub-group of technologically active affiliates.

Thereby, we proceed in three principal steps. First, we estimate an enhanced base specification of general location choice on the population as well as the sample of foreign and West German owned multinational affiliates. Subsequently, we differentiate locational factors for affiliates with R&D or innovation in comparison to the respective control group. In the final stage, we discriminate locational factors depending on the adopted technological strategy following the taxonomy developed by Patel and Vega (1999) and Le Bas and Sierra (2002). The differentiation of locational factors employs information from the survey, and hence can only be implemented for the sample of foreign and West German owned multinational affiliates.

Our model of location choice of technological activities across East Germany regions builds on the assumption that foreign and West German owned MNEs decided at one point in time to undertake direct investment in specific technological activities in one particular region within East Germany. We observe the regional choice for the localisation of affiliates that implement specific technological activities at a particular point in time as a function of region and industry specific exogenous determinants measured at the year preceding the entry of affiliates. In other words, the observation whether multinationals implement specific technological activities has a time lag to the measurement of exogenous variables. By using lagged independent variables we avoid econometric endogeneity between affiliates' investment and the exogenous region and industry specific factors. This approach is in line with other existing studies (Cantwell and Piscitello 2005, 2007). However, we thereby we also assume that the decision to implement specific technological activities was already taken at the time of entry.

This assumption might be challenged as the decision to implement specific technological activities might develop over time rather than being taken ex ante to market entry. For example, Ronstadt (1978) observed in a study of foreign R&D investment by US based multinationals that the majority of R&D projects followed an evolutionary pattern. Fisher and Behrman (1979) show for US and European multinationals evidence of various modes and time frames of establishing foreign R&D activities ranging from gradual evolution to direct placement of full R&D units. In contrast, Kuemmerle (1999) looked at foreign R&D labs in the electronics and pharmaceutical industry and detected virtually no shift in their strategic character. He argues that the intended orientation of a laboratory influences the choice of location to a degree that is very costly to reverse. Building on this argument, we consider that the assumption that the decision to locate specific technological activities is taken already at the time prior to entry given the implied sunk costs.

The main focus of our empirical investigation is on the relevance of the potentials from location bound technological knowledge externalities and other agglomeration related effects in the decision-making process. It has been argued that managers are highly cognisant of the phenomenon of spatially bound spillovers (Saxenian 1994). Therefore, the assumption that managers are likely to take into account future spillovers potential when making decisions regarding where to locate or to acquire new technological activities is in line with existing theoretical approaches (Feinberg and Gupta 2004, Verspagen and Scheonmakers 2004, Cantwell and Piscitello 2005, 2007 etc.). Furthermore, we control for a number of other exogenous variables that are relevant for this choice including regional market characteristics, labour market conditions, as well as public policy interventions.

Following our approach in chapter 5, we consider the existence of J spatial choices among East German regions with $j = 1, \dots, J$ and N investors with $i = 1, \dots, N$, then the utility π derived by investor i if he locates at area j is given by

$$\pi_{ij} = \beta' z_{ij} + \epsilon_{ij} ,$$

where β is a vector of unknown parameters, z_{ij} is a vector of observed explanatory variables, and ϵ_{ij} is a random term. Thus, the utility for the investor i of locating at region j is composed of a deterministic and a stochastic component. The investor will choose the region that will yield him the highest expected utility. If the ϵ_{ij} are independent and *iid* extreme value distributed, it can be shown that

$$P_{ij} = \frac{e^{\beta' z_{ij}}}{\sum_{j=1}^{J} e^{\beta' z_{ij}}}$$

where P_{ij} is the probability that the investor i locates at region j. If we let $d_{ij} = 1$ in case investor i picks choice j and $d_{ij} = 0$ otherwise, then we can write the log likelihood of the conditional logit model as

$$\log L_{cl} = \sum_{i=1}^{N} \sum_{j=1}^{J} d_{ij} \log P_{ij} \ ,$$

In our base specification the utility derived by investor i if he locates at area j is given by

(I)
$$\begin{aligned}\pi_{ij} = {} & \beta_1 TS_{jh_i t_{i_{-1}}} + \beta_2 TD_{jt_{i_{-1}}} + \beta_3 HE_{jt_{i_{-1}}} + \beta_4 IS_{jh_i t_{i_{-1}}} + \beta_5 ID_{jt_{i_{-1}}} + \\ & \beta_6 \left(IS_{jh_i t_{i_{-1}}} * TS_{jh_i t_{i_{-1}}} \right) + \beta_7 \left(IS_{jh_i t_{i_{-1}}} * TD_{jt_{i_{-1}}} \right) + \\ & \beta_8 \left(ID_{jt_{i_{-1}}} * TS_{jh_i t_{i_{-1}}} \right) + \beta_9 \left(ID_{jt_{i_{-1}}} * TD_{jt_{i_{-1}}} \right) + \beta_{10} FA_{jt_{i_{-1}}} + \\ & \beta_{11} GDP_{jt_{i_{-1}}} + \beta_{12} HR_{jh_i t_{i_{-1}}} + \beta_{13} LAND_{jt_{i_{-1}}} + \beta_{14} GRW_{jt_{i_{-1}}} + \beta_{15} TAX_{jt_{i_{-1}}} + \\ & \beta_{16} INFRA_j + \beta_{17} SIZE_j + \epsilon_{ij},\end{aligned}$$

where $\beta_1 TS_{jh_i t_{i_{-1}}}$ approximates the technological specialisation of region j in industry h of investor i at t_{-1} [18]as the year prior to the entry of investor i (see Table 8, p. 80 for detailed description of measurement), $\beta_2 TD_{jt_{i_{-1}}}$ the technological diversification within region j at t_{-1}, $\beta_3 HE_{jt_{i_{-1}}}$ public expenditure for higher education infrastructure of region j at t_{-1} , $\beta_4 IS_{jh_i t_{i_{-1}}}$ the specialisation of region j in the industry h of investor i at t_{-1}, $\beta_5 ID_{jt_{i_{-1}}}$ the diversification across industries of region j at t_{-1}, $\beta_6 \left(IS_{jh_i t_{i_{-1}}} * TS_{jh_i t_{i_{-1}}} \right)$ the interaction term between general industry and technological specialisation in region j of industry h of investor i at t_{-1}, $\beta_7 \left(IS_{jh_i t_{i_{-1}}} * TD_{jt_{i_{-1}}} \right)$ the interaction term between general industry specialisation in region j of industry h and technological diversification of region j at t_{-1}, $\beta_8 \left(ID_{jt_{i_{-1}}} * TS_{jh_i t_{i_{-1}}} \right)$ the interaction term between general industry diversification of region j and technological specialisation in region j of industry h of investor i at t_{-1}, and

[18] Apart from β_{18} and β_{19} all parameters variables are measured at t_{-1} as the year preceding the entry of investor i. However, reliable comprehensive data on the regional level is only available back until 1995. Therefore, we need to assume 1996 as earliest possible entry year for all investors that entered before 1996. Thus the entry years range between 1996 until 2006.

$\beta_9\left(ID_{jt_{i_{-1}}} * TD_{jt_{i_{-1}}}\right)$ the interaction term between general industry and technological diversification of region j of affiliate i at t_{-1}. The parameters β_1 to β_9 corresponding to the hypotheses (H1) to (H9) as developed in this chapter.

All remaining parameters control for other relevant exogenous variables including $\beta_{10}FA_{jt_{i_{-1}}}$ for the agglomeration of foreign and West German multinational firms in region j at t_{-1} of investor i, $\beta_{11}GDP_{jt_{i_{-1}}}$ for the per capita gross domestic product of region j at t_{-1} of investor i, $\beta_{12}HR_{jh_it_{i_{-1}}}$ for the share of human resources in science and technology occupations of the region j in the industry h at t_{-1} of investor i , $\beta_{13}LAND_{jt_{i_{-1}}}$ for the average price of developed commercial sites of region j at t_{-1} of investor i, $\beta_{14}GRW_{jt_{i_{-1}}}$ for general investment grants per employee of region j at t_{-1} of investor i, $\beta_{15}TAX_{ij}$ for the average tax levied by local authorities (counties) of the region j at t_{-1} of investor i, $\beta_{16}INFRA_j$ for the average distance to the closest airport of investors located in region j, and $\beta_{17}SIZE_j$ the size of the surface of region j.

In principal, this specification follows the basis model of general location choice as introduced in chapter five. However, we enhance the specification by adding the parameters $\beta_6$to β_9 for interaction effects between location specific technology related knowledge externalities and other agglomeration related externalities in line with our hypotheses developed in this chapter.

In order to account for affiliate heterogeneity with regard to R&D activity, we estimate specification two, where the utility π derived by investor i if he locates at area j is given by

$$\textit{(II)} \qquad \pi_{ij} = \beta' z_{ij} + \gamma' RDdum_i * v_{ij} + u_{ij} \,,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables as in specification *(I)*, γ a vector of unknown parameters from the interaction between $RDdum_i$ and v_{ij}, and u_{ij} a random term. $RDdum_i$ is a dummy variable that equals to one if the affiliate i had intra or extramural R&D expenditures in the year 2005 (see Annex Codebook v19_2b). The vector v_{ij} is in principal analogous to z_{ij} apart from the fact that it does not entails parameter $\beta_{17}SIZE_j$ for the size of the surface of region j. This parameter is left out as it is a control variable to avoid correlation across choices between regions rather that a locational factor as such.

In order to account for affiliate heterogeneity with regard to innovation activity, we estimate specification two, where the utility π derived by investor i if he locates at area j is given by

$$\textit{(III)} \qquad \pi_{ij} = \beta' z_{ij} + \delta' INNOdum_i * v_{ij} + w_{ij} \,,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables as in specification *(I)*, δ a vector of unknown parameters from the interaction between $INNOdum_i$ and v_{ij}, and w_{ij} a random term. $INNOdum_i$ is a dummy variable that equals to one if the affiliate i conducted product innovations in the period between 2002 and 2005 (see Annex Codebook v18_1).

In the final estimation set, we differentiate locational factors according to four mutually exclusive technological strategies according to the taxonomy developed by Patel and Vega (1999) and Le Bas and Sierra (2002). In order to account for affiliate heterogeneity with regard to technology seeking, we estimate specification four, where the utility π derived by investor i if he locates at area j is given by

$$\textit{(IV)} \qquad \pi_{ij} = \beta' z_{ij} + \mu' T_1 dum_i * v_{ij} + h_{ij} \,,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables as in specification *(I)*, μ a vector of unknown parameters from the interaction between $T_1 dum_i$ and v_{ij}, and h_{ij} a random term. $T_1 dum_i$ is a dummy variable that equals to one if the affiliate i indicated that it considers itself as an important, very important, or extremely important source of technological knowledge with respect to R&D and innovation for the headquarter (see Annex Codebook v23_1b) and simultaneously it considers its foreign or West German based headquarter as little or no important source of technological knowledge with respect to R&D and innovation implemented locally in East Germany (see Annex Codebook v22_3b).

In order to account for affiliate heterogeneity with regard to asset exploiting, we estimate specification five, where the utility π derived by investor i if he locates at area j is given by

$$\textit{(V)} \qquad \pi_{ij} = \beta' z_{ij} + \sigma' T_2 dum_i * v_{ij} + e_{ij} \,,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables as in specification *(I)*, σ a vector of unknown parameters from the interaction between $T_2 dum_i$ and v_{ij}, and e_{ij} a random term. $T_2 dum_i$ is a dummy variable that equals to one if the affiliate i indicated that it considers itself as a little or no important source of technological knowledge with respect to R&D and innovation for the headquarter (see Annex Codebook v23_1b) and simultaneously it considers its foreign or West German based headquarter as an important, very important, or extremely important source of technological knowledge with respect to R&D and innovation implemented locally in East Germany (see Annex Codebook v22_3b).

In order to account for affiliate heterogeneity with regard to asset augmenting, we estimate specification six, where the utility π derived by investor i if he locates at area j is given by

$$(VI) \qquad \pi_{ij} = \beta' z_{ij} + \varphi' T_3 dum_i * v_{ij} + g_{ij} \,,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables as in specification *(I)*, φ a vector of unknown parameters from the interaction between $T_3 dum_i$ and v_{ij}, and g_{ij} a random term. $T_3 dum_i$ is a dummy variable that equals to one if the affiliate i indicated that it considers itself as an important, very important, or extremely important source of technological knowledge with respect to R&D and innovation for the headquarter (see Annex Codebook v23_1b) and simultaneously it considers its foreign or West German based headquarter as an important, very important, or extremely important source of technological knowledge with respect to R&D and innovation implemented locally in East Germany (see Annex Codebook v22_3b).

In order to account for affiliate heterogeneity with regard to market seeking, we estimate specification seven, where the utility π derived by investor i if he locates at area j is given by

$$(VII) \qquad \pi_{ij} = \beta' z_{ij} + \rho' T_4 dum_i * v_{ij} + l_{ij} \,,$$

where β is a vector of unknown parameters, z_{ij} the vector of the observed explanatory variables as in specification *(I)*, ρ a vector of unknown parameters from the interaction between $T_4 dum_i$ and v_{ij}, and l_{ij} a random term. $T_4 dum_i$ is a dummy variable that equals to one if the affiliate i indicated that it considers itself as a little or no important source of technological knowledge with respect to R&D and innovation for the headquarter (see Annex Codebook v23_1b) and simultaneously it considers its foreign or West German based headquarter as a little or no important source of technological knowledge with respect to R&D and innovation implemented locally in East Germany (see Annex Codebook v22_3b).

6.5.2 Econometric approach

Existing empirical approaches use binominal regression models to capture the effect of region and industry specific exogenous variables on the incidence of technological activities by foreign owned affiliates measured in terms of patent output (Cantwell and Piscitello 2005, 2007). This kind of linear exponential model offers an appropriate methodology for estimations that use patent or innovation counts as dependent variable (Cameron and Trivedi 1998). However, we purposely frame the localisation choice for technological activities in the context general location choice and therefore, use a conditional fixed effect logit model (CLM) as widely applied in the empirical literature on industrial location choice.

As discussed in chapter 5 through an application of the CLM, Carlton (1979, 1983) first demonstrated that industrial location decisions can be modelled in a random utility maximization framework as developed by McFadden (1974). We adapt this model in a way that we cast the decision about the location of the affiliate with specific technological activities as a discrete choice problem in which utility maximizing MNEs select sites from a distinct set of regions within East Germany. The advantage of the CLM is that it links estimates for regional characteristics directly to their influence on a firm's utility maximization function. Under the CLM, the probability of locating an affiliate that implements specific technological activities in a particular region depends on the relative level of utility that can be derived at this site compared with those of all other alternatives. The critical assumption of the CLM is that the unobserved factors are uncorrelated over alternatives, as well as having the same variance for all alternatives (Train 2003).

As discussed in chapter 5 this independence of irrelevant alternatives (IIA) assumption, while restrictive, provides a very convenient form for the choice probability. When dealing with small geographical units, this problem may be relevant as neglected site characteristics can more easily extend their influence beyond the boundaries of the considered spatial units. However, as discussed in chapter 5 it seems appropriate to apply a CLM approach to our choice set of 23 fairly small functional units of *'Raumordungsregionen'* under the condition that we observe variables such as federal grants, infrastructure, and other public investment as well as the size of the regions in order to avoid any correlation across choices between regions that might make some regions closer substitutes for any investors.

6.6 Results and discussion

6.6.1 Estimation results

Base model of location choice

We first estimate the basic specification of general location choice for the sample of foreign and West German owned multinationals. This specification is an extension of the basic model introduced in chapter five which is augmented by the four interaction terms between technological knowledge spillovers and other general industry externalities. The estimation of the basic specification on the population (see column 1 and 2 Table 24) shows a log-likelihood of -3659 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis. The likelihood ratio index indicates a Pseudo-R^2 [19] of 0.111.

Table 24 Estimation results for basic model of location choice in population and sample

Base model	Population		Sample	
VARIABLES	Coeff.	Std.Err.	Coeff.	Std.Err.
Column	(1)	(2)	(3)	(4)
Technology specialisation	0.316**	(0.110)	0.704**	(0.237)
Technology diversification	1.060*	(0.581)	1.930*	(1.124)
Science infrastructure	0.107***	(0.029)	0.199**	(0.066)
Industry specialisation	0.757***	(0.071)	1.013***	(0.160)
Industry diversification	1.207**	(0.470)	2.590**	(0.894)
Ind. spec. * Tech. spec.	0.024	(0.173)	0.047	(0.363)
Ind. spec.* Tech. divers.	7.486	(4.661)	2.404**	(0.906)
Ind. divers.* Tech. spec.	0.449	(0.742)	-1.035	(1.460)
Ind. divers. * Tech. divers.	0.386	(0.620)	21.884**	(7.440)
Foreign and WG agglomeration	0.280***	(0.058)	0.184	(0.132)
GDP	0.311**	(0.135)	-0.129	(0.273)
Prices for commercial property	-0.155	(0.110)	-0.370	(0.231)
Investment grants	0.240***	(0.057)	0.171	(0.118)
HR in S&T occupations	-0.002	(0.116)	0.252	(0.175)
Local authority trade tax	-0.425	(0.380)	0.631	(0.785)
Distance to closest airport	-0.046	(0.080)	-0.115	(0.160)
Size of region	-0.387**	(0.116)	-0.360	(0.236)
Observations	30199		6601	
No. of firms	1313		287	
Loglikelihood (null)	-4117		-899.9	
Loglikelihood (model)	-3659		-794.5	
Chi-square	779.91		156.26	
P-value Chi	0.000		0.0000	
PseudoR2	0.1113		0.1146	
AIC	7351		1627	
BIC	7492		1742	

*** p<0.001, ** p<0.05, * p<0.1

[19] In non-linear models such as CLM the Pseudo-R^2 is not bounded by zero and unity and can only be interpreted as absolute value. It does not provide information on the percentage of variance explained over total variance.

In general, the estimation results from the enhanced base model of location choice confirm the findings obtained from the base model estimation on the total population of foreign and West German multinational affiliates in chapter 5 with three exceptions (compare Table 9 p. 83). The potential spillover effect from technological diversification turns now significantly positive in contrast to the base model (without interaction terms). Furthermore, the effect of prices for commercial land and local tax turn now statistically insignificant. However, the main insight from the current perspective is that spillover potentials from technological specialisation, diversification, and science infrastructure attract multinationals positively. Yet none of the interaction terms has a statistical significant effect on general location choice of foreign and West German affiliates in East Germany.

If we repeat the estimation of the enhanced base model on our sample of foreign and West German affiliates, the picture changes slightly. The estimation on the sample shows a log-likelihood of -795 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 3 and 4 Table 24). The likelihood ratio index indicates a Pseudo-R^2 [20]of 0.115. Again the results confirm that affiliates are more likely to locate in regions that are characterised by a higher potential for spillovers from technological specialisation, technological diversification and science infrastructure as well as general industry specialisation and diversification.

However, two interaction effects exert a statistically significant effect on general location choice on affiliates in the sample: spillover potential from joint industry specialisation and technological diversification as well as combined industry and technological diversification. The interaction effects of industry and technological specialisation as well as joint industry diversification and technological specialisation are found to be statistically insignificant. Furthermore, in contrast to the estimation on the population we find no statistically significant effect for the regional GDP, prior foreign and West German agglomerations, and investment grants as controls. In principle, we would have expected to same results from the estimation on the sample as well as the total population. However, such differences in significance level are very likely related to limitations in terms sample representativeness as described in Chapter 3.

[20] In non-linear models such as CLM the Pseudo-R^2 is not bounded by zero and unity and can only be interpreted as absolute value. It does not provide information on the percentage of variance explained over total variance.

Still, the estimation of the enhanced basic model serves as a reference point for with regard to the general location choice of foreign and West German multinational affiliates. It informs us which locational factors are relevant for all affiliates disregarding technological activities. So far we have confirmed that the technology related knowledge spillover potential affect the location choice of multinationals in general. At least with regard to the sample, we only have evidence for two interaction effects as factors with relevance for general location choice. Thus, the purpose of the subsequent investigations is scrutinising whether the other two interaction effects steer the localisation of technological activities rather than location choice in general.

Location choice for affiliates with R&D and innovation

The second specification tests whether locational determinants differ depending on the fact that affiliates are actively engaged in R&D measured in terms of affiliate's expenditures on intra- and extramural R&D. This specification includes 16 interaction terms between the exogenous variables from the base model and a dummy for R&D activities. The upper part of the Table 25 shows the coefficients and standard errors for the respective parameters of affiliates without R&D, the lower part the corresponding results for affiliates performing R&D. Adding the coefficient of the lower and upper part, we get the joint effect of the variable.

The estimation of the second specification (see column 1 and 2 Table 25) shows a log-likelihood of -524 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis. The likelihood ratio index indicates a Pseudo-R2 of 0.134. Whereas affiliates without R&D react positively to spillovers from industry specialisation, this effect on its own is not statistically significant for affiliates implementing R&D. However, this changes if general industry specialisation effects are accompanied by technological diversification. In line with hypothesis (H7) we find that the probability of location choice increases with the spillover potential from joint industry specialisation and technological diversification within the region. In such a situation the affiliate takes advantage of specialised labour, or concentrated suppliers within the same sector of activities and combines it with technology related knowledge spillovers from a heterogeneous industrial knowledge base within the region. Furthermore, in line with hypothesis (H8) R&D active affiliates are attracted into regions with a higher spillover potential from industry diversification in combination with technological specialisation.

Table 25 Estimation results for location of affiliates' R&D and innovation

Specification	(II)		(III)	
VARIABLES	Coeff.	Std.Err.	Coeff.	Std.Err.
Column	(1)	(2)	(3)	(4)
(H1) Technology specialisation	0.336	(0.905)	0.946*	(0.498)
(H2) Technology diversification	1.206	(4.426)	2.474	(2.114)
(H3) Science infrastructure	-0.046	(0.205)	0.182	(0.136)
(H4) Industry specialisation	0.746**	(0.329)	0.780**	(0.270)
(H5) Industry diversification	2.403	(3.546)	2.423	(1.920)
(H6) Ind. spec. * Tech. spec.	-0.911	(0.953)	-1.741**	(0.739)
(H7) Ind. spec.* Tech. divers.	-0.705	(1.972)	-0.712	(1.559)
(H8) Ind. divers.* Tech. spec.	-14.39**	(6.989)	-0.996	(2.645)
(H9) Ind. divers. * Tech. divers.	22.89	(28.76)	37.98**	(14.15)
Foreign and WG agglomeration	-0.628	(0.479)	0.188	(0.256)
GDP	0.034	(0.966)	-0.147	(0.459)
Prices for commercial property	0.272	(0.819)	-0.382	(0.478)
Investment grants	0.655	(0.507)	0.340	(0.221)
HR in S&T occupations	0.072	(0.281)	0.068	(0.196)
Local authority trade tax	-1.197	(2.955)	0.796	(1.543)
Distance to closest airport	0.035	(0.606)	-0.170	(0.323)
Size of region	-0.502*	(0.288)	-0.341	(0.240)
INTERACTION TERMS	**R&D**		**Innovation**	
(H1) Technology specialisation	0.444	(0.952)	-0.290	(0.570)
(H2) Technology diversification	2.232	(4.715)	-0.397	(2.540)
(H3) Science infrastructure	0.272	(0.211)	0.045	(0.143)
(H4) Industry specialisation	0.503	(0.397)	0.389	(0.330)
(H5) Industry diversification	1.019	(3.694)	0.573	(2.170)
(H6) Ind. spec. * Tech. spec.	0.577	(1.046)	2.219**	(0.823)
(H7) Ind. spec.* Tech. divers.	5.366**	(2.547)	4.660**	(1.974)
(H8) Ind. divers.* Tech. spec.	14.03*	(7.267)	0.010	(3.207)
(H9) Ind. divers. * Tech. divers.	-1.482	(30.79)	-19.71	(16.94)
Foreign and WG agglomeration	0.891*	(0.503)	0.005	(0.296)
GDP	-0.360	(0.995)	-0.069	(0.532)
Prices for commercial property	-0.594	(0.861)	0.112	(0.541)
Investment grants	-0.542	(0.529)	-0.224	(0.261)
HR in S&T occupations	0.109	(0.421)	-0.008	(0.330)
Local authority trade tax	2.632	(3.131)	0.031	(1.810)
Distance to closest airport	0.024	(0.643)	0.107	(0.376)
Observations	4439		6325	
No. of firms	193		275	
Loglikelihood (null)	-605.2		-826.3	
Loglikelihood (model)	-523.8		-755.5	
Chi-square	137.5		183.0	
P-value Chi	0.0000		0.0000	
PseudoR2	0.134		0.124	
AIC	1113		1577	
BIC	1324		1799	

*** p<0.001, ** p<0.05, * p<0.1

The opposite is true for affiliates without R&D[21]. Thus, foreign and West German multinational R&D activities drive particularly well in an environment of technological specialisation within the sector of activity and complementary R&D inputs such as labour, suppliers, or other partners from a diversified industrial structure within the region.

The significance of these two interaction terms indicates that multinationals are more likely to locate R&D in regions that offer spillover potential from a combination of specialisation and diversification as well as a combination of knowledge and other agglomeration related aspects. The one without the other is not able to attract multinational R&D activity. Furthermore, the estimation shows that affiliates with R&D are more likely to locate in regions that are characterised by existing agglomerations of foreign and West German multinational affiliate. Thus it seems that the presence of other multinationals in the region is a crucial factor that facilitates the localisation of R&D activities.

Let us now turn to the results from specification (III) that differentiated locational effects according the introduction of product innovations during the period from 2002 to 2005 from other non-product innovators in the sample of foreign and West German multinationals. The estimation of the specification (III) shows a log-likelihood of -756 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 3 and 4 Table 25). The likelihood ratio index indicates a Pseudo-R2 of 0.124. As for affiliates with R&D, product innovators are more likely to locate in regions with a higher spillover potential from industry specialisation combined with technological diversification. Thus this evidence conforms to hypothesis (H7). In line with hypothesis (H6), we find that the location probability of product innovators increases in the context of higher spillover potential from a combination of industry specialisation and technological specialisation. Whereas technological specialisation and industry specialisation on their own affect positively the location choice of non-innovators, only the combination of both attracts multinationals' product innovation activities[22].

[21] This opposing effect of spillover potential from industry diversification in combination with technological specialisation for affiliates with and without R&D could explain why this specific interaction term turned out to be insignificant in the base model as described above.

[22] In turn non-innovators are less likely to locate in such a context. Again these opposing effects might explain why this interaction term turned out to be insignificant in our base model.

Location choice and technological strategies

In the third and final estimation set, we differentiate locational factors according to four mutually exclusive technological strategies according to the taxonomy developed by Patel and Vega (1999) and Le Bas and Sierra (2002). The specification (IV) (see column 1 to 2 of Table 26) for affiliates implementing a technology seeking strategy shows a log-likelihood of -667 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis. The likelihood ratio index indicates a Pseudo-R2 of 0.139. The results of the specification (IV) indicate that, in line with (H4) technology seekers are more likely to locate in regions that are endowed with a higher potential with regard to externalities from industry specialisation, however, less so in comparison to the other affiliates in the sample. In line with (H6), technology seekers are more likely than other affiliates to locate in regions, where they are able to benefit from a spillover potential that combines general industry with technological specialisation advantages. Yet, in contrast to other affiliates for technology seekers the probability of location choice is negative in regions that are characterised by a spillovers potential from simultaneous industry specialisation and technological diversification. This is in contrast to (H7). In addition, we observe a positive and significant effect on location probability if the share of existing foreign and West German multinationals within the affiliates' industry is high. Thus, affiliates following technology seeking strategy in East Germany prefer a regional environment where they are able to observe industry leaders or competitors in the context of industry and technology specialisation.

The specification (V) (see column 3 to 4 of Table 26) for affiliates implementing a technology exploiting strategy shows a log-likelihood of -670 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis. The likelihood ratio index indicates a Pseudo-R2 of 0.135. The results indicate that the location probability of affiliates that exploit existing MNE-group technological advantages in comparison to the other affiliates is higher for regions endowed with spillovers potentials from industry specialisation and industry diversification. This is in line with is in line with (H4) and (H5). However, neither technological specialisation nor diversification as single factors nor in combination with other agglomeration related externalities are statistical significant locational factors for technology exploiters. Yet, the results show that the probability for location choice is increased, the higher the regional income. Therefore, it could be argued that affiliates that exploit existing MNE-group level technological advantages are more responsive to non-technological agglomeration effects and regional market characteristics compared to other affiliates within East Germany.

Table 26 Estimation results for location choice with different motives for technological activities

Specification	(IV)		(V)		(VI)		(VII)	
VARIABLES	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(H1) Technology specialisation	0.805**	(0.372)	0.832**	(0.302)	0.623**	(0.313)	0.523*	(0.298)
(H2) Technology diver.	1.697	(1.596)	1.857	(1.412)	2.367*	(1.329)	2.850*	(1.456)
(H3) Science infrastructure	0.188**	(0.082)	0.248**	(0.085)	0.168**	(0.076)	0.224**	(0.077)
(H4) Industry specialisation	1.276***	(0.233)	0.857***	(0.198)	0.978***	(0.186)	1.069***	(0.205)
(H5) Industry diversification	3.229**	(1.211)	2.114**	(1.060)	2.482**	(1.121)	2.997**	(1.144)
(H6) Ind. spec. * Tech. spec.	-0.819	(0.643)	0.050	(0.443)	-0.068	(0.488)	0.874**	(0.323)
(H7) Ind. spec.* Tech. divers.	3.479**	(1.178)	1.441	(1.151)	1.722*	(1.031)	1.611	(1.459)
(H8) Ind. divers.* Tech. spec.	-0.252	(2.044)	0.946	(1.668)	-0.373	(1.778)	1.611	(1.648)
(H9) Ind. divers. * Tech. divers.	23.97**	(9.831)	15.48	(9.463)	21.33**	(9.196)	23.19**	(9.370)
Foreign/WG agglomeration	-0.103	(0.189)	0.318*	(0.166)	0.242	(0.154)	0.231	(0.168)
GDP	0.110	(0.374)	-0.414	(0.327)	0.093	(0.320)	-0.244	(0.332)
Prices for com. property	-0.642**	(0.321)	-0.319	(0.281)	-0.637**	(0.254)	-0.470	(0.294)
Investment grants	0.057	(0.165)	0.113	(0.137)	0.230*	(0.133)	0.102	(0.151)
HR in S&T occupations	0.193	(0.327)	0.081	(0.244)	0.015	(0.245)	-0.106	(0.204)
Local authority trade tax	-0.096	(1.071)	0.805	(1.014)	-0.102	(0.919)	0.314	(1.013)
Distance to closest airport	-0.442**	(0.221)	-0.181	(0.195)	-0.235	(0.188)	-0.247	(0.199)
Size of region	-0.307	(0.260)	-0.334	(0.266)	-0.350	(0.258)	-0.348	(0.258)
INTERACTION TERMS	**T1**		**T2**		**T3**		**T4**	
(H1) Technology specialisation	-0.072	(0.581)	-1.015	(0.721)	0.428	(0.732)	0.094	(0.643)
(H2) Technology divers.	1.073	(2.633)	0.935	(3.192)	-0.173	(4.355)	-1.746	(2.806)
(H3) Science infrastructure	0.054	(0.130)	-0.146	(0.128)	0.327*	(0.198)	-0.039	(0.148)
(H4) Industry specialisation	-0.625*	(0.363)	0.855**	(0.369)	0.792	(0.537)	-0.253	(0.374)
(H5) Industry diversification	-1.133	(2.076)	4.083*	(2.386)	1.497	(2.879)	-1.540	(2.304)
(H6) Ind. spec. * Tech. spec.	1.679**	(0.734)	0.458	(1.161)	1.128	(0.868)	-3.158***	(0.761)
(H7) Ind. spec.* Tech. divers.	-4.198*	(2.431)	2.745	(2.085)	5.520**	(2.807)	-0.176	(2.038)
(H8) Ind. divers.* Tech. spec.	1.709	(3.171)	-1.432	(3.775)	5.235	(4.103)	-3.610	(3.863)
(H9) Ind. divers. * Tech. divers.	-9.460	(17.45)	28.21	(18.05)	-0.253	(25.10)	-9.685	(20.31)
Foreign /WG agglomeration	0.668**	(0.291)	-0.562	(0.397)	-0.300	(0.456)	-0.268	(0.315)
GDP	-0.677	(0.527)	1.207*	(0.644)	-1.792**	(0.904)	0.537	(0.589)
Prices for com. property	0.382	(0.500)	-0.840	(0.614)	1.048	(0.935)	-0.261	(0.495)
Investment grants	0.212	(0.256)	0.074	(0.380)	-0.642*	(0.366)	0.125	(0.282)
HR in S&T occupations	-0.295	(0.417)	-0.259	(0.574)	0.308	(0.583)	0.942*	(0.550)
Local authority trade tax	1.228	(1.798)	-1.661	(2.199)	2.269	(2.782)	-0.640	(1.896)
Distance to closest airport	0.451	(0.359)	-0.216	(0.426)	-0.403	(0.469)	-0.152	(0.401)
Observations	5681		5681		5681		5681	
No. of firms	247		247		247		247	
Loglikelihood (null)	-775		-775		-775		-775	
Loglikelihood (model)	-667.0		-669.9		-670.7		-669.3	
Chi-square	169.4		186.7		168.2		173.6	
P-value Chi	0.0000		0.0000		0.0000		0.0000	
PseudoR2	0.139		0.135		0.134		0.136	
AIC	1400		1406		1407		1405	
BIC	1679		1625		1626		1623	

*** p<0.001, ** p<0.05, * p<0.1

The specification (VI) (see column 5 to 6 of Table 26) for affiliates implementing a technology augmenting strategy shows a log-likelihood of -671 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis. The likelihood ratio index indicates a Pseudo-R2 of 0.134. The results indicate that the location probability of affiliates that actively augment MNE-group technological advantages in comparison to the other affiliates is higher for regions that offer a higher potential for science-industry spillovers. This is in line with hypothesis (H3). Furthermore, in line with (H7) they are more positively sensitive to a location bound spillovers potential from combined industry specialisation and technological diversification. In contrast, a higher regional income lowers the location probability. Thus, we could conclude that technology augmenting affiliates in East Germany favour regional environment where they can actively search for new or complementary knowledge beyond their own sector of activity. This applies to public science as well as other industry sectors within the region.

Finally, specification (VII) (see column 7 to 8 of Table 26) for affiliates implementing a market oriented technological strategy shows a log-likelihood of -670 which according to the probability value of the Chi-square statistic significantly different from the null hypothesis. The likelihood ratio index indicates a Pseudo-R2 of 0.136. The results indicate that the location probability of affiliates such affiliates differs from the rest of the sample with regard to two locational determinants. In contrast to (H6) they do not locate in regions characterised by spillover potential from joint industry and technological specialisation. Somehow surprising, the location probability is higher when the sector in question is endowed with a higher share of human resources in S&T occupations. Apart from these two factors, we find no statistical significant differences from the remainder of the sample.

6.6.2 Discussion

The second empirical part of the dissertation investigated how various interaction of technology related spillover potentials and other agglomeration related externalities impact on MNEs' location choice for R&D and innovation. The notion that the geographical dispersion of technological development enhances innovation in the network of the MNE as a whole is founded on the belief that innovation is location specific as well as firm specific (Cantwell 1989). Thereby, it is assumed that geographic proximity, localised knowledge spillovers, and agglomeration related externalities are highly relevant for the location of MNEs' R&D and innovation abroad (Cantwell and Iammarino 1998, 2001, 2003).

From existing empirical evidence that foreign and West German affiliates operate a higher level of technological activities in terms of R&D and innovation compared to domestic owned firms in East Germany. However, this is the first investigation into the role of agglomeration externalities on the locational pattern of foreign and West German multinationals' technological activities within East Germany.

Existing international studies find that technology related knowledge spillover potentials from regional specialisation, diversification, and science infrastructure affect the location of foreign owned R&D (Cantwell and Piscitello 2005, 2007). Yet, we find that technology related knowledge spillover potentials affect the location choice of multinationals in general (see Chapter 5). However, we find no statistically significant different effect of technology related knowledge spillover potentials on the location probability when we compare R&D performing to non-performing affiliates or when differentiating between innovating and non-innovating affiliates. In other words, technology related knowledge spillover potentials affect affiliates with or without technological activities in the same positive way. This finding is surprising in particular with regard to the knowledge spillover potential from the science infrastructure. We would have expected that the science infrastructure is more important for the location decision of technologically active affiliates (especially in R&D) compared to purely production oriented affiliates. However, this seems statistically not to be the case for our sample of MNE affiliates based in East Germany. Instead, we find that the localisation of technological activities is sensitive to specific combinations of potentials for technological related knowledge spillovers and other agglomeration related externalities. Joint industry and technological specialisation has a positive effect on the localisation of innovation activities. The location choice for both R&D and innovation is positively influenced by the co-presence of externalities from general industry specialisation and technological diversification within the region. The localisation of R&D is responsive to the joint existence of spillover potentials from industry diversification and technological specialisation within the region.

Given that we find no significant effects for hypothesis (6) and (8) in the base model on general location choice from the estimation on the population as well as the sample, but opposing effects when differentiating affiliates according to the implementation of technological activities, we could argue that two combinations of technology related knowledge spillovers and other agglomeration externalities are most decisive: On the one hand, it would be joint technological and industry specialisation for innovation, and on the other, technological specialisation in combination with industry diversification for the location of R&D.

Furthermore, we inquired whether locational factors differ significantly depending upon the strategic nature or better the underlying motive for the internationalisation of technological activities by MNEs. It has been suggested that location specific factors differ depending on the nature of technological activities (Patel and Vega 1999, Cantwell and Mudambi 2005, Narula and Zanfei 2005, Cantwell and Piscitello 2007). In order to do this, we exploited information from the survey to approximate the relative technological advantage at the level of the corporation. We simply compared the foreign/West German parents' importance as a source for technological knowledge for the affiliate with the importance of the respective affiliate as a source for technological knowledge for the foreign/West German parent. This allowed us to approximate the technological advantage of home vs. host country. Furthermore, we were able to discriminate between different underlying motives for foreign investments in R&D and innovation. However, survey based measures are subject to self-assessment and limited to the level of the corporation. Thus the information is not measured in relation to other firms in the same industry in host and home region. This would constitute a robust relative measure. However, such times series technological indicators from a large cross-country data set that allows a high degree of regional as well as industry break down are currently not easily available. Therefore, we had to rely on the survey evidence only.

Having this limitation in mind, this is a first study to shed light on the strategic nature of multinational affiliates' technological activities implemented in East Germany as well as on corresponding differences in location choice across region. Descriptive evidence shows that since entry affiliates became less dependent on technological knowledge from the parent, integrated stronger with other MNE-units, and today increasingly contribute to the development of technological ownership advantage of headquarters as well as other MNE units. This is particularly the case for West German multinational affiliates. In comparison to existing studies (Patel and Vega 1999, Le Bas and Sierra 2002), East Germany is characterised by a fairly high share of technology seeking corporate affiliates. Our results show that the relevance of spatially distinct capabilities within the host country differs for the MNEs' location choice depending upon the underlying motive for internationalisation. In principal, the evidence also supports the argument that asset exploiting is more demand driven, whereas asset augmenting is supply driven (Patel and Vega 1999, Cantwell and Mudambi 2005, Narula and Zanfei 2005, Cantwell and Piscitello 2007).

Furthermore, we are able to show that technology seeking affiliates are more likely to locate in a locality where they are able to absorb spillovers from joint technological and industry specialisation as well as other existing multinationals. This way affiliates are able to learn and to overcome the technological weakness of the home country. Technology augmenting affiliates are attracted by regions that facilitate active search for new or complementary knowledge beyond their own sector of activity by absorbing technology related spillovers from the science infrastructure as well as other industries within the region. The level of regional income has a negative effect on location choice for asset augmenting affiliates. The opposite is true for affiliates exploiting an existing firm specific technological advantage, which favour high regional demand. These are not responsive to any technological externality but industry specialisation and diversification. This could indicate that they exploit existing competence in the context of local static rather than dynamic economies of scale. Finally, market oriented technological activities do not have a distinct location pattern.

In sum, our findings support the argument of the technology accumulation theory that firms' internationalisation of technological activities can not only be understood as a consequence of ex ante technological ownership advantage to be exploited in foreign markets.

7. Empirical Part III: Technological spillovers from MNEs

7.1 Introduction and research questions

Aim of the chapter

The final empirical chapter of the dissertation is going to analyse to what extent foreign and West German multinational affiliates have a potential to generate technological spillover effects to suppliers, customers, and competitors located in East Germany. Thereby, we test the impact of centrally and locally driven technological MNE heterogeneity as well as existing spatially distinct technological capabilities on the potential for vertical and horizontal technological spillovers to the East German economy.

Internationalisation theory

Cantwell (1989, 1995) proposes a dynamic interaction between firm specific ownership and location specific advantages. He argues that successful innovators tend to invest in innovation activities in several sub-national centres across countries. As they do so, their investment generates spillover effects to the location and the industry, thus encouraging more investment and innovation activities by other firms. Thus, each innovating firm brings external benefits to the locality in which it invests (ibid). Thus, we could infer that MNEs generate spillovers to the host economy subject to foreign affiliates' investment in innovation.

Cantwell (1987, 1989) holds that inward FDI may have competitive and anti-competitive effects on host countries. Where indigenous firms enjoy a strong technological tradition in the sector in question, the growth of international production provides a competitive stimulus which encourages an increase in local research related activity. In this case, a strong indigenous technological tradition is associated with beneficial knowledge and hence productivity spillovers between foreign-owned and local companies. However, where such tradition is weaker, the research of local firms may be displaced by simpler assembly types of production organised by foreign MNEs (ibid.). Thus, spillover effects from FDI are also subject to spatially distinct and sector specific technological capabilities of the host country location.

Spillover models with heterogeneity

The first models on technological spillovers through inward FDI argued that they are positively related to the size of the technology gap (Findlay 1978), whereas later authors suggest a positive relation between the stock of human capital as well as absorptive capacity in the host economy (Borensztein et al. 1998). Recent authors underline the role of centrally and locally driven MNE heterogeneity in respect to technological activities as crucial parameter in FDI spillover models. If foreign firms are heterogeneous, not every foreign firm provides the same knowledge opportunities or spillover potential for domestic firms. The new generation of FDI models suggests four main factors which differentiate foreign affiliates with regard to their spillover potential: (i) the strategic nature of centrally driven technological activities; (ii) the extent of local R&D, innovation, or knowledge enhancing activities; (iii) the propensity to establish technological cooperation; and (iv) the length of establishment in the host country (see Chung 2001, Driffield and Love 2007, Todo and Miyamoto 2002, Marin and Bell 2006, Castellani and Zanfei 2006).

Empirical evidence from East Germany

The empirical evidence on knowledge spillover effects from the presence of foreign and West German owned firms in East German manufacturing is scarce. Peri and Urban (2006) find evidence for non-pecuniary horizontal productivity spillover effects from foreign ultimate ownership in German manufacturing at the level of federal states (NUTS1). Günther and Lehman (2007) find ambiguous evidence for pecuniary spillovers from foreign and West German ownership in vertically linked industries of East German manufacturing at different levels of regional aggregation. Both studies take into account the spatial dimension of knowledge spillovers. Only Günther and Lehman (2007) account for the absorptive capacity of domestic owned firms. However, both studies neglect the heterogeneity of foreign and West German affiliates in respect to technological activities when searching for knowledge spillover effects.

Research approach and method

In contrast to most empirical applications, we do not apply a production function approach that estimates whether the share of foreign investment impacts significantly on the productivity of domestic firms and interprets this as indirect evidence for spillover effects. Instead we exploit survey data that indicates the potential for technological spillover effects originating from foreign and West German multinationals. We differentiate between the potential for technological spillovers via forward and backward linkages as well as horizontal spillover effect. This information is drawn from the 2007 survey of the *IWH FDI micro database*. This has two explanations: First, the survey offers the most comprehensive information source available to assess variations in technological activities and linkages of foreign and West German multinationals based in East Germany. Second, this data source does not suffer from the limitations of representatives for the group of foreign and West German multinationals based in East Germany in comparison to the data sets used so far in empirical research.

However, this data is restricted to foreign and West German multinational affiliates. Therefore, we are not able to measure technological spillovers in domestic owned firms directly, instead we use information provided by the affiliates on the potential of technological spillover for other firms. We believe that this approach is able to generate new insights about the extent and determinants of technology related spillovers induced by foreign and West German affiliates in East Germany.

Structure of the chapter

The following section of this chapter reviews the theory and corresponding empirical evidence from international research on FDI spillovers. Thereby, we focus in particular on MNE heterogeneity. We also take a look at the existing evidence on technological spillovers of foreign and West German multinational affiliates within East Germany and contextualise the existing findings in the light of theory. Section three introduces the research hypotheses of this chapter. Section four offers descriptive overview of the extent of technological spillovers from foreign and West German multinational affiliates differentiated into vertical and horizontal effects using evidence from the *IWH FDI micro database* 2007. Section five introduces the theoretical model and econometric model as well as variables used to test the hypotheses. The final section concludes with a presentation of estimation results and brief discussion of estimation results in the context of the theory and existing evidence.

7.2 Theory and international empirical evidence

7.2.1 Traditional approaches to model FDI spillovers

Teece (1976) fundamentally challenged the position that technology can be made available to all at zero social cost. He argued that technology transfer requires the commitment of real resources, and that transfer cost decline with each application of innovation. This position is in line with the technology accumulation approach (Cantwell 1989, 1995) and was later taken up in a formal model by Wang and Blomström (1992) on FDI spillovers. The authors criticise the ad hoc modelling of externalities in traditional approaches, where a host country's production efficiency is simply modelled as an increasing function of FDI and the technological gap between home and host economy (see for example Findlay 1978). Instead their model explicitly recognises two types of costs associated with technology diffusion – the costs to the multinational transferring technology to its subsidiary and learning costs of domestic firms. The latter aspect has also been associated with domestic firms' absorptive capacity as defined by Cohen and Levinthal (1989, 1990). It is assumed that domestic firms have to make their own investment in R&D and employee training, and adapt organisational structures that allow for innovation in order to benefit from the presence of a foreign knowledge stock (Glass and Saggi 2002, Keller 1996, Kinoshita 2000).

There are a large number of studies that empirically scrutinise the incidence of spillover effects on the productivity of domestic firms in various host economies (Meyer and Sinani 2009). Since the 1990s the several contributions focused on European transition economies (see for an overview Jindra 2005). Most of these studies use the traditional technology gap model of FDI spillovers, which is by several authors augmented by absorptive capacity of domestic firms (Djankov and Hoekman 1998, Kinoshita 2000, Schoors and van d. Tool 2002, Damijan et al. 2003, Damijan et al. 2008). By and large the results show mixed or negative results for horizontal spillover effects in transition economies. There are fewer studies that consider vertical spillovers but corresponding results show positive effects from backward linkages and mixed or negative effects from forward linkages. Probably the most comprehensive study covering ten transition economies (Damijan et al. 2008) shows evidence that only more productive domestic firms and domestic firms with higher absorptive capacities are able to both compete with foreign affiliates in the same sector and benefit from the increased upstream demand for intermediates generated by foreign affiliates. However, all of these studies assume homogeneity of MNEs in the way spillovers are generated.

7.2.2 Models with centrally driven MNE heterogeneity

Recent contributions have questioned the homogeneity of MNE behaviour that underpinned FDI spillover models so far. Chung (2001) holds that the productivity outcome for the host industry will be contingent upon the motives of foreign firms' investing. Either foreign entrants exploit capabilities and transfer technology to the host market and productivity rises, else foreign entrants generate new capabilities by absorbing technology from the host market with little positive effect on productivity. In turn, he argues that firms' investment motive will be endogenously be determined by local market characteristics. Highly developed and competitive markets force firms to be regularly innovative and are likely sources for new capabilities for MNEs. However, foreign entrants sourcing best practices are not as competitive as the incumbents that they are interested in learning from. The presence of less competitive entrants may then drag on the market's productivity. In contrast, less developed markets are more suitable for exploiting existing capabilities. These host markets will experience productivity growth as the foreign entrants force economic discipline and development. Marginal firms will be forced out and remaining firms will have to improve their efficiency to ensure their survival. Chung (2001) holds that modelling productivity outcome as a linear function of FDI without accounting for this endogeneity is misleading.

In a similar vein, Driffield and Love (2007) link heterogeneity in FDI motivations to the potential prospect of productivity spillovers. They develop a taxonomy that accounts for technology sourcing or seeking behaviour on the one hand, and relative labour cost differentials between the home and the host location on the other. The authors anticipate from technology sourcing no positive effects on domestic productivity. In combination with a relative unit labour cost advantage, it could even have a negative effect as the benefit of reduced local factor cost achieved in the host economy may render such investors able to out-compete indigenous enterprises. In contrast, technology exploitation offers the prospect of productivity spillovers to the domestic sector as long as the technology effect outweighs any market stealing effect. The effect is likely to be lower in combination with relative factor cost advantages of the host location, as this type of investment may involve less transfer of new technology.

Chung (2001) and Driffield and Love (2007) put forward evidence that positive effects are associated with a MNE strategy of exploiting an ex ante technological advantage rather than sourcing new technological assets abroad. Chung (2001) presents empirical results from FDI in US manufacturing between 1987 and 1991. He shows that when the differential influences due to heterogeneous investment motives are ignored, changing foreign presence's affect on productivity growth is not statistically significant. The results change once the industries' initial level of competition is included to distinguish between those industries where firms are likely exploiting existing skills versus sourcing new skills. He shows that with changing foreign presence productivity increases in less competitive industries but stagnates in more competitive ones. These findings are consistent with positive technology spillover effects occurring in less competitive industries where firms enter to exploit an ex ante technological advantage, and are consistent with less productive foreign firms entering more competitive industries to learn best practices.

Driffield and Love (2007) find that in terms of domestic productivity growth, the UK gains substantially only from inward FDI motivated by an ex ante technology based ownership advantage. In turn, inward FDI motivated by technology sourcing considerations leads to no productivity spillovers. In line with their assumption the combination of technology souring and relative labour cost advantage even leads to a negative effect. They conclude that in contrast to FDI associated with technological advantages of the home country, FDI motivated by technology sourcing or efficiency seeking generates little potential for spillover effects and in the short run can even cause domestic productivity to decline.

The findings by Chung (2001) and Driffield and Love (2007) on the impact of centrally driven technological MNEs heterogeneity on spillover effects to the domestic sector are measured in terms of industry level indicators from the home and host country and therefore, independent from the actual nature of technological activities implemented by the affiliates locally. However, this aspect has been the focus of a new emerging stream in the literature.

7.2.3 Models with locally driven MNE heterogeneity

Marin and Bell (2006) challenged the traditional models by Wang and Blomström (1992) or Chung (2001) which they consider essentially as centrally driven because heterogeneity is seen as arising from MNE's decision about international transfer of technology to the affiliate. In this process foreign affiliates continue to be seen as playing a passive role. Instead, they argue that spillovers arise only if foreign affiliates are engaged in knowledge creating activities in host economies. The authors refer to the literature on subsidiary roles which shows that variation in innovative capabilities across subsidiaries, and over time, depends on much more than the centralised decisions of the parent company including the decisions and strategies of subsidiaries themselves; and aspects of the local environment that create constraints and opportunities for subsidiaries (Birksinshaw and Hood 1998, Frost 2001).

Castellani and Zanfei (2006) hold that the across and within heterogeneity of MNEs should be taken into consideration when analysing how the presence of MNEs affects the performance of a given host economy. Heterogeneity across MNEs implies that foreign firms differ with respect to their country of origin, level of internationalisation, and entry mode. The main point of within MNE heterogeneity is that not every affiliate of an MNE is equally involved in the creation, adoption, and diffusion of innovation. Knowledge tends to accumulate in some units more than in others and the distribution of competitive advantages is uneven within MNEs.

Factors such as proximity, agglomeration forces, co-ordination costs and tension for the strategic control of knowledge contribute to this differentiation (ibid.).

Castellani and Zanfei (2006) take a closer look at three aspects within MNE heterogeneity: R&D and innovation activity, technological cooperation, and time since entry. Similar to Marin and Bell (2006), they argue that when foreign affiliates implement locally R&D activities, they bring the host economy not only technology developed by the MNE elsewhere, but also knowledge developed in their own laboratories and incorporated in their products and processes. This provides an opportunity for imitation and learning which can favour technological spillovers to domestic firms. Moreover, pecuniary externalities through the labour market can be much more significant when R&D and innovation activities are implemented locally. In this case foreign affiliates increase the demand for scientists and engineers and often offer local universities incentives to supply such resources (ibid.).

Furthermore, R&D and innovation might require inputs from or induce technological cooperation with, domestic counterparts. Consequently knowledge exchange between foreign affiliates and domestic firms can be much more intense. Therefore, Castellani and Zanfei (2006) expect that an increase in the share of foreign firms involved in the local technological cooperation generates higher potentials for technological externalities. This applies not only to vertical inter-firm linkages that have been suggested as an important channel through which spillover effects occur (Lall 1980, Smarzynska Javorcick 2004, Rodriguez-Clare 1996, Alfaro and Rodriguez-Clare 2004) as many MNEs establish horizontal linkages with local firms through a variety of modes. This is for example the case of R&D cooperation, joint product development, co-design and standard setting. In these ventures explicit and tacit knowledge can flow from the MNE to the local firm and vice versa. Within horizontal agreements some knowledge can be lost and transferred to the counterpart, bit might be compensated by access to complementary assets, which enrich the firm's knowledge base (Castellani and Zanfei 2006).

Finally, the length of time since establishment of the foreign affiliate in the host country can significantly reduce both external and internal uncertainty associated with international operations (Castellani and Zanfei 2004), and hence generate a more favourable environment for spillovers (Castellani and Zanfei 2006). External uncertainty stems from the variety and volatility of demand, technological opportunities, as well as institutional conditions. Internal uncertainty relates to the difficulty of observing and measuring the adherence of contracting parties to the agreements and the problems of measuring the performance of these parties (Robertson and Gatignon 1998).

With regard to empirical evidence on the role of locally driven MNE heterogeneity the evidence is still limited but potentially insightful. Todo and Miyamato (2002) use establishment level panel data from the Indonesian manufacturing sector between 1995 and 1997. First, they find that the intensity of foreign affiliates' R&D expenditure as well as expenditure for training of human resources enhances the generation of horizontal spillover effects to the domestic owned part of Indonesian manufacturing. Second, the authors are able to show that domestic firms absorb knowledge spillovers from MNEs within the same sector of activity when they possess absorptive capacity in terms of own intra-industry R&D spending.

Marin and Bell (2006) use data from the Argentine Innovation Survey on manufacturing firms from 1992 to 1996 in their empirical investigation. The measure heterogeneity of affiliates as well as domestic firms in terms of knowledge enhancing activities in a very comprehensive way by considering a variety of measures for affiliates' investments in disembodied knowledge and skills, investment in capital embodied technology, and the innovation strategy of the enterprise. First the authors estimate models accounting for a centrally driven technology transfer and absorptive capacity of domestic firms. In both cases they do not find evidence for horizontal spillover effects to the domestic sector. Only, if they control in a subsequent set of estimations for foreign affiliates' heterogeneity in technological behaviour they detect positive spillovers. The effects are positive and significant for all indicators apart from R&D intensity and the importance of process innovation.

Castellani and Zanfei (2006) use a panel dataset on Italian manufacturing firms that combines information from the Community Innovation Survey (1994 and 1996) with financial information from the ELIOS dataset (1994-2000). They test for the impact of foreign affiliate heterogeneity on the productivity of domestic firms within the same sector of activity. They find a positive impact of R&D intensity. The effect of technological cooperation is found to be statistically not significant, whereas the authors identify a positive significant effect of the time since entry of the foreign affiliate. In addition, they control for absorptive capacity of domestic firms. They find that exporting domestic firms benefit to a larger extent from horizontal spillovers induced by inward FDI in comparison to none exporting firms. However, the effect of domestic multinationals is not significant. They conclude that internationalisation of domestic firms affects their absorptive capacity of foreign spillovers; however, this effect is non-linear.

Summing up the empirical evidence from international studies, we can conclude from models of centrally driven technological MNE heterogeneity that the prospect of positive horizontal spillover effects on domestic productivity is only justified if MNEs exploit an ex ante technological advantage rather than source new technological assets in foreign locations. Studies modelling locally driven technological MNE heterogeneity show that horizontal spillover effects depend positively on the extent of affiliates' technological activities and the length since their establishment in the host country.

7.2.4 Empirical evidence from East Germany

For East Germany, the evidence on productivity spillovers from foreign and West German investment is scarce. In fact, we find only two studies that deal with the issue in detail. Peri and Urban (2006) use an unbalanced panel of manufacturing firms based in the united Germany with ultimate foreign (or West German ownership in case of East Germany) drawn from the Amadeus data of Bureau von Dijk. The total number of manufacturing ranges between 912 in 1994 and 409 in 1999. Their analysis is conducted at the NUTS1 level ('Bundesländer'). The data shows representativeness deficiencies with regard to East Germany as such as well as several industries, which are partially corrected by weighting observation according to statistics drawn from the central bank ('Bundesbank') (Peri and Urban 2002). Yet, despite corrections it seems that their regionalised dataset suffers from insufficient coverage of foreign owned firms in East Germany. For example, they do not find any foreign firms in the East German federal state of Saxony (Peri and Urban 2002). Moreover, as discussed in Chapter 3 we know that due to registration procedures the number and volume of FDI in central bank data ('Bundesbank') is underestimated for East Germany (Günther 2005, Votteler 2001).

In their study, Peri and Urban (2006) test the technology gap hypothesis as formulated by Findlay (1978) i.e. the productivity advantage of foreign owned firms in a sector and region is an important determinant of productivity growth for the domestic firms in the same sector and region especially in technological backward regions. They employ a production function approach and used various measures of total factor productivity (TFP).

Peri and Urban (2006) find for Germany that foreign owned firms are on average 50 per cent more productive than local ones and their presence would induce a long-run productivity gain for local firms of around 8 per cent. They argue that it is the relative productivity gap rather than the concentration of foreign firms in the sector and region creating horizontal spillovers to domestic firms. Thus, they conclude that FDI can be concentrated in advanced regions

(West Germany), where there is not much scope for technological learning, while fewer but highly productive foreign companies can have a strong domestic impact in less-developed regions (East Germany). An earlier working paper version entails also a test of the absorptive capacity hypothesis (Peri and Urban 2002). In case of German regions, the hypothesis cannot be confirmed as regions with low human capital show a slightly larger potential for horizontal spillover effects. In sum, the authors interpret their evidence in support of the technology gap hypothesis.

Lehman and Günther (2004) and Günther and Lehman (2007) provide another study on productivity spillovers from the presence of foreign and West German investors in East Germany. They use data of about 1.800 manufacturing establishments drawn from the IAB panel in 1999 to 2003. As discussed in Chapter 3, the IAB establishment panel is representative for East German manufacturing as a whole however, not necessarily for the sub-groups of foreign and West German owned firms within East German manufacturing.

Günther and Lehman (2007) investigate the existence of vertical productivity spillover effects at three different levels of regional proximity: East Germany as a whole, the NUTS1 level (‘*Bundesländer’*), and the even lower level of ‘*Raumordnungsregionen’*. The authors use value added per employee as labour productivity measure in their production function approach. They test for the effects of the employment share of foreign and West German majority owned establishments in vertically linked industries as well as the regional concentration in terms of numbers of establishments on domestic establishments’ productivity. They control for absorptive capacity in East German establishments in terms of human capital as well as export intensity.

Estimation results from the annual cross section at the lower levels of regional disaggregation (‘*Bundesländer’*, ‘*Raumordnungsregionen’*) are fairly ambiguous. There are no clear indications for positive productivity effects from investors’ employment shares in forward or backward linked sectors. The authors even identify negative effects of the regional concentration of foreign and West German majority owned establishments in vertically linked sectors. Only for East Germany as a whole they are able to identify positive backward linkage effects on domestic establishments’ labour productivity from the employment as well as number of external firm concentration (Günther and Lehman 2007).They conclude that there seems to be no clear cut evidence for vertical productivity spillover effects from their analysis at different level of regional proximity in East Germany.

Günther and Lehman (2007) hint at selected limitations of their approach. First, they point out that a time lag of one to two years might not be appropriate to capture productivity spillovers. Second, the underlying input-output matrix used to calculate linkage coefficients applies to Germany as whole and might not be suitable to proxy linkages of foreign and West German owned firms within East German manufacturing. An alternative approach would require firm level information on the trade structure of foreign and West German affiliates in East Germany.

In sum, Peri and Urban (2006) find evidence for non-pecuniary horizontal productivity spillover effects level from foreign West German ultimate ownership in German manufacturing at the NUTS1 level. Günther and Lehman (2007) find ambiguous evidence for pecuniary spillovers from the presence of majority owned foreign and West German ownership in vertically linked industries of East German manufacturing at different level of regional aggregation. Both studies take into account the spatial dimension of knowledge spillovers. Günther and Lehman (2007) account for the absorptive capacity of domestic owned firms. However, both studies neglect the technological heterogeneity of MNEs when searching for knowledge spillover effects.

7.2.5 Contextualisation of existing findings in the light of theory

The technological accumulation approach holds that MNEs that invest in technological activities bring external effects to other firms in the locality in which they invest conditional on the existing sector specific technological strength of the location prior to entry (Cantwell 1989, 1995). Where indigenous firms enjoy a strong technological tradition, inward FDI provides a competitive stimulus which encourages an increase in local research related activity. In this case there is a prospect of productivity spillovers between foreign-owned and local companies (ibid.). From this perspective, positive technological spillovers from FDI do not require an ex ante technological advantage, instead it is subject to foreign affiliates' investment in R&D and innovation on the one hand and existing sector specific technological strength of the host country location on the other.

The consideration of a nexus between MNEs' technological heterogeneity and spillovers to the host economy became only recently part of theoretical models. Chung (2001) as well as Driffield and Love (2007) produce evidence that positive spillover effects to the domestic sector are linked to an ex ante technological advantage of MNEs. This approach assumes centrally driven technological heterogeneity of MNEs and ignores the potential role of local technological activities in foreign affiliates. This aspect is being dealt with by a new generation of FDI spillover models that place the emphasis on locally driven MNE heterogeneity. Corresponding empirical applications (Todo and Miyamoto 2002, Marin and Bell 2006, Castellani and Zanfei 2006) show convincingly that the extent of foreign affiliates' investment into R&D, innovation, or knowledge enhancing activities generates horizontal spillovers to the domestic sector. This evidence would be in line with the principal argument developed by Cantwell (1989, 1995).

Yet, it remains the question, whether the findings on the impact of foreign affiliates' heterogeneity in respect to technological behaviour are independent from an ex ante technological advantage of the investing firm? In other words is it affiliates exploiting or augmenting activities independent from an ex ante technological advantage that generates positive spillover effects? This would be in line with the technological accumulation approach that argues that the internationalisation of R&D and innovation does not rely on an ex ante technological advantage, however, the generation of spillover effects requires foreign affiliates' investment in local R&D and innovation. Furthermore, the role of location specific technological strength for the generation of technological spillovers remains underexplored in existing empirical applications. An investigation that takes account of MNE heterogeneity, absorptive capacity, and location specific technological strength would add to the limited empirical evidence for East Germany.

7.3 Hypotheses

In line with models of centrally driven technological heterogeneity (Chung 2001, Driffield and Love 2007), it could be argued that the motivation for FDI matters for the prospect of technological spillovers from to the domestic sector of the host economy. More precisely, only firms that exploit an ex ante sector specific technological advantage of the home country vis-à-vis the host country is prone to generate external effects. No, or even negative, effects can be expected from firms that do not possess an ex ante technological advantage but instead source new technological assets from abroad. Therefore, we could hypothesise:

(1) *Other things equal, foreign and West German multinational firms that possess an ex ante technological advantage have a higher potential to generate technological spillovers effects to other firms based in East Germany.*

However, independent of an ex ante technological advantage affiliates can be engaged in competence exploiting or augmenting activities. The latter can motivated by the desire to overcome technological weakness in the home country or to leverage new or complementary knowledge from the host country to enhance MNE's technological advantage (Cantwell 1989, 1995). Home base augmenting activities are associated with investment in local R&D and innovation and therefore, should be more likely to generate technology spillovers to other firms in the location in comparison to exploiting activities. Therefore, we could hypothesis:

(2) *Other things equal, foreign and West German multinational affiliates that implement home base augmenting activities have a higher potential to generate technological spillovers effects to other firms based in East Germany.*

Following models of locally driven technological MNE heterogeneity two more technology related factors are suggested that affect the potential of spillovers: the extent of affiliates' technological activities and the propensity to implement technological cooperation (Todo and Miyamoto 2002, Marin and Bell 2006, Castellani and Zanfei 2006). In line with these assumptions, we hypothesise that:

(3) *Other things equal, foreign and West German multinational affiliates that invest in technological activities have a higher potential to generate technological spillovers effects to other firms based in East Germany.*
(4) *Other things equal, foreign and West German multinational affiliates that implement local technological cooperation have a higher potential to generate technological spillovers effects to other firms based in East Germany.*

FDI spillover models explicitly recognise that domestic firms have to make their own investment in R&D and employee training, and adapt organisational structures that allow for innovation in order to benefit from the presence of a foreign knowledge stock (Wang and Blomström 1992, Glass and Saggi 2002, Keller 1996, Kinoshita 2000). Therefore, we hypothesise that:

(5) *Other things equal, foreign and West German multinational affiliates have a higher potential to generate technological spillovers effects to other firms based in East Germany, if domestic firms are endowed with a high level of absorptive capacity.*

Finally, the technological accumulation approach (Cantwell 1989, 1995) suggest that the prospect of productivity spillovers between foreign-owned and local companies is higher, when indigenous firms enjoy a sector specific technological strength prior to entry in the host country location. From our point of view, the existing technological strength could be associated with location specific specialisation or diversification advantages within a region in terms of technology or industrial structure as such. Therefore, we hypothesise that:

(6) *Other things equal, foreign and West German multinational affiliates have a higher potential to generate technological spillovers to other firms based in East Germany, if the investment location is characterised by an existing technological strength.*

We assume that the above hypotheses apply equally to technological spillover effects within the same sector of activity (horizontal or intra-industry effects) as well as effects via backward and forward linkages to related sectors (vertical or inter-industry effects).

7.4 Descriptive analysis

Before, we analyse the various determinants of horizontal and vertical spillovers in line with our hypotheses we need to clarify the extent to which foreign and West German affiliates actually indicate potentials for technological spillover effects. This is possible as we do not apply the traditional production function approach that measures the impact of foreign presence on domestic productivity which is generally interpreted indirect evidence of spillovers. Instead, we rely on survey evidence from foreign and West German multinational affiliates based in East Germany. The affiliates have been asked to evaluate "… their importance as a source of technological knowledge for R&D and innovation for others, at entry of the foreign/West German investors and today". The affiliates indicated the level of importance on a scale from one to five (1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important).

The information is available for affiliates' suppliers and customers differentiated according to their location: abroad, in West Germany, and in East Germany. In case the affiliate did not have suppliers or customers in the respective location the question has not been asked. In contrast to traditional approaches of measuring linkage effects by input-output coefficients, we are able to link directly affiliate level information on the trade structure with data on the corresponding potential of technological spillovers. The information on spillover potential is also available for affiliates' competitors differentiated according to their location: abroad and West Germany or East Germany. In this case all affiliates have been asked the respective questions, if they do not have any competitor in the respective location the answer to the question was marked as "does not apply". So let us first take a look at the potential for technological spillovers to suppliers (see Table 27). For the time of entry of the foreign or West German multinational investors only about 10 per cent of affiliates indicate a spillover potential for suppliers located abroad. The potential is slightly higher with about 16 per cent for suppliers located in West Germany or East Germany.

Table 27 Potential for technological spillovers via backward linkages

	Spillovers*	No Spillovers**	No supplies	n. a.
All affiliates (n=295)				
Foreign suppliers at entry	9,49	51,53	38,98	0,00
Foreign suppliers today	14,58	46,44	38,98	0,00
West German supplier at entry	15,93	55,59	27,80	0,68
West German supplier today	21,69	49,83	27,80	0,68
East German suppliers at entry	**15,93**	55,25	28,14	0,68
East German suppliers at today	**22,37**	48,81	28,14	0,68

Note: *Affiliates indicated 3 = important, 4 = very important, or 5 = extremely important. **Affiliates indicated 1 = not important or 2 = little important (See Annex Codebook v23_4b).

Source: IWH FDI micro database – Survey 2007, author's calculations

For today, it increased to about 15 per cent in case of foreign and about 22 per cent for West German or East German suppliers. Despite an increasing trend today, still close to 50 per cent of all foreign and West German affiliates indicate no or very low spillover potential for their supplier located in East Germany. Moreover, about 28 per cent of affiliates do not have any East German suppliers. With regard to differences between West German and foreign owned multinational affiliates, we find a lower extent of backward linkages as well as correspondingly lower spillover potential for the latter group (see Annex Table A31, p. 236).

Table 28 Potential for technological spillovers via forward linkages

	Spillovers*	No Spillovers**	No sales	n. a.
All affiliates (n=295)				
Foreign customers at entry	22,37	44,75	31,86	1,02
Foreign customers today	30,85	36,27	31,86	1,02
West German customers at entry	31,86	43,05	24,07	1,02
West German customers today	40,68	34,24	24,07	1,02
East German customers at entry	**29,83**	40,00	28,81	1,36
East German customers at today	**38,31**	31,53	28,81	1,36

Note: *Affiliates indicated 3 = important, 4 = very important, or 5 = extremely important. **Affiliates indicated 1 = not important or 2 = little important. (See Annex Codebook v23_6b).

Source: IWH FDI micro database – Survey 2007, author's calculations

The picture looks slightly different if we consider forward linkages. For the time of entry of the foreign or West German multinational investors about 22 per cent of affiliates indicate a spillover potential for foreign customer firms, about 32 per cent of affiliates for customers located in West Germany, and about 30 per cent for customers located in East Germany. For today it increased to about 31 per cent, 41 per cent, and 38 per cent respectively. However, again today about 32 per cent of all foreign and West German affiliates indicate no or very low spillover potential for their customers located in East Germany and about 28 per cent of affiliates do not maintain any forward linkages with East German customer firms. Trade integration via forward linkages is slightly lower with East Germany compared to the West Germany economy and so is the corresponding potential for technological spillovers effects. In contrast to backward linkages, for those that maintain forward linkages to East German customer firms a majority indicates a potential for technological spillover effects. With regard to differences between West German and foreign owned multinational affiliates, we find as in the case of backward linkages a lower extent of forward linkages and corresponding spillover potential for the group of foreign owners (see Annex Table A32, p. 236).

Table 29 Potential for horizontal technological spillovers

	Spillovers*	No Spillovers**	Does not apply	n. a.
All affiliates (n=295)				
Foreign/WG competitors at entry	20,68	66,10	6,44	6,78
Foreign/WG competitors today	28,83	48,65	7,21	15,32
EG competitors at entry	**15,32**	61,71	15,77	7,21
EG competitors at today	**19,82**	56,31	16,67	7,21

Note: *Affiliates indicated 3 = important, 4 = very important, or 5 = extremely important. **Affiliates indicated 1 = not important or 2 = little important. (See Annex Codebook v23_8b).

Source: IWH FDI micro database – Survey 2007, author's calculations

Finally, we consider the potential for horizontal technological spillover effects. For the time of entry of the foreign or West German multinational investors about 21 per cent of affiliates indicate a spillover potential for their competitors based in West Germany or abroad, whereas only 15 per cent identified such as potential for competitors located in East Germany. For today, this increased to about 29 per cent for West German and foreign competitors but only 20 per cent in case of East German competitors. Today, about 56 per cent of affiliates see no or little potential for horizontal spillovers to East German competitors. About 17 per cent do not identify any relevant competitor in East Germany. With regard to differences between West German and foreign owned multinational affiliates in East Germany, we find today about

25 per cent of West German multinational affiliates do so in comparison to about 20 per cent from foreign affiliates (see Annex Table A33, p. 237).

In sum, the potential for technological spillover effects has been increasing since entry of multinational investors. However, today a majority of affiliates does not maintain any vertical linkages or does indicate no or very low spillovers potentials to East German customers or suppliers. Similarly, the majority of multinational affiliates do identify no or very low spillovers potential to competitors based in East Germany. According to the survey data, the potential for technological spillover effects in East Germany is higher in case of forward linkages compared to backward or horizontal effects. By and large West German owned affiliates indicate a higher spillover potential compared to foreign firms. To analyse the firm and region specific drivers of the spillover potential for East German firms is the task of the following section.

7.5 Theoretical and econometric model

7.5.1 Theoretical model

Traditional studies of FDI spillovers use the production function approach that measures effects from the presence of FDI for example in terms of employment or value added on domestic firms' total factor or labour productivity within the same sector (see Jindra 2005 for an overview). Studies that assess vertical effects use inter-sectoral linkage coefficients to weight the foreign presence in related sectors. Significant effects on domestic productivity are interpreted as indirect evidence for spillover effects (ibid).

In contrast, our approach does not rely on productivity measures but instead uses survey evidence to "trace the flow of technological knowledge" more directly. We use information on affiliate's perceived importance as a provider of knowledge relevant for R&D and innovation activities in respective customer firms, suppliers, and competitors located in East Germany. This information can be interpreted as a 'potential' for technological externalities via vertical or horizontal linkages.

In line with Chung (2001) and Driffield and Love (2007) we first implement a FDI spillover model that takes account of centrally driven heterogeneity of MNEs with regard to technological investment motives. We differentiate between affiliates that exploit an ex ante technological advantage vis-à-vis East Germany and control for absorptive capacity of the respective local partners (suppliers, customers, competitors) based in East Germany, as well as local technological strength within the region of the investment project. Following Todo and Miyamato (2002), Marin and Bell (2006), and Castellani and Zanfei (2006) in a second step, we estimate a locally driven heterogeneity model. In the first version we take account of heterogeneity in innovation activities of foreign and West German affiliates. In a second version we account for heterogeneity in R&D conducted locally. Both versions include affiliate level measures of the extent to which foreign and West German owned entities augment and exploit the parents' technological advantage.

7.5.2 Econometric approach

The information on the presence of technological spillovers is given by a discrete variable that equals zero if the affiliate indicates no or little importance as a provider for technological knowledge relevant for others, and which is one if it considers itself as important, very important, or extremely important source of such technological knowledge. Therefore, we use a binary probit regression that estimates the probability with that the outcome of a technological spillover occurs and build the model as follows:

$$y^{*} = x'\beta + \varepsilon$$

where y^{*} is the unobserved latent endogenous variable, β is the parameter vector, and ε is the error term. In binary probit regression models the real y is unobserved. That is because the answers given are only given in some discrete value that best fits to the real y of the person interviewed. Therefore, we only observe whether an answer falls into a particular category or not. This is given by the responses:

$$y = 0 \; if \; y^{*} \leq 0,$$
$$y = 1 \; if \; 0 < y^{*} \leq \mu$$

where μ is the unknown parameter to be estimated with β. Greene (2003) argues that a sufficient assumption is that the distribution is known and continuous as for all maximum likelihood estimations. However, in binary probit models it is also assumed that ε is normally distributed with mean equal to zero and variance equal to unity.

Thus, we get:

$$\Pr(y = 0 \,\mathrm{I}\, x) = \varphi(-x'\beta),$$
$$\Pr(y = 1 \,\mathrm{I}\, x) = \varphi(\mu - x'\beta) - \varphi(-x'\beta)$$

, where $\varphi(-x'\beta)$ measures the estimated probability that $y = 0$ conditional on x, and $\varphi(\mu - x'\beta) - \varphi(-x'\beta)$ measures the estimated probability that $y = 1$ conditional on x.

In our first specification that follows the centrally driven heterogeneity model the parameter vector is given by

$$\beta_{central} = Home_i; Cap_i;\ TS_{jh_it_{i_{-1}}};\ TD_{jt_{i_{-1}}};\ IS_{jh_it_{i_{-1}}}; ID_{jt_{i_{-1}}}; GRW_{jt_{i_{-1}}};\ FA_{jt_{i_{-1}}};$$
$$Green_i; Owner_i; West_i; Size_i; Age_i; Trade_i$$

where $Home_i$is a dummy that equals one if the investor i has a ex ante technological advantage of the home country vis-à-vis the host country and equals zero if not (see Table 30 for more detailed description of variables), Cap_i approximates the absorptive capacity of the local partners (suppliers, customers, competitors respectively) as perceived by the affiliate i, $TS_{jh_it_{i_{-1}}}$ the technological specialisation of region j in industry h of investor i at t_{-1} as the year prior to the entry of investor i, $TD_{jt_{i_{-1}}}$ the technological diversification within region j at t_{-1}, $IS_{jh_it_{i_{-1}}}$ the specialisation of region j in the industry h of investor i at t_{-1}, $ID_{jt_{i_{-1}}}$ the diversification across industries of region j at t_{-1}. The remaining exogenous variables are control variables as suggested by the standard literature on spillover effects including $GRW_{jt_{i_{-1}}}$as the general investment grants per employee of region j at t_{-1} of investor i, $FA_{jt_{i_{-1}}}$ as the existing agglomeration of foreign and West German multinational firms in region j at t_{-1} of investor i, $Green_i$ as a dummy if the affiliate i is a Greenfield project and zero otherwise, $Owner_i$ as a dummy if the affiliate i is fully owned by a foreign or West German multinational and zero otherwise, as $West_i$ is a dummy if the affiliate i is owned by a West German multinational and zero otherwise, $Size_i$ as the number of employees of affiliate i, Age_i as the years since entry of investor i, and $Trade_i$ as the share of local trade of affiliate i .

In our second specification, we implement a locally driven innovation heterogeneity model where the parameter vector is given by

$$\beta_{locInn} = Au_i; Ex_i; In_i;\ Insal_i;\ Cap_i; TS_{jh_it_{i_{-1}}};\ TD_{jt_{i_{-1}}}; IS_{jh_it_{i_{-1}}}; ID_{jt_{i_{-1}}}; GRW_{jt_{i_{-1}}}; FA_{jt_{i_{-1}}};$$
$$Green_i; Owner_i; West_i; Size_i; Age_i; Trade_i$$

where Au_i approximates the extent to what affiliate i actively augments the technological ownership advantage of its MNE, Ex_i the extent to what affiliate i exploits an existing ex ante technological ownership advantage of its MNE, In_i the level of innovation intensity of affiliate i, $Insal_i$ the share of innovative sales. The following variables of the parameter vector are identical with the centrally driven heterogeneity model (see above).

Finally, we estimate a locally driven R&D heterogeneity model where the parameter vector is given by

$$\beta_{locRD} = Au_i; Ex_i; RD_i;\ Cap_i; TS_{jh_i t_{i-1}};\ TD_{jt_{i-1}}; IS_{jh_i t_{i-1}}; ID_{jt_{i-1}}; GRW_{jt_{i-1}}; FA_{jt_{i-1}};$$
$$Green_i; Owner_i; West_i; Size_i; Age_i; Trade_i$$

where Au_i approximates the extent to what affiliate i actively augments the technological ownership advantage of its MNE, Ex_i the extent to what affiliate i exploits an existing ex ante technological ownership advantage of its MNE, and RD_i the intensity of R&D expenditures of affiliate i in the year 2005. Again the subsequent variables are identical with the parameter vector of the centrally driven heterogeneity model.

The above specifications are estimated for all three types of technological spillovers: backward, forward, and horizontal. However, in the case of backward and forward spillovers the exogenous variable $Trade_i$ as the share of local trade of affiliate i is omitted as by definition the information about backward and forward linkage effects was only given if the affiliate had local trade with suppliers or customers based in East Germany. The inclusion of this variable would have generated spurious findings.

Thus we estimate:

$$y^*_{HOR} = \beta x' + \varepsilon$$

where y^*_{HOR} is the unobserved latent endogenous variable of the probability that the affiliate i indicated that it perceived itself as important source of technological knowledge for R&D and innovation in its competing firms based in East Germany at the time of the survey (see Annex Codebook v23_8b), β is the parameter vector of the underlying model, and ε is the error term.

$$y^*_{BACK} = x'\beta + \varepsilon$$

where y^*_{BACK} is the unobserved latent endogenous variable of the probability that the affiliate i indicated that it perceived itself as an important source of technological knowledge for R&D and innovation of its East German suppliers at the time of the survey (see Annex Codebook v23_4b), β is the respective parameter vector of the underlying model, and ε is the error term.

$$y_{FOR}^{*} = x'\beta + \varepsilon$$

where y_{FOR}^{*} is the unobserved latent endogenous variable of the probability that the affiliate i indicated that it perceived itself as an important source of technological knowledge for R&D and innovation for its customer firms based in East Germany at the time of the survey ((see Annex Codebook v23_6b), β is the respective parameter vector of the underlying model, and ε is the error term.

We estimate all equations using a stepwise backward procedure. It starts with the full model and eliminates the exogenous variable with the lowest significance level from the equation and re-estimates the equation until all remaining variables show a p-value below 0.4. This procedure is often used with small sample sizes.

Table 30 Measurement of variables in estimations of chapter 7

Variable	Measurement	Year	Source
Firm specific variables			
Technological ex ante advantage	Dummy variable that equals one if the affiliate considers its foreign/West German parent as a more or equally important as source for locally conducted R&D and innovation compared to its own contribution of technological knowledge relevant for R&D and innovation of the foreign/West German parent (v22_3b/v23_1b).	2007	FDI micro database (2007)
Augmenting	Extent to what the affiliate considers itself as an important source of technological knowledge relevant for R&D and innovation of the foreign/West German parent (not important, little important, important, very important, extremely important) (v23_1b)	2007	FDI micro database (2007)
Exploiting	Extent to what the affiliate considers the foreign/West German parent as an important source of technological knowledge relevant for R&D and innovation locally conducted (not important, little important, important, very important, extremely important) (v22_3b).	2007	FDI micro database (2007)
Innovation intensity	Intensity of product innovation of the affiliate in comparison to its main competitor(s) in the relevant market (v18_1a).	2005-2007	FDI micro database (2007)
Innovative sales	Log of the share of innovative goods and services in total turnover (v20_b).	2005	FDI micro database (2007)
Technological cooperation	Extent to which the affiliate considers cooperation (with other MNE units, firms or organisations) as an important source for R&D and innovation (not important, little important, important, very important, extremely important) (v21_2EDE).	2007	FDI micro database (2007)
R&D intensity	Log of the share of total R&D expenditures in total turnover of the affiliate (v19_2b).	2005	FDI micro database (2007)
Absorptive capacity	Extent to what the affiliate considers its East German based suppliers, customers, and competitors respectively as an important source of technological knowledge relevant for R&D and innovation locally conducted (not important, little important, important, very important, extremely important) (v22_6b/v22_8b/v22_9b).	2007	FDI micro database (2007)
Greenfield	Dummy that equals one if the investment project is a Greenfield project and zero otherwise (v7).	2007	FDI micro database (2007)
Ownership	Dummy that equals one if the affiliate is fully foreign/West German owned and zero otherwise (v3_3).	2007	FDI micro database (2007)
West German ownership	Dummy that equals one if the affiliate is West German owned and zero otherwise.	2007	FDI micro database (2007)
Age	Log of the years since entry of the foreign/West German investors (v2).	2007	FDI micro database (2007)
Size	Log of the number of employees of affiliate (v11_1b).	2005	FDI micro database (2007)
Local Trade	Log of the share of trade with East German based suppliers and customers in total trade of affiliate (v9_4/v10_4).	2007	FDI micro database (2007)
Region specific variables			
Technology specialisation	Revealed technological advantage (RTA) measured in terms of patent applications from industry and natural persons. Number of patent applications per industry (NACE 2-digit level) and region (ROR) standardised by total patent applications per region divided by the number of patent applications per industry (NACE 2-digit level) and region (ROR) standardised by total number of patent applications.	1995-2005	Patentatlas (2001, 2006)
Technology diversification	Inverse Herfindahl Index of patent application of industry and natural persons over industries (NACE 2 digit level) per region (ROR). The Herfindhal index is calculated as squared sum of the shares of patent applications of each industry (NACE 2) per region in total patent applications per region (ROR).	1995-2005	Patentatlas (2001, 2006)
Industry specialisation	Number of employees per industry (NACE 2-digit level) and region (ROR) standardised by total employment per region divided by the number of employees per industry (NACE 2-digit level) and region (ROR) standardised by total number of employees in all regions.	2005	Statistik der Bundesagentur für Arbeit (2005)
Industry diversification	Inverse Herfindahl index of employment per industry (NACE 2 digit level) and region (ROR). The Herfindhal index is calculated as squared sum of the shares of employment of each industry (NACE 2) per region in total employment per region (ROR).	2005	Statistik der Bundesagentur für Arbeit (2005)
Foreign firm agglomeration	Share of foreign and West German multinational employment over total employment (including self-employment) in region (ROR).	1995-2005	IWH FDI Micro database (2007), AK VGR der Länder (2009)
Investment grants	Annual sum of investment grants per employee per region (ROR). Includes grants for new private investment, investment directed at business expansion or acquisition of a firm that is facing closure ('Investitionszuschuss im Rahmen der Gemeinschaftsaufgabe').	1995-2005	Bundesminsiterium für Bau- und Raumordnung (2005)

7.6 Estimation results and discussion

7.6.1 Estimation results

The first set of estimations has been implemented following the centrally driven heterogeneity model. Estimation of the specification (I) on the potential of technological spillovers via backward linkages shows a log-likelihood of -97.29 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 1 and 2 Table 31). The likelihood ratio index indicates a Pseudo-R2 of 0.167. In line with hypothesis (1) affiliates with an ex ante technological advantage have a positive impact on the probability of technological spillovers effects to East German suppliers.

Table 31 Estimation results for model with centrally driven technological heterogeneity

Specification	(I)		(II)		(III)	
	Backward		**Forward**		**Horizontal**	
VARIABLES	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Column	(1)	(2)	(3)	(4)	(5)	(6)
(H1) Ex ante technological advantage	0.399*	(0.221)	0.386*	(0.222)	-	-
(H6) Absorptive capacity	0.834***	(0.206)	1.055***	(0.206)	0.484**	(0.185)
(H7) Technological specialisation	-	-	-0.639	(0.427)		
(H7) Technological diversification	-	-	-	-	-1.209	(1.225)
(H7) Industry specialisation	-	-	0.435***	(0.194)	0.174	(0.176)
(H7) Industry diversification	2.167**	(0.998)	-1.202	(0.914)		
Investment grants	-	-	0.183	(0.154)	0.370**	(0.160)
Foreign and WG agglomeration	-0.273	(0.178)	0.236	(0.181)	-0.226	(0.182)
Greenfield	-	-	-	-	0.324	(0.218)
Ownership share	0.506	(0.332)	-	-	-	-
West German ownership	-0.283	(0.233)	-	-	-	-
Size	-	-	-	-	-	-
Age	-	-	-	-	-0.336**	(0.159)
Local trade	X	X	X	X	0.114	(0.117)
Constant	-3.263**	(1.477)	-0.724	(1.662)	-2.906**	(1.005)
Observations	183		174		203	
Loglikelihood (null)	-115.78		-118.7		-108.6	
Loglikelihood (model)	-97.29		-100.2		-98.4	
Chi-square	33.62		33.88		19.11	
P-value Chi	0.0000		0.0000		0.0143	
PseudoR2	0.167		0.156		0.0945	
AIC	208		217		214	
BIC	231		242		244	

Note: The binary probit estimations above use a stepwise backward procedure. Not listed coefficients in the table above have been eliminated from the model if their p-value was above 0.4.
*** p<0.001, ** p<0.05, * p<0.1

In line with hypotheses (6), the absorptive capacity of East German suppliers increases the probability of technological spillovers. In accordance with hypothesis (7), regions characterised by a technological strength - in terms of a diversified industrial structure - increase the probability of technological spillovers via backward linkages.

Estimation of the specification (II) on the potential of technological spillovers via forward linkages shows a log-likelihood of -100.2 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 3 and 4 Table 31). The likelihood ratio index indicates a Pseudo-R2 of 0.156. In line with hypothesis (1), affiliates with an ex ante technological advantage have a positive impact on the probability of technological spillovers effects to East German customer firms. In line with hypotheses (6), the absorptive capacity of East German customers increases the probability of technological spillovers. In accordance with hypothesis (7), regions characterised by a technological strength - in terms of a specialised industrial structure - increase the probability of technological spillovers via forward linkages.

Estimation of the specification (III) on the potential of horizontal technological spillovers shows a log-likelihood of -98.4 which is, according to the probability value of the Chi-square statistic, not significantly different from the null hypothesis (see column 5 Table 31). Thus, the centrally driven technology heterogeneity approach fails to produce a statistical significant model of horizontal spillovers. As a result the parameter estimates cannot be interpreted.

The subsequent set of estimations has been implemented following the model of locally driven innovation heterogeneity. Estimation of the specification (I) on the potential of technological spillovers via backward linkages shows a log-likelihood of -57.77 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 1 and 2 Table 32). The likelihood ratio index indicates a Pseudo-R2 of 0.325. In line with hypothesis (2) home base augmenting activities of affiliates have a positive impact on the probability of technological spillovers effects to East German suppliers. Home base exploiting activities have no statistically significant effect. The positive impact of affiliates' innovation intensity on the backward spillover potential is in accordance with hypotheses (3). However, the effect of affiliates' share of innovative sales in total turnover is not significant. In support of hypothesis (4), affiliates' propensity to engage in technological cooperation increases the likelihood of backward spillovers to other firms. As in the model with centrally driven technology heterogeneity, we find a positive effect of East German suppliers' absorptive capacity and of regions with a diversified industrial structure on the spillover likelihood. This would be in support of hypotheses (6) and (7) respectively. From the set of control variables we find a negative effect of existing regional agglomeration of foreign and West German multinational affiliates. In contrast, there is a positive effect of affiliates' size and Greenfield projects on the likelihood of backward spillovers.

Table 32 Estimation results for model with locally driven innovation heterogeneity

Specification	(I)		(II)		(III)	
	Backward		**Forward**		**Horizontal**	
VARIABLES	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Column	(1)	(2)	(3)	(4)	(5)	(6)
(H2) Technology augmenting	0.859**	(0.349)	-	-	0.663**	(0.301)
(H2) Technology exploiting	-	-	-	-	-	-
(H3) Innovation intensity	0.803*	(0.450)	-0.405	(0.422)	0.708	(0.489)
(H3) Share of innovative sales	0.040	(0.042)	0.043*	(0.023)	-0.089**	(0.033)
(H4) Technological cooperation	0.510*	(0.294)	0.709**	(0.257)	1.122**	(0.708)
(H5) Absorptive capacity	1.219***	(0.299)	0.951***	(0.242)	0.545**	(0.227)
(H6) Technological specialisation	-	-	-	-	0.735	(0.567)
(H6) Technological diversification	-	-	-	-	-	-
(H6) Industry specialisation	0.384	(0.255)	0.518*	(0.274)	-	-
(H6) Industry diversification	3.585**	(1.341)	-2.194**	(1.038)	-2.120*	(1.088)
Investment grants	-	-	-	-	0.764***	(0.213)
Foreign and WG agglomeration	-0.529**	(0.230)	-	-	-	-
Greenfield	0.570*	(0.304)	-	-	-	-
Ownership share	0.633	(0.527)	-	-	-	-
West German ownership	-0.377	(0.276)	-	-	-	-
Size	0.187*	(0.103)	-	-	-	-
Age	-	-	-	-	-0.246	(0.198)
Local trade	X	X	X	X	0.185	(0.175)
Constant	-7.276**	(2.526)	-0.615	(0.562)	-8.055***	(1.630)
Observations	136		126		147	
Loglikelihood (null)	-85.61		-83.22		-79.50	
Loglikelihood (model)	-57.77		-66.86		-55.94	
Chi-square	45.88		29.59		38.64	
P-value Chi	0.0000		0.0000		0.0000	
PseudoR2	0.325		0.197		0.296	
AIC	141		147		134	
BIC	179		167		167	

Note: The binary probit estimations above use a stepwise backward procedure. Not listed coefficients in the table above have been eliminated from the model if their p-value was above 0.4.
*** p<0.001, ** p<0.05, * p<0.1

Estimation of the specification (II) on the potential of technological spillovers via forward linkages shows a log-likelihood of -66.86 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 3 and 4 Table 32). The likelihood ratio index indicates a Pseudo-R2 of 0.197. We find no statistical significant effect of home base augmenting or exploiting activities on the likelihood of technological spillover via forward linkages. Similarly, we find no statistically significant effect of affiliates' innovation intensity. Yet, the effect of affiliates' share of innovative sales in total turnover is positively significant and therefore in accordance with hypotheses (3). As in the case of backward linkage effects and in line with hypothesis (4) affiliates' propensity to engage into technological cooperation increases the likelihood of forward spillovers.

Similarly, we also can confirm a positive effect of East German customers' absorptive capacity on the forward spillover potential as suggested by hypothesis (5). In turn, we find a positive and significant effect of regions' endowed with a industrial specialisation advantages and a negative effect of regions with a diversified industrial structure.

In contrast to the centrally driven heterogeneity model the approach that models horizontal spillovers as a function of locally driven innovation heterogeneity is able to produce an overall significant estimation. The corresponding estimation of the specification (III) shows a log-likelihood of -55.94 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 5 and 6 Table 32). The likelihood ratio index indicates a Pseudo-R2 of 0.296. As in the estimation of backward spillovers and in line with our hypothesis (2) we find a statistical significant effect of home base augmenting activities on the likelihood of horizontal technological spillovers to East German competitors. The effect of home base exploiting activities is not significant. The results show no statistically significant effect of affiliates' innovation intensity. However, affiliates' share of innovative sales in total turnover has a negative effect on the likelihood of horizontal technological spillovers in contrast to hypotheses (3). As in the case of backward and forward linkage effects and in line with hypothesis (4), affiliates' propensity to engage into technological cooperation increases the likelihood of horizontal spillovers. Similarly, we can confirm a positive effect of East German competitors' absorptive capacity on the likelihood of technological spillover as suggested by hypothesis (6). With regard to region specific effects horizontal spillovers are less likely in regions characterised by a diversified industrial structure. From the set of control variables we find horizontal effects more likely if the affiliate is located in a region characterised by a high intensity of public investment grants.

The final set of estimations follows a model of locally driven R&D heterogeneity. Estimation of the specification (I) on the potential of technological spillovers via backward linkages shows a log-likelihood of -57.39 which is, according to the probability value of the Chi-square statistic, not significantly different from the null hypothesis (see column 1 Table 33). Therefore, the parameter estimates cannot be interpreted.

Table 33 Estimation results for model with locally driven R&D heterogeneity

Specification	(I)		(II)		(III)	
	Backward		**Forward**		**Horizontal**	
VARIABLES	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
Column	(1)	(2)	(3)	(4)	(3)	(4)
(H2) Technology augmenting	1.273***	(0.379)	0.395	(0.294)	0.456	(0.292)
(H2) Technology exploiting	-	-	-	-	-	-
(H3) R&D intensity	-	-	0.473	(0.390)	-0.637	(0.450)
(H4) Technological cooperation	0.508*	(0.304)	0.690**	(0.278)	1.381**	(0.708)
(H5) Absorptive capacity	1.002**	(0.324)	1.140***	(0.259)	0.313	(0.215)
(H6) Technological specialisation	-	-	-0.926	(0.587)	-	-
(H6) Technological diversification	4.160	(2.720)	2.957	(1.778)	-	-
(H6) Industry specialisation	0.414	(0.276)	0.435	(0.287)	-	-
(H6) Industry diversification	3.980**	(1.501)	-2.204**	(1.038)	-	-
Investment grants	0.243	(0.260)	0.323	(0.199)	0.566***	(0.205)
Foreign and WG agglomeration	-0.426*	(0.243)	-	-	-0.241	(0.230)
Greenfield	0.348	(0.310)	-	-	0.474*	(0.265)
Ownership share	0.914	(0.574)	-0.340	(0.350)	-	-
West German ownership	-	-	-	-	-	-
Size of affiliate	0.206**	(0.103)	-	-	-	-
Age	-	-	-0.226	(0.205)	-0.396**	(0.184)
Local trade	X	X	X	X	-	-
Constant	-9.017**	(2.526)	-1.652	(1.855)	-4.616**	(1.409)
Observations	133		133		154	
Loglikelihood (null)	-82.16		-90.19		-84.91	
Loglikelihood (model)	-57.39		-67.69		-65.30	
Chi-square	31.02		39.11		33.84	
P-value Chi	0.0011		0.0000		0.0000	
PseudoR2	0.325		0.249		0.231	
AIC	138		159		149	
BIC	173		194		176	

Note: The binary probit estimations above use a stepwise backward procedure. Not listed coefficients in the table above have been eliminated from the model if their p-value was above 0.4.
*** p<0.001, ** p<0.05, * p<0.1

Estimation of the specification (II) on the potential of technological spillovers via forward linkages shows a log-likelihood of -67.69 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 3 and 4 Table 33). The likelihood ratio index indicates a Pseudo-R2 of 0.249. We find no statistical significant effect of home base augmenting or exploiting activities on the likelihood of technological spillover via forward linkages. Equally we find no statistically significant effect of affiliates' R&D intensity on the spillover likelihood. As in prior estimations and in line with hypothesis (4), affiliates' propensity to engage into technological cooperation increases the likelihood of forward spillovers. We also can confirm a positive effect of East German customers' absorptive capacity on the forward spillover potential as suggested by hypothesis (5), but a negative effect of a diversified industrial structure within a region.

The estimation of specification (III) on horizontal spillovers shows a log-likelihood of -65.30 which is, according to the probability value of the Chi-square statistic, significantly different from the null hypothesis (see column 5 and 6 Table 33). The likelihood ratio index indicates a Pseudo-R2 of 0.231. We find no statistical significant effect of home base augmenting or exploiting activities on the likelihood of horizontal technological spillovers. Again, there is evidence for a positive effect of technological cooperation a suggested by hypothesis (4). From the set of control variables we find horizontal effects more likely if the affiliate is located in a region characterised by a high intensity of investment grants, if it is a Greenfield project, and if it exists already for a longer period of time.

7.6.2 Discussion

The final empirical chapter of the dissertation analysed to what extent suppliers, customers, and competitors located in East Germany potentially benefit from technological spillover effects generated by foreign and West German multinational affiliates. Cantwell (1987, 1989, 1995) proposes a dynamic interaction between firm specific ownership and location specific advantages. He argues that each innovating firm brings external benefits to the locality in which it invests. However, inward FDI may have competitive and anti-competitive effects on host countries depending upon the question whether indigenous firms enjoy a strong technological tradition in the sector (ibid). So far, the evidence on externalities from the presence of foreign and West German firms in East Germany is based on traditional FDI spillover models and neglects the role of MNE heterogeneity as well as local technological capabilities when searching for knowledge spillover effects (Peri and Urban 2006, Günther and Lehman 2007).

Traditional studies of FDI spillovers use the production function approach that measures effects from the presence of FDI for example in terms of employment or value added on domestic firms' total factor or labour productivity within the same or related sectors. Significant effects on domestic firms' productivity are interpreted as indirect evidence for spillover effects. In contrast, our approach does not rely on productivity measures but uses survey evidence. We attempt to "trace the flow of technological knowledge" by assessing technology related knowledge flows from multinational affiliates to local firms. However, these measures are subject to self-assessment by multinational affiliates. From this information we are not able to draw any conclusion with regard to the economic effects of such knowledge flows 'other firms' based in East Germany. These firms could be domestic owned but similarly foreign or West German owned. Furthermore, our measurement approach does only capture a particular channel for externalities. For example, we cannot account for any potential externalities from multinational affiliates through labour mobility. Finally, within our framework we cannot disentangle negative competition and positive technological spillover effects. However, both can be associated with the entry of multinational firms. Thus, our survey based approach to measure spillovers suffers from considerable limitations. It remains indirect evidence of spillovers that should be better termed as a 'potential for technological externalities'. Yet, the use of survey-based indicators for spillover analysis seems to be justified as the main focus in this investigation has been on the role of centrally and locally driven technological MNE heterogeneity. The required information is not available from other existing micro-datasets that are representative for both, foreign and domestic firms within East Germany.

Our descriptive evidence indicates that the majority of foreign and West German affiliates indicate nor or very low potential for technological externalities. The potential for technological spillover effects is higher in case of forward linkages compared to backward or horizontal effects. This finding is in contrast to results for other post-communist transition economies derived from the investigations applying the production function approach (see Rojec et al. 2008 or Jindra 2005).

Following Chung (2001) and Driffield and Love (2007) we implemented a central driven MNE heterogeneity model. The estimation results show that MNEs having an ex ante technological advantage of the home country vis-à-vis east Germany are more likely to generate technological spillover effects via backward and forward linkages. The model does not hold statistically for horizontal effects. Chung (2001) and Driffield and Love (2007) argue that it is only FDI in the exploitation of an existing technological asset and not technology sourcing that generates spillovers to the domestic economy. In order to test this we implement a locally driven innovation heterogeneity model. Our results show that pure exploitation of an existing technological advantage of the MNE does not statistically impact on the generation of all three types of technological spillovers. In contrast, only affiliates that augment an existing technological advantage have a statistical significant and positive effect on horizontal as well as backward spillover effects. In contrast to the conclusion by Chung (2001) and Driffield and Love (2007) we would argue that independent from an ex ante technological advantage of the

MNE it is local competence creating rather than purely competence exploiting activities that is crucial for the generation of technological spillovers to the host economy. This finding is in line with the position the local evolution of subsidiaries towards competence creating capabilities matters to the capacity of subsidiaries and indigenous firms to interact, and hence for the presence and absence of local spillovers in either direction (Cantwell and Piscitello 2007, Marin 2006, Cantwell 2009).

Furthermore, we are able to show that the intensity of innovation activity of affiliates based in East Germany in comparison to the main competitors in the relative market affects positively technological externalities via backward linkages. Similarly, the innovation output affects positively technological externalities via forward linkages. This finding would be in line with Cantwell (1989) and other studies that applied locally driven heterogeneity FDI spillover models (Todo and Miyamoto 2002, Marin and Bell 2006, Castellani and Zanfei 2006). However, affiliates' share of innovative sales has a negative effect on the extent of horizontal spillovers. This would imply in contrast to the proposition of the technological accumulation approach a kind of adverse selection process as suggested by other authors (Alcácer and Chung 2007) i.e. technologically leading affiliates tend to prevent leakage of technological knowledge to their competitors.

Our results from the locally driven technology heterogeneity models also show that affiliates that conduct technological cooperation are more likely to generate technological externalities of all three types scrutinized. Moreover, in both types of heterogeneity models the absorptive capacity of other suppliers, customers, as well as competitors has a positive effect on the existence of corresponding technological spillover effects. The evidence on affiliates' technological cooperation and other firms' absorptive capacity indicates the kind of reciprocity of knowledge spillovers for both intra and inter-industry relations between foreign and domestic firms as proposed by Castellani and Zanfei (2006).

However, (Cantwell 1989, 1995) also points to the importance of existing sector specific technological strength of the host country location as a condition for technological spillovers to develop from the activities of multinationals. In the estimation results from the centrally as well as locally driven heterogeneity models, we never find a statistical significant effect of sector specific technological specialisation of the region in which the affiliate invests. More persistently, we can show that in regions that are characterised by a diverse industry structure technological spillover effects via backward linkage are more likely. In other words, if the region has a higher degree of industry diversification this increases the potential for multinational affiliates to source supplies regionally. In turn, higher linkage intensity increases the potential for technological spillovers between the MNE and local supplier firms. This relationship would be in line with models of backward linkage effects proposed by Rodríguez-Clare (1996) and Smarzynska Javorcik (2004). However, our investigation also shows that technological spillovers from multinational affiliates to local customer firms are more likely in regions that show industry specialisation. This would imply that if a region has a relative specialisation in the industry in which the MNE invests, this offers more opportunities to multinational affiliates to sell to other local firms, which in turn seems to increase the potential of technological spillover effects to local customer firms. Yet, the absence of any statistically significant effects of existing sector specific technological strength at spillover potential form MNEs based in East Germany could hint at a disturbed interaction between ownership and location specific advantages as postulated by the technological accumulation approach.

8. Main contributions, limitations, and further research

This final chapter of the thesis contextualises the findings from the dissertation and derives the main contributions with regard to the theoretical, empirical, and policy dimension. We introduce the chapter by summarising briefly the findings to the research questions of the dissertation. Second, we consider the research implications for the theory of technological accumulation and firm internationalisation. Thereby, the discussion revolves around the main propositions of the approach namely technological accumulation and firm location, motives for the internationalisation of R&D and innovation, and the dynamic interaction between ownership and locational advantages. The third section deduces the additions to the existing research on East Germany and probes into possible generalisations for other post communist transition economies. In particular, we pay attention to the role of spatially distinct capabilities in MNEs' location choice, regions' capability to attract MNEs' R&D and innovation, as well as the extent and conditions for technological spillovers from MNEs to the host economy. The fourth section draws the main policy implications with regard to behaviourally aspects of investment and regional policy, linkage promotion, R&D and innovation, as well as science and higher education. Finally, we spell out the main limitations of the research approach with respect to assumption in the research approach, data, measurement, and estimation procedures and identify possible future research directions on the subject.

8.1 Summary of research results

The dissertation applied the technological accumulation approach in a comprehensive way to explain the internationalisation of foreign and West German multinationals into East German manufacturing since the start of transition. Thereby, we proceeded in three analytical steps, which according to the theory are interrelated: MNEs location choice, the localisation of technological activities, and the potential for technological externalities from MNEs to the host economy.

First, the research showed that, other things equal, agglomeration economies of associated with regional industry localisation and urbanisation effects affect foreign and West German multinationals' general location choice. Furthermore, we are able to show that spatially distinct technological capabilities in terms of technological specialisation and science industry spillovers affect MNEs' regional location choice in East Germany. However, locational factors do not apply uniformly across investors. Instead, we find that significance of agglomeration related effects on MNEs' location choice is subject to firm and industry heterogeneity.

Second, we find that foreign and West German multinational affiliates are more frequently active in R&D but with lower R&D intensities compared to the total East German manufacturing. Similarly, MNEs are more often engaged in product and process innovation and generated a higher innovation output compared to the total of East German manufacturing firms. Differentiating the underlying motives for the internationalisation of R&D and innovation we find a relatively high share of technology seeking affiliates and overall a close balance of affiliates that actively draw from the technological strength of East Germany and firms that predominantly exploit an ex ante technological advantage of the home country. The estimation results show that location specific technological externalities across East German regions are not powerful enough to attract the MNEs' R&D and innovation activities. Yet, specific combinations of technology and other agglomeration economies within regions influence the location of technological activities by multinationals. MNEs' innovation takes advantage of technological and industry specialisation within regions, whereas foreign R&D benefits from technological specialisation in combination with a diversified industry structure. Taking into consideration the underlying motive for internationalisation of R&D and innovation, we find that affiliates that exploit an ex ante technological advantage are not responsive to existing technological externalities, whereas technology seeking and asset augmenting affiliates are.

Third, we find that the majority of foreign and the majority of foreign and West German affiliates indicate nor or very low potential for technological externalities. The potential for technological spillover effects is higher in case of forward linkages compared to backward or horizontal effects. The potential for technological spillovers is higher for multinational affiliates that possess a centrally accumulated ex ante technological advantage in the home country vis-à-vis East Germany. However, the locally driven heterogeneity model shows that technological asset seeking and augmenting activities rather than pure asset exploiting activities increase the potential for technological externalities to other firms located in the East German economy. Furthermore, the innovative activity increases the potential for vertical spillovers. However, the opposite is true for horizontal spillover effects. We find no corresponding effects of affiliates' R&D activity. Finally, indigenous spatially distinct technological capabilities do not affect the spillover potential, however local firms' absorptive capacity and other industry agglomeration does.

8.2 Implications for the technology accumulation approach

8.2.1 Technological accumulation matters for MNEs' location choice

From Cantwell`s (1989, 1995) point of view, the generation of new technological capability is a condition for every firm in an oligopolistic industry to maintain or increase profits. In this capability based view of the firm, the major issue is how to establish a spatially and scectorally diffuse system for the creation of new capability (Cantwell and Piscitello 2000). It is suggested that the use of technology in new environments feeds back into fresh adaptation and new innovation depending on the state of local scientific and technological capability (Cantwell 1989). Thereby, it is assumed that MNEs take advantage of externalities in foreign locations which stimulate the internal learning process of the multinational firm (Cantwell and Immarino 1998, 2001, 2003).

From our perspective, this argument applies not only to the location of technological but also production activities and hence, to the location of multinational affiliates in general. To our best knowledge, this is the first study to test the impact of regional knowledge spillover potential form technological specialisation, diversification as well as science infrastructure controlling for standard variables including other agglomeration economies related to employment and industry structure on MNEs' sub-national location choice. In line with existing empirical investigations (Basile 2004, Basile et al. 2008, Barrios et al. 2006, Chung and Alcácer 2002, Crozet et al. 2004, Guimarães et al. 2000, Spies 2010), we can show that region specific external economies associated with industry specialisation, industry diversification, as well as existing foreign/West German firm concentration affect positively multinationals' regional location choice. As an original contribution, we are able to show that knowledge spillover potentials from regional technological specialisation as well as public science infrastructure are significant determinants of MNEs' location choice too. In contrast, we find the effect of regional technological diversification on location choice statistically not significant.

Following the principal argument of Chung and Alcácer (2002), we are able to show that MNEs' industry and firm heterogeneity affects significantly the valuation of technology related externalities as locational factors. The evidence indicates that the spillover potential from regional technological specialisation is particularly relevant for location choice in industries in which firms' competitiveness depends to a large extent depends upon R&D inputs. With regard to firm heterogeneity, we find that location specific technological diversification matters statistically only for multinationals pursuing a multiple entry or staged acquisition strategy in the host economy.

We could conclude that spatially distinct technological capabilities in terms of technological specialisation in the private sector and public science-industry spillovers affect positively the profit maximisation function underlying multinationals' sub-national location choice. In principal, our evidence shows that both existing spatially distinct technology externalities as well as other existing agglomeration economies associated with specialised or diversified employment/industry structure attract MNEs. This supports the proposition that internationalised firms take advantages from dynamic economies of scope that derive from the complementarities between related technological fields or the complementarity between related paths of innovation in foreign spatially distinct settings (Cantwell and Piscitello 2000) as well as the evolutionary position that technological and capital accumulation are interlinked and continued processes which take place in a localised context (Cantwell 1989).

8.2.2 Technological externalities alone do not attract R&D and innovation

The technological accumulation approach proposes that the localisation of MNEs' technological activities depends upon the interrelationship between their corporate strategy and location specific characteristics (Cantwell and Piscitello 2005). This is based on the assumption that innovation is location specific as well as firm specific (ibid). In fact, Cantwell and Piscitello (2005, 2007) empirically confirm that technology related knowledge spillover potential from regional specialisation, diversification, and science infrastructure affect significantly the location of foreign owned R&D.

In contrast, to existing empirical applications (Cantwell and Piscitello 2005, 2007), we account for other agglomeration externalities associated with labour and firm structure within the region when analysing the impact of location specific technology related externalities on MNEs localisation of technological activities abroad. Thereby, we can differentiate between existing location specific technological and capital accumulations as locational determinants for MNEs' R&D and innovation. Moreover, we are able to test for possible interactions between the two types of location specific externalities. In contrast to existing studies we test for statistical differences in locational determinants between affiliates that implement technological activities, and those that do not. This avoids a potential estimation bias. Furthermore, we differentiate between the location of R&D and innovation by MNEs, whereas existing applications generated evidence on the location of MNEs' invention activities.

In contrast to Cantwell and Piscitello (2005, 2007), our findings indicate that technology related spillover potentials affect significantly the location choice of multinationals in general, however, not the location of MNEs' technological activities. We argue that technology related spillover potentials on their own are not powerful enough to attract multinationals' technological activities. Instead, the localisation of technological activities is sensitive to specific combinations of potentials for technology related and other agglomeration externalities within a region. More specifically, the localisation of MNEs' innovation activities is responsive to a technological specialisation in combination with industry specialisation within the region. The localisation of foreign R&D is responsive to the joint presence of a technological specialisation and industry diversification within the region.

Our results do not render the argument of Cantwell and Piscitello (2005, 2007) invalid. Instead, we simply suggest a more differentiated picture with regard to the role of spatially distinct capabilities for the internationalisation of technological activities. It seems that MNEs foster the development of capability by placing technological activities in localities that offer specific combinations of technology and other agglomeration related spillovers. Thereby, spillovers from technological and industry specialisation of an industry within a particular foreign location feed back into the innovation activities of the MNE. Foreign R&D benefits from a spatial proximity to a specialised technology and complementary inputs into the R&D process from a diversified industry structure. In principal, our evidence shows that location specific capabilities feed into capability formation of MNEs and supports the notion of the MNE as a geographically dispersed innovation network as suggested by the technological accumulation approach.

8.2.3 Competence creating as motive for foreign R&D and innovation

A debate developed on the question whether innovation and R&D primarily takes place in the home country of the MNE, or also abroad. Vernon (1966) proposed the hypothesis of an innovation driven ownership advantage that originates in the home country and that is exploited in foreign operations. This position is rejected, Cantwell (1995). From this discussion on the generation of ownership advantages, emerged a differentiation of foreign affiliates into asset or competence exploiting vs. asset or competence creating (Dunning and Narula 1995, Kuemmerle 1996, Cantwell and Mudambi 2005). From a technology perspective, the role of the first group would be restricted to the adoption and diffusion of an existing centrally accumulated technological advantage (Patel and Vega 1999, Zanfei 2000), whereas the latter group absorbs knowledge in foreign location in order to enhance MNEs' technological ownership advantage (Zanfei 2000, Cantwell 1995, Cantwell and Piscitello 2007).

In line with existing empirical studies (Patel and Vega 1999, Le Bas and Sierra 2002), we find a close balance of affiliates that predominantly exploit an ex ante technological advantage of the home country, and affiliates that acquire new technological capability or enhance the existing technological advantage of the MNE in the host economy. However, we find a relatively high share of technology seeking affiliates. Thus, it seems that a sizeable part of MNEs places technological activities in East Germany in order to overcome technological weaknesses at home. This finding would support the position of Cantwell (Cantwell 1989, 1995) that an ex ante technological advantage is not a priory a requirement for the internationalisation of technological activities.

Apart from Cantwell and Piscitello (2007), this is one of the first studies that empirically tests for differences in MNEs' sub-national location choice depending upon the underlying motive for technology internationalisation. Our evidence supports the general argument that competence exploiting is predominantly demand driven, whereas competence creating is more supply driven (Patel and Vega 1999, Cantwell and Mudambi 2005, Narula and Zanfei 2005, Cantwell and Piscitello 2007). As an original contribution, we show that technology seekers overcome a technological weakness at home by locating in regions where they are able to observe other multinationals and can absorb intra industry spillovers from technological and industry specialisation. Affiliates augmenting the existing technological advantage of the MNE are attracted by host country regions that facilitate active search for new or complementary knowledge beyond their own sector of activity by absorbing science-industry and inter-industry spillovers. Thus, we show the distinct locational patterns of MNEs that choose foreign locations as a means of improving existing assets, or to acquire and create new technological assets. This evidence further supports the argument that firms' internationalisation of technological activities can not only be understood as a consequence of ex ante technological ownership advantage to be exploited in foreign markets (Cantwell 1989, 1995, Narula and Zanfei 2005).

8.2.4 MNEs' spillovers subject to competence creating

The literature on the technological accumulation approach suggests that presence of spillover effects from multinational affiliates to the host economy depends on local evolution toward competence creating capabilities (Cantwell 2009). This view differs for example from Vernon (1966) product life cycle approach to firms' internationalisation and corresponding models that assume FDI spillover effects to be conditional upon a centrally accumulated technological advantage (Chung 2001, Driffield and Love 2007). Here, it is suggested that it is only FDI in the exploitation of an ex ante technological asset and not technology sourcing that generates spillovers to the domestic economy (ibid).

In fact, our evidence from a centrally driven technological MNE heterogeneity model indicates that an ex ante technological advantage of the home country vis-à-vis the host country increases the potential for technological spillovers from multinational affiliates. So far, our findings would correspond to existing studies implementing a centrally driven heterogeneity model (Chung 2001, Driffield and Love 2007). However, we also implement a locally driven heterogeneity model in order to test to what extent spillover effects depend on the actual technological behaviour of affiliates independent from an ex ante technological advantage. In line with the position of the technological accumulation approach (Cantwell 2009) the evidence suggests that it is local competence creating rather than purely competence exploiting activities that is crucial for the generation of technological spillovers to the host economy.

Thus, we find evidence that existing spatially distinct technological capabilities attract the location of multinationals and in combination with other agglomeration economies also the location of affiliates seeking to acquire new technological assets or that augment an existing technological advantage of the MNE. In turn, we find evidence that such local competence creating activities also increase the potential for technological externalities to other firms any, and thereby reinforce existing distinct technological capabilities of the foreign location.

8.2.5 Limited dynamic interaction of ownership and location advantages

In Cantwell's (1989, 1995), technology accumulation approach ownership advantages become endogenous to the active strategic role of firms in using innovation and technological accumulation to develop their competitive edge. In turn, location advantages become endogenous via the innovative activity of companies and their technological spillover effects on the industry and locality (ibid). The perception of the MNE as a network for geographically dispersed innovation stresses the dynamic connectedness between local knowledge creation and exchange. Cantwell's (2009) holds that an integrated interactive network for the generation of ownership advantages relies on the interrelatedness between specialised activities conducted in particular locations, each of which takes advantage of spatially specific capabilities through relationship with other local actors (ibid). This perspective suggests on the one hand that spatially distinct technological capabilities in the host country affect the location choice of MNEs and the localisation of their technological activities. On the other hand, it is assumed that technological externalities from MNEs are more likely if the affiliate invests in technological activities and is based in host country regions characterised by distinct technological capabilities.

In fact, our evidence indicates that existing regionally distinct capabilities matter for the location choice of MNEs in general as well as for the localisation of their technological activities. In particular, we could show that existing location bound technology related externalities attract MNEs. In combination with other agglomeration advantages they also matter for the localisation of R&D and innovation. This would support Cantwell (1989) position that MNEs' ownership advantages are endogenously created by strategic location abroad.

Furthermore, affiliates that conduct technological cooperation are more likely to generate vertical or horizontal technological spillovers. In turn, the absorptive capacity of local firms has a positive effect on the existence of corresponding technological spillover effects. This in fact, indicates the kind of reciprocity of knowledge exchange proposed for both intra and inter-industry relations between foreign and domestic firms (Castellani and Zanfei 2006, Cantwell 2009).

However, Cantwell (1989) holds that locational advantages are endogenously created by MNEs' innovation and location strategies combined with spillover effects of their activities. Yet, our evidence indicates that affiliates investment into innovation activities can have a positive effect in case of vertical spillovers, but also a negative effect in terms of horizontal effects. It seems that technologically leading MNEs are less likely to generate intra-industry spillovers and therefore, do not reinforce existing distinct technological capabilities. This result could be explained by an adverse selection process, where technological leading MNEs place their foreign innovation activities not in proximity to other technological competitors to prevent knowledge outflows, whereas technologically lagging MNEs might do so in order to benefit from knowledge inflows as suggested by Alcácer and Chung (2007).

Furthermore, Cantwell (1989, 1995) points to the importance of existing sector specific technological strength of the host country location as a condition for technological spillovers to develop from the activities of multinationals. Yet, we find no corresponding effect on the likelihood of such existing technological externalities on the spillover potential from MNEs to the host economy. Furthermore, we find that existing foreign agglomerations can have a negative effect on the potential for technological externalities.

Thus, on the one hand technological externalities attract MNEs in general and in combination with other agglomeration economies also their R&D and innovation into foreign location. Thus, MNEs' ownership advantage is in fact endogenously created by strategic location and investment decisions as postulated by the technology accumulation approach. On the other hand, sector and regions characterised by distinct technological advantages are not necessarily those that benefit from technological externalities generated by MNEs. Furthermore, affiliates' innovation activities can have positive as well as negative impact on the spillover potential from MNEs. Thus, it is possible that an adverse selection process prevents locational advantages within the same sector of activity are endogenously created by MNEs' innovation strategies combined with spillover effects of their activities as assumed by the technological accumulation approach. In sum, this evidence does not fully support a dynamic interaction between ownership and locational advantages in the internationalisation of firms.

8.3 Contributions to research on East Germany

To our best knowledge, this is the first empirical application of the technological accumulation approach towards explaining the phenomenon of firm internationalisation into East Germany as a post-communist transition region of Central and East Europe. Following the theory, we investigate three interrelated empirical questions which otherwise are treated independently from each other: MNEs' location choice, internationalisation of R&D and innovation, and the potential for spillovers from MNEs to the host economy.

8.3.1 Agglomeration economies matter for MNEs' location choice

During the 1990s, the locational attractiveness of East Germany for foreign firms was explained by mainly three factors: access to the German and West European markets, low capital cost mainly due to investment incentive schemes, and the availability of qualified and motivated personnel at relative low labour cost (Belitz et al 1999). In a more recent study (Thum et al. 2007), East German foreign affiliates indicated more often 'advantageous local production conditions' compared to 'market access' as dominant investment motive. However, they also pointed at the 'availability of scientific knowledge of public research and higher education institutions' as another important investment motive.

None of the prior studies on locational determinants of FDI in East Germany takes systematically account of the role of various agglomeration economies, which have been recognised as crucial by other recent international contributions on MNEs' regional location choice (Basile 2004, Basile et al. 2008, Barrios et al. 2006, Chung and Alcácer 2002, Crozet et al.

2004, Guimarães et al. 2000). Our evidence shows that East German regions characterised by a revealed advantage of industry specialisations and a diversified industry structure are more likely to attract MNEs. As suggested by the technological accumulation approach (Cantwell 1989), we find that spatially distinct capabilities matter too. More specifically, a revealed technological advantage as well as a high potential for science-industry spillovers draw multinationals into East German regions.

Furthermore, this is the first study testing for East Germany whether locational factors apply uniformly across investors as challenged by recent international research (Basile et al. 2008, Chung and Alcácer 2002, Crozet et al. 2004). With regard to technology related externalities, we find that the potential for knowledge spillovers from technological specialisation is higher for firms in high-and medium high-tech industries, diversification of a region across different technologies matters for affiliates implementing a staged or multiple entry strategy, and finally science-industry spillover are stronger pull factors for foreign vs. West German multinationals and affiliates that entered after the initial phase of liberalisation and privatisation process was finalised.

In sum, we would argue that our evidence confirms the relevance of market access and public policy instruments (investment grants and local tax) as important location factors for MNEs in East Germany. In addition, we firmly establish that industrial agglomeration economies as well as technology related externalities play a significant role in the location choice as suggested by the technological accumulation approach. Existing studies from various European economies and the US confirm the relevance of agglomeration economies in MNEs' location choice. Our evidence confirms that this rationale applies also to East German as a post communist transition region. This is, in particular, relevant with regard to the role of technological externalities, which arguably have been affected strongly by the privatisation process as well as the transformation of the innovation system throughout the transition period. To what extent the same results on MNEs location choice could be expected for other transition economies remains an open question as we lack corresponding empirical applications.

8.3.2 Regions capable of attracting MNEs' R&D and innovation

Koschatzki et al. (2006) argues that despite 'considerable policy efforts at different levels to promote FDI into East Germany in the context of global location choice multinationals requirements for regional innovation systems can only be very rarely be fulfilled by East Germany' (p.8). This position might also be related to the situation during the privatisation process until the mid 1990s, where most foreign and West German investors had not much interest in the existing R&D departments and R&D institutes of the former combinates. Instead, they usually relied on R&D taking place in the headquarters or another affiliates of their enterprise group in West Germany or abroad (Günther et al. 2009b).

However, already existing empirical evidence indicated that foreign and West German affiliates operate a higher level of technological activities in terms of R&D and innovation compared to domestic owned firms in East Germany throughout 1990s (Günther and Lehmann 2004, Günther and Gebhardt 2005, Günther and Peglow 2007). In addition, our research showed that since entry foreign and West German affiliates became on average less dependent on technological knowledge from the parent, integrated stronger with other MNE-units, and today increasingly contribute to the development of technological ownership advantage of headquarters as well as other MNE units.

This is the first study to shed light on the underlying motives for the location of technological activities within East Germany. We find a close balance of affiliates that predominantly exploit an ex ante technological advantage of the home country, and affiliates that acquire new technological capability or enhance the existing MNEs' technological advantage from locations within East Germany. In comparison to other international studies, the share of technology seeking investment to overcome a technological weakness in the home country is relatively high in East Germany.

Furthermore, MNEs investment into technological activities is characterised by distinct regional specialisation as well as diversification patterns. The econometric analyses generated evidence that location bound technology related knowledge spillovers in combinations with other agglomeration externalities are decisive for the localisation of R&D and innovation within East Germany. The localisation of MNEs' innovation activities is responsive to a revealed technological advantage in combination with industry specialisation within the region. Foreign R&D is responsive to the joint presence of a revealed technological advantage and industry diversification within the region.

In sum, given this new evidence, we would argue that East German regions and corresponding technological capabilities in the private and public sector are in fact able to draw multinationals' R&D and innovation activities. The employment share of MNEs in East German manufacturing, their high level of technological activity, and the alignment of multinationals R&D and innovation with spatially distinct capabilities shows that they have a considerable impact on the regional economic structure and could act as important network organisers in the regional innovation system. This result might not apply to the same extent to regional innovation systems of other post-communist countries for mainly reasons: First with few exceptions the total size of the R&D sector and the relative size of the private R&D sector is smaller in other transition economies compared to East Germany (Günther et al. 2010). Second the institutional reform regard to the public science sector lagging further behind in transition economies (von Dyker 2010, Dyker 2004). Finally, most FDI into the region is market rather than efficiency seeking which inhibits the evolution toward more technological oriented functions undertaken locally (von Tunzelmann 2004).

8.3.3 Spillovers from MNEs limited and not an automatic process

The central argument of Peri and Urban (2006) with regard to horizontal spillovers is that FDI can be concentrated in advanced regions of West Germany, where there is not much scope for technological learning, while fewer but highly productive foreign companies can have a strong domestic impact in the backward regions of East Germany. This argument can be related back to the traditional models of FDI spillover effects, which in principal assumes that spillovers simply result from the presence of investors' knowledge stock. This type of models partially augmented by domestic firms' absorptive capacity underlies also most of the research on spillover effects in post-communist transition economies of Central and East Europe. Corresponding results are mixed but on tendency show that only the more productive domestic firms and firms with higher absorptive benefit.

In line with technology accumulation approach, we challenge the assumption of MNE homogeneity when searching for horizontal and vertical FDI spillover effects in East Germany. We are able to show that foreign and West German multinationals that have an ex ante technological advantage vis-à-vis East Germany are more likely to generate technological externalities to other firms within East Germany. Independent from a centrally accumulated technological advantage, heterogeneity of local foreign and West German affiliates matters too. Affiliates that actively augment the existing technological advantage of the MNE, invest in innovation activities, and have a propensity to implement technological cooperation are more likely to generate the desired externalities. Consequently, the local evolution of affiliates towards competence creating matters for the capability of multinationals to generate spillovers. In line with existing studies from other transition economies, our results confirm that externalities from MNEs drive particularly well if domestic firms show a high level of absorptive capacity.

This evidence firmly underlines that spillovers from MNEs in East Germany cannot be treated as following a unidirectional pipeline of knowledge transfer simply trickling down from the parent company through subsidiaries on to other actors. Consequently, not every multinational firm provides the same knowledge opportunities. In fact, the majority of affiliates do not indicate a potential for technological externalities to other firms located in East Germany. The potential for technological spillover effects is higher in case of forward linkages compared to backward or horizontal effects. The low level of vertical effects can partially be explained by limited trade integration of foreign and West German with East German customers or suppliers. This position is supported by the finding that a diversified industrial structure within East German regions fosters backward linkage effects, whereas regional industry specialisation triggers forward linkage effects.

In sum, we would argue that the potential for technological externalities from MNEs in East Germany is subject to investors' and local firms' collective investment into technological activities as well as emerging location specific agglomeration economies. It is certainly not an automatic consequence from the presence of multinationals' knowledge stocks. Other studies showed the relevance of MNE heterogeneity for variety of economies such as Italy (Castellani and Zanfei 2006), Argentina (Marin and Bell 2006), or Indonesia (Todo and Miyamato 2002). Therefore, we have all reasons to assume that MNE heterogeneity affects similarly the potential for FDI spillovers in other post-communist transition economies.

8.4 Policy implications

Given our research result, one of the main policy challenges would be not only to increase the locational attractiveness of East German regions for multinational investment as such but the promotion of their technological activities as well as the stimulation of technological externalities from affiliates' activities to the wider East German economy. This policy objective cuts across various instruments including investment and regional policy, investment promotion agencies, innovation policy as well as higher education policy.

8.4.1 Behavioural aspects in investment and regional policy

Accelerated liberalisation processes in the field of FDI have resulted in the entry of new potential host countries including former communist economies in the 'FDI market' in the last two decades. Increased inter-country competition has resulted in aggressive policies for attracting FDI. Policy measures include investment incentives, image building, direct acquisition of FDI, and the provision of general services to investors. Investment incentives are at the core of FDI policy in theory and policy discussion. The use of locational incentives to attract FDI has considerably expanded in frequency and value. The widespread and growing incidence of both fiscal and financial incentives is well documented (Charlton 2003, OECD 2003, OECD 2005a, UNCTAD 1996, Oman 2000).

Incentives can be used for attracting new FDI to a host country (locational incentives) or for making foreign affiliates in a country undertake functions regarded as desirable (behavioural incentives). The objective of the former is primarily to increase FDI inflows (quantitative goal), while the latter stimulates specific behaviour of foreign owned firms (qualitative goals), such as R&D and innovation, export propensity, employment, regional aspects etc. Most incentives do not discriminate between domestic and foreign investors, but they sometimes target one of the two (UNCTAD 2003). Within the EU, investment incentives are, as a rule, non-selective i.e. directed at domestic and foreign investors alike.

The rationale for policy intervention with respect to FDI has frequently been associated with the potentially positive effect of FDI on the productivity of domestic firms via knowledge spillovers and linkage effects (Charlton 2003, UNCTAD 2003). However, existing international evidence showed that foreign firms are heterogeneous and therefore, not every foreign firm provides the same knowledge opportunities or spillover potential for domestic firms (Castellani and Zanfei 2006, Marin 2006, Marin and Bell 2006).

Our research on the internationalisation of multinationals into East German regions shows that that MNEs' general location choice is responsive to the intensity of public investment grants. This is not the case for the localisation of MNEs' R&D and innovation activities. In turn, we find a positive effect of public investment grants on the potential for MNEs' intra-industry technological externalities. Yet, the overall potential for technological spillover effects from MNEs is relatively low and subject to affiliates' heterogeneity. In particular, affiliates' innovation activity and their propensity to conduct technological cooperation increase the potential for technological externalities. Thus, the question emerged to what extent existing investment design is appropriate to foster technological spillover effects from multinationals' to other firms in the East German economy.

East German investment policy is composed of three components: investment tax benefits, investment grants, and other instruments. Investment tax benefits and investment grants are in investment volume the most important instruments. Between 1991 and 2004 about 21 billion Euros were spent on investment tax benefits and about 25 billion on investment grants in East Germany (IWH 2009). Investment tax benefits are an unspecified automatic instrument and are going to be phased out soon. In contrast, the investment grant scheme is a specific and discretionary instrument. It is one of the most important instruments of the German regional policy as part of the so called Joint Task "For the improvement of the Regional economic structure according to article 91a ('*Grundgesetz'*).

The investment grant scheme is coordinated within a central framework and gives federal states certain discretion in the implementation. The investment grants are partially co-financed by the European Regional Development Fund (ERDF). The scheme must be in line with the EU regulations on state aid (Art. 87 Paragraph 3 EC Treaty). The grants are available for investment projects that are related to the construction of a new or extension of an existing production site, the diversification of products, fundamental changes to the production process, and takeover of a viable production site that otherwise faces closure. The investment project needs to generate a minimum increase of permanent employment (5 years) or secure permanent employment. Firms can choose between a grant related to fixed assets or labour costs. The investment grant scheme considers the creation of human capital, applied R&D, and the introduction of product innovations as non-investment measures (for an overview see Titze 2007). However, these non-investment measures are part of separate regional programs that aim at the regional competitiveness and innovation potential of small and medium sized firms (SMEs)[23]. Only the East German federal state of Brandenburg introduced an additional incentive if the investment includes training and R&D activities under the general investment grant scheme (ibid).

It has been argued that the employment related requirements in the investment grants scheme potentially induce inefficient combinations of production factors (Titze 2009). According to the argument, the prime objective of the investment grant is the creation of capital stock. Other secondary objectives such as employment, innovation, environmental aspects could possibly lead to distortions in the efficient allocation of production factors from a static point of view (ibid.).

From our point of view, the investment grant could be characterised as primarily locational rather than behavioural nature. The behavioural aspects are mainly related to employment

[23] Koordinierungsrahmen der Gemeinschaftsaufgabe "Verbesserung der regionalen Wirtschaftstsruktur" ab 2009, Deutscher Bundestag, Drucksache 16/13950.

rather than technology. De facto the investment grant scheme provides incentives to all firms including multinationals for investment in embodied technology (machinery and equipment) as well as process innovation. However, the restriction of incentives related to training, applied R&D, and product innovation to SMEs limits the potential incentives for investment by large multinational affiliates in such activities, and thus their evolution towards competence creating and spillover potential to the domestic economy. Thus, it could be argued that the existing incentive grant scheme fosters at best static instead of dynamic economies of scale, which should be the main concern for policy intervention from a capability based perspective. An increased focus on technological aspects in the investment grant scheme would not only increase the potential for technological spillovers from MNEs but also improve the absorption capability of domestic firms. This seems to be particularly important in the context of a tightening public budget constraint in the years to come.

8.4.2 Role of investment promotion agencies for linkage creation

By definition, technological spillovers effects from FDI to the host economy through vertical linkages require an adequate firm structure in the up- and down-stream sector. In fact, our evidence shows that a diversified industry structure within the region fosters technological backward linkage effects, whereas industry specialisation within a region increases the potential for forward linkage effects. Therefore, a business linkage programme could be an effective way to facilitate the generation of externalities between agents involved. Given an adequate firm structure in the respective filed of activity, investment promotion agencies could play an important role in fostering linkages between multinationals and other local firms.

Successful implementation of the policy of integrating multinational affiliates in a host country economy demands very active and competent functioning of the responsible government agencies. The following activities seem of the utmost importance in this context: informing multinationals about the possibilities of engaging local suppliers, matching affiliates and local companies, assisting potential local suppliers to establish production at a level to meet the requirements of foreign-owned companies (capacity upgrading with promotion of SME development), training employees in potential local suppliers, and assistance in financing the production of inputs.

A possibly best practice example in promoting linkages between foreign-owned and local companies is a linkage promotion program implemented by the Irish Development Agency (Barry et al. 2003, IDA 2008). The main insights from this experience are that linking local suppliers with foreign-owned companies and mediating these links require accompanying measures for capacity building of existing and potential domestic suppliers; efforts for the development of local suppliers should be selective, directed to those local companies which possess the highest growth potential; close cooperation with foreign subsidiaries and their parent companies is crucial; and cooperation among various domestic agencies involved in assisting local suppliers is also necessary (ibid).

Our results show that linkages in terms of technological co-operation foster the generation of externalities from multinational investment in East Germany. Therefore, a business linkage programme should not be limited to establish trade but also technological linkages between investing multinationals and existing other firms in East Germany. The example of the Irish approach shows that for example technological capabilities of suppliers might be central to the establishment of trade linkages. Therefore, accompanying measures for capacity building in local firms and corresponding coordination of possible funding opportunities by the investment promotion agencies in East Germany could increase the spillover potential.

During the 1990s, the 'Industrial Investment Council' (IIC) was created as an agency in charge of promoting East Germany as investment location internationally. This task has been also performed by regional investment agencies ('*Wirtschaftsfördergesellschaften'*) in each of the six federal states in East Germany. In 2007, the German government re-emphasised the importance of inward FDI and bundled the existing competencies and resources through a merger of IIC with Invest in Germany (IIG), which now overarching the agency called Germany Trade and Invest (GTaI) under control of the Federal Ministry of Technology and Economy. The basic idea is that foreign investors contact GTaI and subsequently the investor is referred to a respective regional agency that provides further services. In practise, there is naturally considerable competition between regional agencies for the acquisition of new investment projects. To our knowledge, all regional agencies provide investors with services geared towards establishing business linkages with other East German firms. However, the extent and quality might differ, and the kind of coordinated approach including local supplier upgrading by use of complementary policy measures might overstretch the current capacity of selected regional agencies. In this case, cooperation with private sector industry specific initiatives aimed at the promotion of linkages and upgrading might be an alternative.

8.4.3 Re-alignment of global networks through innovation policy

In her analysis of MNEs' regional location choice for Germany Spies (2010) argues that East German policy makers 'might consider the promotion of industry clusters' as a way to attract MNEs. However, while much government policy at different levels has been directed in recent years at promoting clusters, there is a danger for them to cut themselves off and become pockets of traditional values, especially in eras of 'fast history' (von Tunzelmann et al. 2010). For a cluster to be progressive its capabilities need to be interactive, i.e. in tune with those of its suppliers and its customers, and to be dynamic, i.e. interactive in 'real time' in a context where suppliers' and customers' needs and abilities are constantly changing (ibid). These are the basic requirements of a 'regional system of innovation' in which the emphasis can be shifted from mere co-location to co-evolution (ibid). Therefore, a regional innovation system rather than a cluster approach might be more appropriate as policy framework from a capability perspective.

The institutional transformation of the socialist S&T system created the starting point for the regeneration of interactive and dynamic capabilities in East German innovation. The agents faced a number of challenges such as overcoming weak industrial R&D and low innovative capacity, missing or anti-developmental science-industry linkages, misaligned global and local networks, and designing an appropriate set of innovation policies (von Tunzelmann 2010).

In the privatisation process until the mid 1990s, most foreign and West German investors had not much interest in local industrial R&D departments and R&D institutes of the former combinates and relied upon existing capabilities within the MNE network (Günther et al. 2009b). This created a new mis-alignment of global networks that inhibited interactive dynamic capabilities of multinational affiliates based in East Germany. Due to the severe decline in the privatised industrial R&D sector in the early 1990s, demand-led innovation policy schemes were introduced that aimed at maintaining existing R&D capacities ('*Personalförderung Ost*', '*Personalzuwachsförderung Ost*'). In order to re-align global networks with the East German innovation system, the government also created instruments to support R&D cooperation between East German companies and West German or foreign enterprises (Becher et al. 1993).

Since the mid 1990s, the promotion of R&D cooperation gained more and more importance (for example the '*Pro Inno*' programme). The emphasis on co-operation was not a specific East German approach but a paradigmatic change in German and European R&D and innovation policy at the time (Gassler et al. 2006). This policy tool fostered inter-firm and science-industry linkages that had in effect totally broken down during the privatisation process and therefore, also contributed towards realignment global networks. At this time, innovation policy started to support the innovation potential of whole regions instead of selected local research co-operations (‘*InnoRegio’*, ‘*Innovative Wachstumskerne’*). The shift towards a regionally oriented R&D and innovation policy seems appropriate to realign global networks as our research confirms that agglomeration economies associated with employment, firm structure, and technology attract MNEs R&D and innovation activities.

More recently, the promotion of R&D and innovation networks (‘*Netzwerkmanagement Ost’*) has become an integral part of the innovation policy (Jappe-Heinze et al. 2008). This approach tries to address the complex structure of interrelations between many actors involved in networks. The allocation of public funds for example to network management could diminish information and knowledge asymmetries. Today, we find hardly any innovation policy programme that is restricted to East Germany. Instead there is an emphasis on small and medium-sized firms. The latter focus seems to be well suited to the peculiarities of the East German economic structure and helps to build domestic capability.

From our point of view, it should remain an important task of innovation policy to target the enhanced alignment of global networks within the East German innovation system. Our research showed that the East German innovation system is capable of attracting MNEs’ R&D and innovation activities. However, technological spillover effects from MNEs are limited and not directly linked to existing spatially distinct technological capabilities within East German regions. Therefore, the R&D and innovation policy should support the local evolution of multinational affiliates towards competence creating technological activities within the East German innovation system. Policy should continue to strengthen R&D cooperation, joint product development, co-design and standard setting in networks that link multinational affiliates with other private and public actors from the East German innovation system.

8.4.4 Role of public science and higher education

It is important to remember that the potential for knowledge spillovers from the public science and higher education infrastructure play a significant role for multinationals investment decisions. Our results for East Germany show that the intensity of regional public investment grants for (re)construction of higher education institutions *(‘Mittel Rahmen der Gemeinschaftsaufgabe Art. 91a GG’*) stimulate the localisation of multinational firms within the region. This effect is even stronger for multinationals that entered East German regions after the privatisation process was completed. Furthermore, science industry spillovers are a significant factor to attract multinational affiliates that augment an existing technological advantage of the MNE.

Unfortunately, all higher education institutions across East German regions are financially under immense pressure. If the educational ministries of East German federal states fail to provide sufficient investment for higher education infrastructure, this could result in a loss of locational attractiveness. This, in turn, is going to worsen the tax position of federal states, which caused the financial pressure for higher education institutions in the first place. Thus, on the one hand there is an important role of public policy in terms of building a competitive higher education infrastructure. On the other hand, higher education institutions should exploit financial resources from the private sector to build joint infrastructure that delivers benefits to both the public and private sector within the region.

The federal government tries to address the challenges faced by higher education institutions and regional government across German regions with a number of new initiatives. First, the federal and regional governments agreed upon 5 per cent annual budget increases for research institutions outside the university sector until 2015 in a joint initiative for research and innovation (‘*Pakt für Forschung and innovation’*). Given that the density of research institutions in East Germany is relatively high, as a result of the reorganisation of the former Academy of Sciences, correspondingly public science institutions in East Germany are going to benefit strongly. In 2006, the federal and regional governments also created an initiative (‘*Exzellenz Initiative’*) which promotes scientific excellence in terms of graduate schools for the scientific qualification, research clusters, and strategic orientation of higher education institutions. However, apart from a few exceptions (University of Jena, Humboldt University Berlin, Technical University of Berlin, Free University of Berlin, Fachhochschule Nordhausen) East German higher education institutions participated not successfully in the competitive funding allocation rounds so far. If the participation of East German public science and higher education institutions outside Berlin remains low, this widen the performance gap of the universities in West and East Germany. In 2008, an initiative was introduced by the federal ministry for Education and Research *(‘Spitzenforschung neue Länder’*) that could be a counterforce to this trend. It is part of the High Tech Strategy of the German federal government and aims primarily at supporting East German public science and higher education institutions in existing localised innovation networks. Furthermore, the Federal Ministry for

Education and Research is going to allocate more funding to higher education institutions until 2015 in order to facilitate an increased student intake. However, this trend is mainly related to the demographic development in West rather than East Germany.

From our point of view, East German higher education and other public science institutions are in need of complementary funding by the federal government that facilitates the agents to put the right education and research infrastructure in place. The funding programs need to set incentives for strategic positioning and science-industry cooperation. Otherwise, East German universities and scientific institutes could lose ground compared to their West German peers, which could imply a loss in locational attractiveness of East German regions for MNEs' R&D and innovation which is crucial in the process of re-alignment of global networks in the East German innovation system.

8.5 Limitations and further research directions

8.5.1 Assumptions in the research approach

The technological accumulation approach suggests a dynamic interrelation between existing indigenous spatially distinct capabilities, MNEs' investment in technological activities, and the generation of technological externalities by MNEs to the locality. Our approach translated this dynamic perspective into three discrete analytical investigations.

In the adopted research approach we assume that a foreign and West German investor has decided to set up an affiliate within East Germany against other alternative options such as exporting or licensing. Subsequently, we follow the logic that an investor maximises profits by locating in a particular region given possible alternative locations within East Germany. His decision depends on the firm specific valuation of different location specific advantages that already exist in the region at the time preceding his entry. In the first stage, we model the choice of foreign and West German investors to locate their affiliate in a particular East German region taking into account location specific characteristics of all possible alternative regions within East Germany at the time preceding firm entry. We assume that investors value various components of the utility function related to location choice differently depending on firm heterogeneity. In principal, in the second stage we introduce the existence of and motive for affiliates' technological activities as part of firm heterogeneity in regional location choice. Finally, we model the potential for technological spillovers from the presence of foreign and West German affiliates for other East German firms as a function of centrally and locally driven technological MNE heterogeneity as well as region specific advantages at the time preceding entry. This research strategy tries to address the complexity of a possible dynamic interaction of the ownership advantage of groups of firms and the locational advantages of the sites in which they produce. However, the approach is based on a number of assumptions that could be challenged.

First, the research treats East Germany as defector separate country. In fact, East Germany was until 1990 a separated state with a very distinct central planning economy, which led to diverging structural and technological development paths between the GDR and the FGR. Since reunification East German has been undergoing considerable economic transition however, it still is characterised differences in the economic and technological structure and has not yet converged to West German income levels (IWH 2009). Furthermore, Spies (2010) proved econometrically that in terms regional location choice foreign investors treat the federal states of East Germany as closer substitutes to each other compared to federal states in West Germany. Therefore, one can take the view that East Germany is still a region in economic and technological transformation that can be compared to other post-communist transition economies of Central and East Europe, despite the fact that it has became part of the fully developed and mature economy of West Germany.

Second, in line with the technological accumulation approach investors might consider locating in a specific sub-national region on the basis of cross-country comparison i.e. comparing possibly region A in country B with region C in country D. As we analyse the location choice of multinationals that entered East Germany between 1995 and 2005 ex post, all of them in fact decided to locate in a particular region within East Germany. Therefore, we model the choice of sub-national against the background of all possible regional alternatives within East Germany rather than on a cross-country basis. This approach is in fact a simplification but related to a lack of regionally disaggregated data which would match the depth of information available for East Germany.

Third, the model of location choice of technological activities builds on the assumption that the decision to implement specific technological activities was already taken at the time of entry. Thereby the observation whether multinationals implement specific technological activities has a time lag to the measurement of region specific exogenous variables. By using lagged independent variables we avoid econometric endogeneity between affiliates' investment and the exogenous region and industry specific factors. This is bases on the argument that the intended orientation of research influences the choice of location to a degree that is very costly to reverse (Kuemmerle 1999). In other words, the decision to locate specific technological activities is taken prior to entry given the implied sunk costs. However, this assumption might be challenged as the decision to implement specific technological activities might develop over time rather than being taken ex ante to market entry (see for example Ronstadt 1978, Fisher and Behrman 1979).

Fourth, in the technology accumulation approach ownership advantages become endogenous to the active strategic role of firms in using innovation and technological accumulation. In turn, location advantages become endogenous via the innovative activity of companies and their technological spillover effects on the industry and locality (ibid). The adopted approach in the dissertation seems adequate in order to deal with the theoretically assumed endogeneity in the econometric context. However, a truly dynamic investigation would require information of the firm over time i.e. a panel data structure. Future investigations could also attempt to implement a multiple equation system that accounts for the simultaneity of existing location specific capabilities, multinationals' investment in R&D and innovation, and subsequent impact on location specific technological capabilities.

Finally, the research analyses the internationalisation of foreign and West German owned multinational firms. The inclusion of West German investors could be challenged as their location does in fact not constitute an act of internationalisation of activities. However, given the considerable role of West German investor in the privatisation process it is accepted that they should be included in any analysis on 'foreign' investment in East Germany as a region in economic transition (Günther 2005). Furthermore, we do not include all West German investors into the analysis but only multinationals i.e. firms that are headquartered in West Germany and possess apart from the respective affiliate(s) in East Germany also at least one affiliate outside Germany. Consequently, selection criteria correspond fully to the group of foreign investors.

8.5.2 Data and representativeness

The dissertation exploits the total population of foreign and West German owned multinational affiliates drawn from the *IWH FDI micro database* for the analysis of MNEs location choice and exploits survey data from a sample of foreign and West German owned multinational affiliates for the investigation of MNEs technological activities as well as for the analysis of MNEs' spillover potential.

It is the first study to exploit the information on the full population in location choice analysis of foreign and West German multinational firms that entered East German manufacturing between 1995 and 2005. Therefore, we overcome some of the limitations with regard to representativeness of existing survey based studies (Belitz et al. 1999, Thum et al. 2007 etc.) as well as deficiencies in terms of regional representation in case of the micro data on direct investment supplied by the German central bank (as used in Spies 2010).

The survey data is representative at the sectoral level but differs significantly from the total population with regard to regional and size distribution. The regional deviations are mainly related to an underrepresentation of firms from Berlin and firms with 10 to 249 employees are overrepresented. Moreover, there are indications for a non-respondent bias. An additional limitation applies as the representativeness was evaluated looking at each criterion (sector, region, size) in turn and not jointly. Therefore, the empirical results should be interpreted having in mind the above limitations. For example, from the estimation of the base model on location choice on the sample, we realise deviations in terms of significance levels for various variables in comparison to the estimation of the base model for the total population. This could be a hint at limitations of the sample in respect to representativeness when estimating sector specific effects on the regional level.

8.5.3 Measurement

Home country regions' technological specialisation

From a theoretical perspective, the home country regions' technological endowment vis-à-vis the host country region are important to understand the general location choice of MNEs as well as locational patterns of MNEs' technological activities. This applies to the respective fields of specialisation as well as the levels of technological specialisation. The levels of technological specialisation of home vs. host region facilitates not only implications with regard to the role of an ex-ante technological advantage in the internationalisation decision but also allows us to test the adverse selection hypothesis i.e. that technologically leading MNEs avoid host country regions with a high density of other technologically capable firms to prevent knowledge leakage, whereas technological lagging MNEs might seek such regions to maximise knowledge inflows. Furthermore, we could differentiate whether the location choice is related to technological specialisation or diversification. From this we could generate further insights whether the internationalisation of technological activities is related to exploitation of an existing technological advantage in the same technological filed, or with the motive to acquire new or complementary knowledge from other technological fields abroad.

So far, we were not able to incorporate corresponding proxies into the location choice analysis of the population of foreign and West German multinational affiliates within East Germany. This would require times series patent data from all investing home countries in a regional and industry break down in order to match the corresponding data from East Germany. R&D data could have been an alternative source of information. However, a corresponding OECD database covers only a limited number of investing countries and varies with respect to time series and industry breakdown. In addition, it is not available at a sub-national level. Furthermore, there would be no corresponding data on R&D spending in East Germany at the level of '*Raumordnungsregionen'* which would require us to move the empirical analysis one step up to the level of federal states. Therefore, we could not include an appropriate measure when analysing the general regional location choice for the population of multinationals.

However, we exploited in the analyses of MNEs' internationalisation of technological activities as well as the knowledge spillover potential information from the survey to approximate the relative technological advantage at the level of the corporation. We simply compared the foreign/West German parents' importance as a source for technological knowledge for the affiliate with the importance of the respective affiliate as a source for technological knowledge for the foreign/West German parent. This allowed us first to approximate the relative technological advantage of home vs. host country and second we were able to discriminate between different underlying motives for foreign investments in R&D and innovation. Given that this measure is limited to the corporation in question and not measured in relation to other firms in the same industry in host and home country it does not allow conclusions with regard to adverse selection processes. Also in this case, we have no information to discern international technological specialisation or diversification strategies.

Spillover effects

Traditional studies of FDI spillovers use the production function approach that measures effects from the presence of FDI for example in terms of employment or value added on domestic firms' total factor or labour productivity within the same sector. Studies that assess vertical effects use inter-sectoral linkage coefficients to weight the foreign presence in related sectors. Significant effects on domestic productivity are interpreted as indirect evidence for spillover effects. In contrast, our approach does not rely on productivity measures but uses survey evidence to “trace the flow of technological knowledge”.

Therefore, we do not have to cope with the various problems associated with measuring productivity, selection bias, or endogeneity. However, it might be objected that we measure a flow of knowledge from foreign to local firms from the sending and not the receiving end. Thus, it remains indirect evidence and should be termed correctly as a ‘potential for technological externalities’. In addition, we trace externalities that have pecuniary character in case of vertical linkages and elements of both, pecuniary and non-pecuniary character in case of horizontal effects. We are not able to draw any conclusion with regard to the economic effect of the externalities for the other firms. Moreover, we have only information about potential effects for *other* firms based in East Germany. These could be domestic owned but similarly foreign or West German owned. Thus we cannot speak of a spillover effects from the presence of MNEs to the *domestic* part of the economy.

One way to extend the existing approach would be to take more explicitly into account the heterogeneity of linkages that facilitate technological externalities. So far, we only have information on the relative importance of affiliates’ for R&D and innovation in supplier, customer, or competing firms. However, Saliola and Zanfei (2009) differentiate linkages of foreign affiliates with regard to their knowledge intensity, collaborative content, and their potential for upgrading for the respective partners. It seems feasible that future surveys in this area could cover these dimensions more in depth in order to account appropriately for the impact of linkage heterogeneity on the technological spillover potential.

Furthermore, our measurement approach does not capture all types of externalities. For example, we miss any potential externalities through labour mobility. Finally, within our framework we cannot disentangle negative competition and positive technological spillover effects. However, both can be associated with the entry of multinational firms. Thus, our approach to measure spillovers suffers from considerable limitations. However, given the methodological problems associated with the production function approach, data availability for East Germany, as well as our main contribution in terms of the role of MNE heterogeneity, we would argue that our choice can be justified.

Heterogeneity of internal structure

In principal, Cantwell (1989) assumes in his model a transnational organisation structure of multinational enterprises which implies the existence of internal networks between the parent firm and the focal affiliate but also between affiliates. This structure facilitates uni- and bi-directional knowledge flows between all units. However, there exist also other types of internal organisation structures in MNEs. Stopford and Wells (1972) suggest a global matrix structure with a divisional organisation of international activities of MNEs. Bartlett et al. (2005) differentiated centralised hub as well as coordinated and decentralised federation structure. These alterative organisational models do not imply an internal network structure in the MNE. Consequently, the flow of knowledge to affiliates based in East Germany, their potential to create knowledge for the rest of the organisation, and any potential for external effects to the host economy depend also on the type of organisational structure of the respective MNE. So far, we lack suitable data to differentiate heterogeneity in organisational structure for the population of foreign and West German multinational affiliates based in East Germany. However, future investigation exploiting survey evidence could add heterogeneity in organisational structures underlying MNEs when investigating their internationalisation process.

8.5.4 Estimation procedures

The first and the second empirical investigation apply a conditional logit approach as widely used in the industrial location literature. However, conditional logit models are based on the independence of irrelevant alternatives assumption i.e. that there is no unobserved correlation across region or firms. We tried to overcome the problem by selecting an appropriate regional unit of analysis. Furthermore, we controlled for a selected range of firm level characteristics. However, an alternative approach for future research might be the application of a mixed logit estimation that does not rely on the independence of irrelevant alternatives assumption.

Our approach to model the location choice of MNEs' technological activities in the utility maximising framework of the conditional logit approach has clear advantage namely that we exclude a potential estimation bias by using location information from all firms instead of only technological active firms. Thus, we observe the probability of location choice of technologically active affiliates from a given choice set in comparison the choice of affiliates that are technologically not active. However, this approach has the limitation in the sense that we observe only the existence of technological activity rather than the corresponding intensity. Other existing applications use count models on patent statistics and therefore, only information on technologically active firms, but are able to consider the intensity.

Furthermore, the first and the second empirical investigation could be improved by taking account of spatial autocorrelation between exogenous variables. This could be implemented by including inter-regional effects or by weighting relevant region specific variables with a neighbour or distance matrix. This would also enhance our understanding with regard to geographic proximity and the role of agglomeration economies for location choice and R&D and innovation internationalisation. However, so far we refrained from such additions to the applied specification due to multicolinearity problems. Adding marginal effects to the current conditional logit estimations would add an important dimension for interpretation with regard to the relative importance or elasticities of different significant locational factors. However, interpretation in particular with regard to interaction effects is critically viewed in the context of maximum likelihood estimations.

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Annex

Table A1 Sectoral distribution in population and sample 2007

	Population		Sample	
NACE Rev 1.1	No. of firms	In %	No. of firms	In %
15	91	6,44	20	9,01
16	3	0,21	0	0,00
17	33	2,34	8	3,60
18	5	0,35	2	0,90
19	2	0,14	1	0,45
20	33	2,34	9	4,05
21	46	3,26	11	4,95
22	60	4,25	9	4,05
23	8	0,57	2	0,90
24	109	7,72	32	14,41
25	75	5,31	14	6,31
26	129	9,14	31	13,96
27	44	3,12	13	5,86
28	150	10,62	27	12,16
29	170	12,04	41	18,47
30	24	1,70	1	0,45
31	72	5,10	8	3,60
32	73	5,17	15	6,76
33	103	7,29	16	7,21
34	72	5,10	10	4,50
35	38	2,69	6	2,70
36	48	3,40	11	4,95
37	24	1,70	8	3,60
Sum	1.412	100	295	100

Source: IWH FDI micro database.

Table A1.1 Sectoral representativeness of foreign firm sample

Chi-square-test- statistic	21,60
Degrees of freedom	21
Asymptotic significance	0,423

Source: Author’s calculations.

Table A2 Average number of employees in population and sample 2007

	Population	Sample
Mean (standard deviation)	199,70 (584,93)	135,49 (287,69)
Skewedness (standard error)	9,32 (0,07)	6,09 (0,14)
Kurtosis (standard error)	110,93 (0,13)	46,68 (0,28)

Source: Author's calculations.

Table A2.1 Differences in means of employees in population and sample

Mann-Whitney-test	187.284
Z-statistic	-1,297
Asymptotic significance	0,195

Source: Author's calculations.

Table A3 Distribution of firms across size classes in population and sample 2007

	Population		Sample	
Size classes (employees)	No. of firms	In %	No. of firms	In %
Micro (1-9)	206	15,44	34	11,53
Small (10-49)	383	28,71	106	35,93
Medium (50-249)	515	38,61	119	40,34
Large (250 - over)	230	17,24	36	12,20
Sum	1.334	100	295	100
Missing values*	78		0	

*For 78 firms the database has no information on the number of employees.

Source: IWH FDI micro database.

Table A3.1 Size class representativeness of sample

Chi-square-test- statistic	12,99
Degrees of freedom	3
Asymptotic significance	0,005

Source: Author's calculations.

Table A4 Regional distribution across federal states in population and sample 2007

	Population		Sample	
Federal States	No. of firms	In %	No. of firms	In %
Berlin	219	15,5	21	7,1
Brandenburg	167	11,8	35	11,9
Mecklenburg-VP	107	7,6	22	7,5
Sachsen-Anhalt	208	14,7	65	22,0
Sachsen	443	31,4	86	29,2
Thüringen	268	19,0	66	22,4
Sum	1.412	100	295	100

Source: IWH FDI micro database.

Table A4.1 Regional representativeness sample at federal state level

Chi-square-test- statistic	18,82
Degrees of freedom	5
Asymptotic significance	0,002

Source: Author’s calculations.

Table A5 Regional distribution across 'ROR' in population and sample 2007

	Population		Sample	
ROR	No. of firms	In %	No. of firms	In %
Westmecklenburg	38	2,7	7	2,4
Mittleres Mecklenburg/Rostock	29	2,1	7	2,4
Vorpommern	19	1,3	7	2,4
Mecklenburgische Seenplatte	22	1,6	1	0,3
Prignitz-Oberhavel	28	2,0	4	1,4
Uckermark-Barnim	14	1,0	6	2,0
Oderland-Spree	33	2,3	7	2,4
Lausitz-Spreewald	33	2,3	6	2,0
Havelland-Fläming	59	4,2	12	4,1
Berlin	219	15,5	21	7,1
Altmark	10	0,7	3	1,0
Magdeburg	74	5,2	14	4,7
Dessau	56	4,0	16	5,4
Halle/S.	67	4,7	22	7,5
Nordthüringen	29	2,1	10	3,4
Mittelthüringen	71	5,0	21	7,1
Südthüringen	75	5,3	10	3,4
Ostthüringen	93	6,6	25	8,5
Westsachsen	93	6,6	20	6,8
Oberes Elbtal/Osterzgebirge	134	9,5	33	11,2
Oberlausitz-Niederschlesien	65	4,6	13	4,4
Chemnitz-Erzgebirge	88	6,2	15	5,1
Südwestsachsen	63	4,5	15	5,1
Sum	1.412	100	295	100

Source: IWH FDI micro database.

Table A5.1 Regional representativeness of sample at 'ROR' level

Chi-square-test- statistic	40,65
Degrees of freedom	22
Asymptotic significance	0,009

Source: Author's calculations.

Table A6 Structure of non-respondents and respondents

Disposition	Frequency	In %
Respondents		
prematurely finished interview	10	0,71
interview completed by fax	9	0,64
completed telephone interview	276	19,54
pretesting	3	0,21
	298	21,10
Non-respondents		
Firm not relevant acc. to interviewed person	114	9,72
no interest in survey	377	2,70
no telephone survey	103	7,29
no time to participate	142	10,06
hung up without answer	2	0,14
appointment for interview made	173	12,25
Other unclassified reasons	38	2,69
	949	67,21
Not-categorised		
wrong number	88	6,23
busy	2	0,14
no contact/answering machine	65	4,60
private line	3	0,21
fax machine	6	0,42
firm does not exist anymore	1	0,07
	165	11,68
Sum	1.412	100

Source: IWH FDI micro database.

Table A7 Sectoral distribution of respondents and non-respondents 2007

	Non-Respondents		Respondents	
NACE Rev 1.1	No. of firms	In %	No. of firms	In %
15	64	6,74	20	6,71
16	3	0,32	0	0,00
17	20	2,11	9	3,02
18	3	0,32	2	0,67
19	1	0,11	1	0,34
20	23	2,42	9	3,02
21	31	3,27	11	3,69
22	46	4,85	9	3,02
23	4	0,42	2	0,67
24	66	6,95	32	10,74
25	55	5,80	14	4,70
26	79	8,32	32	10,74
27	23	2,42	13	4,36
28	108	11,38	27	9,06
29	112	11,80	41	13,76
30	14	1,48	1	0,34
31	47	4,95	8	2,68
32	46	4,85	15	5,03
33	78	8,22	17	5,70
34	51	5,37	10	3,36
35	29	3,06	6	2,01
36	32	3,37	11	3,69
37	14	1,48	8	2,68
Sum	949	100	298	100

Source: IWH FDI micro database.

Table A7.1 Significant deviations in sectoral distribution of respondents

Chi-square-test- statistic	36,36
Degrees of freedom	21
Asymptotic significance	0,020

Source: Author's calculations.

Table A8 Average number of respondents and non-respondents 2007

	Non-Respondents	Respondents
Mean (standard deviation)	215,72 (614,82)	134,81 (286,38)
Skewedness (standard error)	8,91 (0,08)	6,11 (0,14)
Kurtosis (standard error)	102,02 (0,16)	41,13 (0,28)

Source: Author's calculations.

Table A8.1 Differences in means of employees of respondents

Mann-Whitney-test	124.825
Z-statistic	-1,819
Asymptotic significance	0,069

Source: Author's calculations.

Table A9 Distribution of firms across size classes for respondents and non-respondents 2007

	Non-Respondents		Respondents	
Size classes (employees)	No. of firms	In %	No. of firms	In %
Micro (1-9)	146	16,20	35	11,74
Small (10-49)	240	26,64	106	35,57
Medium (50-249)	343	38,07	121	40,60
Large (250 - over)	172	19,09	36	12,08
Sum	901		298	
Missing values*	48		0	

*For 48 firms the database has no information on the number of employees.

Source: IWH FDI micro database, Author's calculations.

Table A9.1 Significant deviations in size distribution respondents

Chi-square-test- statistic	20,98
Degrees of freedom	3
Asymptotic significance	0,000

Source: Author's calculations.

Table A10 Regional distribution of respondents and non-respondents at federal state level

	Non-Respondents		Respondents	
Federal States	No. of firms	In %	No. of firms	In %
Berlin	166	17,5	21	7,0
Brandenburg	114	12,0	36	12,1
Mecklenburg-VP	69	7,3	22	7,4
Sachsen-Anhalt	130	13,7	65	21,8
Sachsen	297	31,3	88	29,5
Thüringen	173	18,2	66	22,1
Sum	949	100	298	100

Source: IWH FDI micro database, Author’s calculations.

Table A10.1 Significant deviations in regional distribution respondents at federal state level

Chi-square-test- statistic	26,20
Degrees of freedom	5
Asymptotic significance	0,000

Source: Author’s calculations.

Table A11 Regional distribution across 'ROR' for respondents and non-respondents

	Non-Respondents		Respondents	
ROR	No. of firms	In %	No. of firms	In %
Westmecklenburg	28	3,0	7	2,3
Mittleres Mecklenburg/Rostock	16	1,7	7	2,3
Vorpommern	9	0,9	7	2,3
Mecklenburgische Seenplatte	16	1,7	1	0,3
Prignitz-Oberhavel	21	2,2	4	1,3
Uckermark-Barnim	7	0,7	6	2,0
Oderland-Spree	22	2,3	7	2,3
Lausitz-Spreewald	23	2,4	7	2,3
Havelland-Fläming	41	4,3	12	4,0
Berlin	166	17,5	21	7,0
Altmark	7	0,7	3	1,0
Magdeburg	54	5,7	14	4,7
Dessau	37	3,9	16	5,4
Halle/S.	32	3,4	22	7,4
Nordthüringen	16	1,7	10	3,4
Mittelthüringen	42	4,4	21	7,0
Südthüringen	54	5,7	10	3,4
Ostthüringen	61	6,4	25	8,4
Westsachsen	64	6,7	20	6,7
Oberes Elbtal/Osterzgebirge	85	9,0	33	11,1
Oberlausitz-Niederschlesien	39	4,1	13	4,4
Chemnitz-Erzgebirge	67	7,1	15	5,0
Südwestsachsen	42	4,4	17	5,7
Sum	949	100	298	100

Source: IWH FDI micro database, Author's calculations.

Table A11.1 – Significant deviations of respondents at 'ROR' level

Chi-square-test- statistic	73,48
Degrees of freedom	22
Asymptotic significance	0,000

Source: Author's calculations.

Table A12 – Year of entry of multinational affiliates in the sample

Year of entry	Sample Frequency	in %
1990	30	10,17
1991	30	10,17
1992	23	7,80
1993	14	4,75
1994	15	5,08
1995	13	4,41
1996	8	2,71
1997	10	3,39
1998	18	6,10
1999	15	2,08
2000	15	5,08
2001	18	6,10
2002	21	7,12
2003	20	6,78
2004	23	7,80
2005	22	7,46
Total	295	100

Source: IWH FDI micro database (2007), Author's calculations.

Table A13 – Share of ownership held by multinational investors in the sample

Share of ownership (in %)	Sample Frequency	in %
10-49	23	7,80
50-99	67	22,70
100	205	69,50
Total	295	100

Source: IWH FDI micro database (2007), Author's calculations.

Table A14 –Type of foreign/West German owner in the sample

Share of ownership (in %)	Sample Frequency	in %
Multinational enterprise group	198	67,10
National enterprise group	29	9,80
Foreign enterprise	35	11,90
Foreign individual or family	33	11,20
Total	295	100

Source: IWH FDI micro database (2007), Author's calculations.

Table A15 – Initial entry mode of investor in the sample

Type of initial entry mode	Sample Frequency	in %
Acquisition as part of the privatisation	51	17,40
Acquisition of a domestic privately owned firm	81	27,50
Acquisition from another foreign investor	47	16,10
Ownership in a completely new enterprise	116	39,00
Total	295	100

Source: IWH FDI micro database (2007), Author's calculations.

Table A16 – Home countries of multinational affiliates in the sample

Home country	Sample Frequency	in %
West Germany (FGR)	73	24,75
Netherlands	33	11,19
Austria	31	10,51
United States	25	8,47
Switzerland	24	8,14
France	14	4,75
Italy	14	4,75
Belgium	13	4,41
Denmark	10	3,39
Sweden	9	3,05
United Kingdom	8	2,71
Canada	5	1,69
Luxemburg	5	1,69
Japan	4	1,36
Spain	3	1,02
Finland	3	1,02
Ireland	3	1,02
Norway	3	1,02
China	2	0,68
Poland	2	0,68
Korea	2	0,38
Bahrain	1	0,34
Czech republic	1	0,34
Israel	1	0,34
India	1	0,34
Lithuania	1	0,34
Mexico	1	0,34
Slovenia	1	0,34
Slovakia	1	0,34
Turkey	1	0,34
Total	295	100

Source: IWH FDI micro database (2007), Author's calculations.

Table A17 Sectoral distribution of total population and manufacturing 2007 – number of firms

Manufacturing group (NACE 2 digit)	Total population Frequency	in %	Total manufacturing* Frequency	in %	Deviation
Food, beverages, and tobacco (15, 16)	94	6,7	6.438	16,4	-9,7
Textiles, clothing and leather (17,18,19)	40	2,8	3.060	7,8	-5,0
Wood and wood products (20)	33	2,3	1.508	3,8	-1,5
Paper, printing, publishing (21, 22)	106	7,5	1.459	3,7	3,8
Chemicals (23, 24)	117	8,3	851	2,2	6,1
Rubber and plastic products (25)	75	5,3	1.455	3,7	1,6
Non-metallic mineral products (26)	129	9,1	2.143	5,5	3,7
Basic metals (27)	44	3,1	679	1,7	1,4
Fabricated metal products (28)	150	10,6	8.213	20,9	-10,3
Machinery and equipment (29)	170	12,0	3.540	9,0	3,0
Electronics (30, 31, 32)	169	12,0	1.937	4,9	7,0
Medical, precision, and optical instr. (33)	103	7,3	3.505	8,9	-1,6
Motor vehicles and trailers (34)	72	5,1	474	1,2	3,9
Other transport equipment (35)	38	2,7	423	1,1	1,6
Furniture and other manufacturing (36)	48	3,4	2.699	6,9	-3,5
Recycling (37)	24	1,7	875	2,2	-0,5
Total	1.412	100	39.259	100	

Source: IWH FDI micro database (2007). *Institute for employment research (2007)

Table A18 Sectoral distribution of total population and manufacturing 2007 – employment

Manufacturing group (NACE 2 digit)	Total population Employment	in %	Total manufacturing* Employment	in %	Deviation
Food, beverages, and tobacco (15, 16)	23.833	8,9	145.485	15,5	-6,6
Textiles, clothing and leather (17,18,19)	5.353	2,0	47.576	5,1	-3,1
Wood and wood products (20)	3.443	1,3	23.417	2,5	-1,2
Paper, printing, publishing (21, 22)	11.114	4,2	56.192	6,0	-1,8
Chemicals (23, 24)	40.413	15,2	43.796	4,7	10,5
Rubber and plastic products (25)	7.102	2,7	49.868	5,3	-2,7
Non-metallic mineral products (26)	14.965	5,6	43.443	4,6	1,0
Basic metals (27)	13.370	5,0	39.171	4,2	0,8
Fabricated metal products (28)	14.789	5,6	139.587	14,9	-9,4
Machinery and equipment (29)	22.401	8,4	113.738	12,1	-3,7
Electronics (30, 31, 32)	47.088	17,7	78.962	8,4	9,2
Medical, precision, optical instrum. (33)	8.934	3,4	53.579	5,7	-2,4
Motor vehicles and trailers (34)	28.746	10,8	42.835	4,6	6,2
Other transport equipment (35)	19.930	7,5	23.932	2,6	4,9
Furniture and other manufacturing (36)	3.094	1,2	22.943	2,5	-1,3
Recycling (37)	1.831	0,7	11.621	1,2	-0,6
Total	266.406		936.145		

Source: IWH FDI micro database (2007). *Institute for employment research (2007)

Table A19 Distributions population across regional units in East Germany 2007

Foreign and West German MNE	Employment		Number of firms	
	absolute	% in	absolute	% in total
Regional unit		total EG M.		total EG M.
Oberes Elbtal/Osterzgebirge	40.956	57,56	134	4,94
Oderland-Spree	8.477	52,45	33	3,77
Berlin	56.439	49,33	219	4,65
Halle/S.	15.059	41,39	67	4,36
Havelland-Fläming	11.376	33,09	59	3,61
Südwestsachsen	15.868	29,98	63	2,89
Mecklenburgische Seenplatte	3.544	29,24	22	3,51
Mittleres Mecklenburg/Rostock	4.194	28,82	29	3,96
Südthüringen	12.793	24,9	75	3,67
Westsachsen	12.901	24,85	93	3,7
Westmecklenburg	6.509	24,79	38	3,49
Lausitz-Spreewald	7.104	23,92	33	2,18
Ostthüringen	13.054	23,83	93	4,25
Mittelthüringen	10.724	23,68	71	3,6
Vorpommern	2.866	22,58	19	2,34
Magdeburg	11.029	21,54	74	3,59
Dessau	6.976	21,38	56	4,26
Nordthüringen	4.521	18,26	29	2,44
Altmark	2.062	18,15	10	1,8
Oberlausitz-Niederschlesien	7.044	16,92	65	3,45
Prignitz-Oberhavel	3.194	16,47	28	3,05
Uckermark-Barnim	1.920	16,16	14	2,24
Chemnitz-Erzgebirge	7.796	10,72	88	2,61
Total	266.406		1.412	

Source: IWH FDI micro database (2007) and Institute for employment research (2007)

Table A20 Regional distribution of firms in total population and EG manufacturing 2007

Number of firms	EG Manufacturing		Total Population		% of Pop.	Dev. %
Regional units ('ROR')	Abs.	In %	Abs.	In %	in EG M.	shares
Westmecklenburg	1.089	2,8	38	2,7	3,49	-0,1
Mittl. Mecklenburg/Rostock	732	1,9	29	2,1	3,96	0,1
Vorpommern	813	2,1	19	1,3	2,34	-0,6
Mecklenburgische Seenplatte	626	1,6	22	1,6	3,51	-0,1
Prignitz-Oberhavel	919	2,4	28	2,0	3,05	-0,2
Uckermark-Barnim	624	1,6	14	1,0	2,24	-0,6
Oderland-Spree	875	2,2	33	2,3	3,77	0,5
Lausitz-Spreewald	1.513	3,9	33	2,3	2,18	-1,3
Havelland-Fläming	1.633	4,2	59	4,2	3,61	-0,1
Berlin	4.706	12,1	219	15,5	4,65	5,7
Altmark	557	1,4	10	0,7	1,80	-0,9
Magdeburg	2.060	5,3	74	5,2	3,59	-0,0
Dessau	1.314	3,4	56	4,0	4,26	0,8
Halle/S.	1.538	3,9	67	4,7	4,36	1,0
Nordthüringen	1.189	3,0	29	2,1	2,44	-1,4
Mittelthüringen	1.971	5,0	71	5,0	3,60	0,5
Südthüringen	2.042	5,2	75	5,3	3,67	-0,4
Ostthüringen	2.187	5,6	93	6,6	4,25	0,9
Westsachsen	2.514	6,4	93	6,6	3,70	-0,8
Oberes Elbtal/Osterzgebirge	2.712	6,9	134	9,5	4,94	2,2
Oberlausitz-Niederschlesien	1.883	4,8	65	4,6	3,45	-0,2
Chemnitz-Erzgebirge	3.372	8,6	88	6,2	2,61	-3,2
Südwestsachsen	2.182	5,6	63	4,5	2,89	-1,6
Sum	39.051	100	1.412	100		

Source: Source: IWH FDI micro database (2007), Author's calculations.

Table A21 Regional distribution of firms in total population and EG manufacturing 2007

Employment	EG Manufacturing		Total Population		% of Pop.	Dev. %
Regional units ('ROR')	Abs.	In %	Abs.	In %	in EG M.	shares
Westmecklenburg	26.258	3,0	6.509	2,4	24,79	-0,5
Mittl. Mecklenburg/Rostock	14.553	1,6	4.194	1,6	28,82	-0,1
Vorpommern	12.693	1,4	2.866	1,1	22,58	-0,4
Mecklenburgische Seenplatte	12.120	1,4	3.544	1,3	29,24	-0,0
Prignitz-Oberhavel	19.396	2,2	3.194	1,2	16,47	-1,0
Uckermark-Barnim	11.883	1,3	1.920	0,7	16,16	-0,6
Oderland-Spree	16.162	1,8	8.477	3,2	52,45	1,4
Lausitz-Spreewald	29.701	3,3	7.104	2,7	23,92	-0,7
Havelland-Fläming	34.377	3,9	11.376	4,3	33,09	0,4
Berlin	114.401	12,9	56.439	21,2	49,33	8,3
Altmark	11.363	1,3	2.062	0,8	18,15	-0,5
Magdeburg	51.201	5,8	11.029	4,1	21,54	-1,6
Dessau	32.624	3,7	6.976	2,6	21,38	-1,0
Halle/S.	36.387	4,1	15.059	5,7	41,39	1,6
Nordthüringen	24.765	2,8	4.521	1,7	18,26	-1,1
Mittelthüringen	45.288	5,1	10.724	4,0	23,68	-1,1
Südthüringen	51.386	5,8	12.793	4,8	24,90	-1,0
Ostthüringen	54.778	6,2	13.054	4,9	23,83	-1,3
Westsachsen	51.911	5,8	12.901	4,8	24,85	-1,0
Oberes Elbtal/Osterzgebirge	71.158	8,0	40.956	15,4	57,56	7,4
Oberlausitz-Niederschlesien	41.636	4,7	7.044	2,6	16,92	-2,0
Chemnitz-Erzgebirge	72.748	8,2	7.796	2,9	10,72	-5,3
Südwestsachsen	52.925	5,9	15.868	6,0	29,98	0,0
Sum	889.714	100	266.406	100		

Source: IWH FDI micro database, Author's calculations.

Table A22 Regional employment distribution of foreign vs. West German population 2007

Employment	Foreign firms		West German MNEs		Deviation
Regional units ('ROR')	Abs.	In %	Abs.	In %	In rel. %-shares
Westmecklenburg	5.944	3,0	565	0,8	-2,2
Mittleres Mecklenburg/Rostock	3.140	1,6	1.054	1,5	-0,1
Vorpommern	2.536	1,3	330	0,5	-0,8
Mecklenburgische Seenplatte	2.956	1,5	588	0,8	-0,7
Prignitz-Oberhavel	2.524	1,3	670	0,9	-0,4
Uckermark-Barnim	1.568	0,8	352	0,5	-0,3
Oderland-Spree	7.124	3,6	1.353	1,9	-1,7
Lausitz-Spreewald	4.246	2,2	2.858	4,0	1,8
Havelland-Fläming	7.465	3,8	3.911	5,5	1,7
Berlin	52.007	26,6	4.432	6,2	-20,4
Altmark	970	0,5	1.092	1,5	1
Magdeburg	5.722	2,9	5.307	7,5	4,6
Dessau	4.929	2,5	2.047	2,9	0,4
Halle/S.	14.539	7,4	520	0,7	-6,7
Nordthüringen	1.399	0,7	3.122	4,4	3,7
Mittelthüringen	9.542	4,9	1.182	1,7	-3,2
Südthüringen	6.832	3,5	5.961	8,4	4,9
Ostthüringen	9.054	4,6	4.000	5,6	1
Westsachsen	7.328	3,7	5.573	7,9	4,2
Oberes Elbtal/Osterzgebirge	29.299	15,0	11.657	16,4	1,4
Oberlausitz-Niederschlesien	5.896	3,0	1.148	1,6	-1,4
Chemnitz-Erzgebirge	5.199	2,7	2.597	3,7	1
Südwestsachsen	5.210	2,7	10.658	15,0	12,3
Sum	195.429	100	70.977	100	

Source: IWH FDI micro database, Author's calculations.

Table A23 Sectoral employment specialisation of foreign vs. West German multinational firms across federal states (2007)

Berlin		Branden-burg		MVP		Sachsen-Anhalt		Sachsen		Thüringen		Total EG	
NACE	Dev.*	NACE	Dev.	NACE	Dev.	NACE	Dev.	NACE	Dev.	NACE	Dev.	NACE	Dev.
24	19,9	27	27,9	25	10,0	23	10,6	31	23,8	32	10,4	31	6,6
35	11,4	35	20,2	33	6,1	29	8,7	24	5,8	34	5,9	15	6,3
26	6,7	21	5,2	24	4,9	26	6,1	35	3,5	27	5,1	35	4,4
15	5,8	28	5,0	15	4,0	32	5,8	15	2,7	25	4,6	27	3,9
31	3,9	15	3,4	21	2,4	28	5,7	30	2,7	20	3,6	24	2,7
30	2,9	30	2,9	31	2,4	33	2,7	25	2,2	21	3,2	23	2,1
27	2,4	36	0,8	20	1,6	34	0,9	17	1,8	15	2,4	30	2,0
16	2,1	37	0,6	34	1,3	20	0,6	16	1,5	24	2,3	21	1,3
23	1,9	32	0,5	37	0,8	17	0,5	27	1,1	31	2,0	25	1,2
17	0,9	33	0,4	19	0,6	15	0,4	21	1,0	30	1,5	26	1,0
36	0,8	16	0,0	28	0,5	35	0,3	20	0,6	29	1,0	16	1,0
25	0,4	17	0,0	26	0,3	16	0,0	26	0,5	28	0,5	20	0,5
19	0,1	18	0,0	23	0,2	18	0,0	36	0,5	36	0,4	28	0,2
21	0,1	19	0,0	16	0,0	19	0,0	28	0,5	18	0,1	19	0,1
37	0,0	23	-0,0	17	0,0	22	0,0	23	0,5	16	0,0	18	-0,1
18	0,0	25	-1,3	18	0,0	30	0,0	19	0,0	19	0,0	36	-0,4
20	0,0	26	-2,6	30	0,0	21	-0,2	33	-0,1	23	0,0	37	-0,6
22	-1,8	22	-2,7	29	-0,7	37	-0,3	18	-0,2	37	-0,5	33	-1,1
33	-2,4	20	-2,8	36	-1,7	25	-2,7	37	-0,7	26	-2,4	32	-1,9
32	-6,2	34	-8,5	27	-4,1	31	-2,8	32	-2,7	33	-6,2	17	-2,4
28	-11,9	31	-10,1	35	-7,5	36	-5,3	22	-2,9	22	-6,9	22	-2,8
34	-13,5	29	-13,3	22	-9,1	27	-5,9	29	-18,9	35	-12,2	29	-10,9
29	-23,5	24	-25,6	32	-12,1	24	-25,0	34	-23,2	17	-14,8	34	-13,1

*'Dev.' indicates the difference between the relative share of foreign firms in the relevant sector and region less the relative share of the West German multinational firms. Thus a positive value shows a specialisation of foreign firms and a negative value a specialisation of West German multinationals.

Source: IWH FDI micro database, Author's calculations.

Table A24 Mean number of employees in population and East German manufacturing (2007)

	N	mean	std.dev.	skewness	std.err.	kurtosis	std.err.
Population WG MNEs	319	222,50	594,00	7,85	0,12	76,17	0,27
Population foreign firms	1015	192,54	582,17	9,82	0,08	123,36	0,15
Total population	1.334	199,70	584,93	9,32	0,07	110,93	0,13
EG manufacturing*	39.258	15,70	58,67	48,04	0,01	4816,9	0,02

Source: IWH FDI micro database, *Institute for employment research, Author's calculations.

Table A25 Distribution of number of employees in East German manufacturing and total population (2007)

	East German manufacturing				Total population			
	no. firms	in %	employ ees	in %	no. firms	in %	employ ees	in %
Micro (1 -9)	23.454	59,7	103.813	11,1	206	15,4	874	0,33
Small (10 - 49)	11.917	30,4	248.773	26,6	383	28,7	9.677	3,63
Medium (50 -249)	3.441	8,8	355.483	38,0	515	38,6	62.419	23,43
Large (over 249)	446	1,1	228.085	24,4	230	17,2	193.436	72,61

Source: IWH FDI micro database, *Institute for employment research, Author's calculations.

Table A26 Distribution of number of employees in foreign and West German multinational population (2007)

	West German population				Foreign population			
	no. firms	in %	employ ees	in %	no. firms	in %	employ ees	in %
Micro (1 -9)	29	9,1	108	0,2	177	17,4	766	0,4
Small (10 - 49)	91	28,5	2.265	3,2	292	28,8	7.412	3,8
Medium (50 -249)	136	42,6	16.271	22,9	379	37,3	46.148	23,6
Large (over 249)	63	19,7	52.333	73,7	167	16,5	141.103	72,2

Source: IWH FDI micro database, *Institute for employment research, Author's calculations.

Table A27 Revealed technological advantage (RTA) of regions in terms of the incidence of R&D expenditure in 2005 by multinational affiliates*

	NACE2																			
ROR	15	17	18	20	21	22	24	25	26	27	28	29	30	31	32	33	34	35	36	37
7	0,00	0,00	0,00	0,00	0,00	0,00	2,87	0,00	0,00	0,00	4,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**7,17**	0,00
8	6,37	0,00	0,00	**9,56**	0,00	0,00	2,87	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
9	3,82	0,00	0,00	5,73	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,82	0,00	0,00	**11,47**	4,30	0,00
25	0,00	0,00	0,00	7,17	0,00	0,00	0,00	5,38	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,31	0,00	0,00	0,00	**8,60**
26	4,78	0,00	0,00	7,17	**10,75**	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**10,12**	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,41	0,00	0,00	0,00	0,00	0,00	0,00	**19,11**	0,00	11,47
29	0,00	0,00	0,00	0,00	0,00	0,00	3,44	0,00	0,00	0,00	0,00	1,23	0,00	0,00	3,82	0,00	0,00	**11,47**	0,00	0,00
30	0,00	0,00	0,00	0,00	1,79	**8,60**	1,43	0,00	0,84	0,00	0,00	0,51	0,00	2,87	0,00	1,10	2,87	0,00	0,00	2,87
31	0,00	0,00	0,00	0,00	0,00	0,00	**8,60**	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
32	2,39	0,00	0,00	3,58	0,00	0,00	0,00	2,69	1,26	0,00	1,65	1,54	0,00	0,00	0,00	0,00	**4,30**	0,00	0,00	0,00
33	1,91	0,00	0,00	0,00	0,00	0,00	2,58	2,15	2,02	3,44	0,00	0,00	0,00	**3,44**	1,91	0,00	0,00	0,00	0,00	0,00
34	0,00	0,00	0,00	0,00	0,00	0,00	1,23	0,00	2,89	0,00	1,89	1,76	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**4,91**
53	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,38	**8,60**
54	1,37	0,00	0,00	0,00	0,00	2,46	0,00	1,54	0,00	0,00	1,89	0,00	**12,29**	0,00	4,10	3,78	2,46	0,00	0,00	0,00
55	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,69	0,00	0,00	3,31	1,54	0,00	**4,30**	0,00	1,65	0,00	0,00	2,69	0,00
56	0,00	**5,06**	0,00	0,00	0,00	0,00	1,01	0,00	2,38	0,00	1,56	0,72	0,00	2,02	1,12	2,33	0,00	0,00	1,26	0,00
57	0,00	0,00	0,00	0,00	**4,03**	0,00	0,54	1,34	0,00	2,15	0,83	2,30	0,00	2,15	0,00	0,83	0,00	0,00	1,34	0,00
58	1,91	0,00	0,00	0,00	0,00	0,00	1,29	1,08	1,01	**3,44**	0,00	1,84	0,00	0,00	0,96	0,66	1,72	0,00	1,08	0,00
59	2,39	0,00	0,00	0,00	0,00	0,00	1,08	2,69	1,26	0,00	0,00	**3,07**	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
60	0,00	0,00	**17,20**	5,73	4,30	0,00	0,00	0,00	2,02	0,00	2,65	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
61	0,00	**6,62**	**6,62**	0,00	1,65	2,65	0,66	0,00	0,00	2,65	1,02	0,95	0,00	0,00	1,47	1,02	2,65	0,00	1,65	0,00

*Source: IWH FDI micro database, Author's calculations. *The RTA is calculated by the number of firms with R&D expenditure in an specific industry of a region divided by the total number of firms with R&D expenditure across all regions in the specific industry in relation to the number of firms with R&D expenditure in an specific industry of a region divided by the total number of firms with R&D expenditure across all industries in the specific region. A value above 1 indicates relative specialisation of that industry in comparison to all other regions. n= 172 affiliates with R&D expenditures in 2005 from the total sample of 295.*

Table A28 Revealed technological advantage (RTA) of regions in terms of the incidence of product innovation during the period from 2002 to 2005*

	NACE2																			
ROR	15	17	18	20	21	22	24	25	26	27	28	29	30	31	32	33	34	35	36	37
7	3,48	0,00	0,00	**5,97**	0,00	0,00	1,82	0,00	0,00	0,00	2,99	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,64	0,00
8	2,90	0,00	0,00	**4,98**	0,00	0,00	1,51	0,00	0,00	**4,98**	0,00	0,00	0,00	0,00	0,00	0,00	5,81	5,81	0,00	0,00
9	3,48	0,00	0,00	5,97	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,99	0,00	0,00	**6,97**	4,64	0,00
25	0,00	0,00	0,00	**7,46**	0,00	0,00	0,00	4,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,02	0,00	0,00	0,00	10,45
26	6,97	0,00	0,00	**5,97**	4,18	0,00	0,00	0,00	0,00	0,00	0,00	1,19	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**14,93**	0,00	2,99	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
28	0,00	0,00	0,00	0,00	4,18	0,00	1,82	0,00	2,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**6,97**	0,00	8,36
29	2,18	0,00	0,00	0,00	0,00	0,00	2,27	0,00	0,00	0,00	0,00	1,49	0,00	0,00	1,87	0,00	0,00	**4,35**	2,90	0,00
30	0,00	0,00	0,00	0,00	1,39	**11,15**	1,21	0,00	0,73	0,00	0,00	0,40	0,00	1,99	1,00	1,07	2,32	4,64	0,00	0,00
31	0,00	0,00	0,00	0,00	0,00	0,00	**9,09**	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
32	0,00	0,00	0,00	3,73	0,00	0,00	0,00	2,38	1,38	0,00	1,87	2,24	0,00	0,00	0,00	0,00	**4,35**	0,00	0,00	0,00
33	1,74	0,00	0,00	0,00	0,00	0,00	1,82	1,90	2,20	**2,99**	1,49	0,00	0,00	**2,99**	1,49	0,00	0,00	0,00	0,00	0,00
34	1,45	0,00	0,00	0,00	0,00	0,00	2,27	0,00	**2,75**	0,00	1,24	1,00	0,00	0,00	1,24	0,00	0,00	0,00	0,00	3,48
53	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,40	0,00	0,00	0,00	0,00	**5,97**	0,00	0,00	0,00	0,00	4,64	8,36
54	0,92	0,00	0,00	0,00	0,00	2,20	0,00	4,00	0,58	0,00	1,57	0,31	**11,00**	0,00	2,36	3,38	1,83	0,00	0,00	0,00
55	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,11	0,00	0,00	**3,32**	1,33	0,00	3,32	0,00	1,79	0,00	0,00	2,58	4,64
56	0,00	**3,48**	0,00	0,00	0,00	0,00	1,36	0,00	2,20	0,00	2,24	0,90	0,00	1,49	0,75	2,41	0,00	0,00	1,16	0,00
57	0,00	0,00	0,00	0,00	**3,92**	0,00	0,00	1,19	0,69	0,00	0,00	2,99	0,00	1,87	0,00	1,00	0,00	0,00	1,45	0,00
58	1,58	0,00	0,00	0,00	0,95	0,00	1,65	0,86	0,50	**4,07**	0,00	1,09	0,00	0,00	2,04	0,73	1,58	0,00	1,06	0,00
59	1,74	0,00	0,00	0,00	**2,09**	0,00	0,91	1,90	1,10	0,00	1,49	2,39	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
60	0,00	8,71	**13,06**	3,73	2,61	0,00	0,00	0,00	1,38	0,00	1,87	0,75	0,00	0,00	1,87	0,00	0,00	0,00	0,00	0,00
61	0,00	5,36	**8,04**	0,00	1,61	0,00	0,70	0,00	0,00	2,30	1,15	0,92	0,00	2,30	1,15	1,24	2,68	0,00	1,79	0,00

*Source: IWH FDI micro database, Author's calculations. *The RTA is calculated by the number of firms with R&D expenditure in an specific industry of a region divided by the total number of firms with R&D expenditure across all regions in the specific industry in relation to the number of firms with R&D expenditure in an specific industry of a region divided by the total number of firms with R&D expenditure across all industries in the specific region. A value above 1 indicates relative specialisation of that industry in comparison to all other regions. n= 209 affiliates with product innovation 2002-2005 from the total sample of 295.*

Table A29 R&D employment and expenditure indicators of foreign multinational affiliates

	2002		2005	
R&D employment*				
Share of affiliates with R&D employment (in %)	222	35,14	222	52,7
Average no. R&D employees per firm	159	6,63	212	7,71
Average share of R&D employees in total employment	155	8,84	212	11
Share of R&D employees of total employment	155	4,92	212	5,76
R&D expenditures**				
Share of affiliates with R&D expenditures (in %)	222	39,64	222	57,66
Average annual R&D expenditure per firm (in Euro)	130	770.586	151	885.557
Average share of R&D expenditure in turnover per firm	110	6,36	149	7,14
Share of R&D expenditure in total turnover (aggregate)	122	3,27	146	3,21

Note: *R&D employment refers to the total number of technical and scientific personnel (headcount) dedicated at all R&D activities undertaken on the affiliate level. **R&D expenditures refer to all annual intra-mural and extramural expenditures on the level of the affiliate. n for R&D expenditures varies due to missing values in the reference value (turnover).

Source: Source: IWH FDI micro database (2007), Author's calculations.

Table A30 R&D employment and expenditure indicators of WG multinational affiliates

	2002		2005	
R&D employment*				
Share of affiliates with R&D employment (in %)	73	36,99	73	56,16
Average no. R&D employees per firm	55	4,84	69	8,88
Average share of R&D employees in total employment	54	8,95	69	10,96
Share of R&D employees of total employment	54	5,33	69	9,11
R&D expenditures**				
Share of affiliates with R&D expenditures (in %)	73	47,95	73	63
Average annual R&D expenditure per firm (in Euro)	38	603.671	47	720.341
Average share of R&D expenditure in turnover per firm	37	4,98	46	6,08
Share of R&D expenditure in total turnover (aggregate)	38	4,23	47	3,93

Note: *R&D employment refers to the total number of technical and scientific personnel (headcount) dedicated at all R&D activities undertaken on the affiliate level. **R&D expenditures refer to all annual intra-mural and extramural expenditures on the level of the affiliate. n for R&D expenditures varies due to missing values in the reference value (turnover).

Source: Source: IWH FDI micro database (2007), Author's calculations.

Table A31 Technological spillovers via various backward trade linkages

	No supplies	Spillovers*	No Spillovers**	n. a.
Foreign affiliates (n=222)				
Foreign suppliers at entry	36,49	9,91	53,60	0,00
Foreign suppliers today	36,49	15,77	47,75	0,00
West German supplier at entry	30,63	16,22	52,70	0,45
West German supplier today	30,63	21,62	47,30	0,45
East German suppliers at entry	30,63	15,32	53,60	0,45
East German suppliers at today	30,63	21,62	47,30	0,45
WG affiliates (n=73)				
Foreign suppliers at entry	46,58	8,22	45,21	0,00
Foreign suppliers today	46,58	10,96	42,47	0,00
West German supplier at entry	19,18	15,07	64,38	1,37
West German supplier today	19,18	21,92	57,53	1,37
East German suppliers at entry	20,55	17,81	60,27	1,37
East German suppliers at today	20,55	24,66	53,42	1,37

Note: *Affiliates indicated 3 = important, 4 = very important, or 5 = extremely important.
**Affiliates indicated 1 = not important or 2 = little important.

Source: Source: IWH FDI micro database (2007), Author's calculations.

Table A32 Technological spillovers via various backward trade linkages

	No sales	Spillovers*	No Spillovers**	n. a.
Foreign affiliates (n=222)				
Foreign customers at entry	29,28	24,77	44,59	1,35
Foreign customers today	29,28	31,08	38,29	1,35
West German customers at entry	22,97	31,08	44,59	1,35
West German customers today	22,97	37,84	37,84	1,35
East German customers at entry	30,18	29,28	38,74	1,80
East German customers at today	30,18	36,04	31,98	1,80
WG affiliates (n=73)				
Foreign customers at entry	39,73	15,07	45,21	0,00
Foreign customers today	39,73	30,14	30,14	0,00
West German customers at entry	27,40	34,25	38,36	0,00
West German customers today	27,40	49,32	23,29	0,00
East German customers at entry	19,18	31,51	43,84	5,48
East German customers at today	19,18	45,21	30,14	5,48

Note: *Affiliates indicated 3 = important, 4 = very important, or 5 = extremely important.
**Affiliates indicated 1 = not important or 2 = little important.

Source: Source: IWH FDI micro database (2007), Author's calculations.

Table A33 Technological spillovers via horizontal linkages

	Does not apply	Spillovers*	No Spillovers**	n. a.
Foreign affiliates (n=222)				
Foreign/WG competitors at entry	7,66	21,62	62,61	8,11
Foreign/WG competitors today	7,21	28,83	48,65	15,32
EG competitors at entry	15,77	15,32	61,71	7,21
EG competitors at today	16,67	19,82	56,31	7,21
West German affiliates (n=73)				
Foreign/WG competitors at entry	2,74	17,81	76,71	2,74
Foreign/WG competitors today	2,74	36,99	54,79	5,48
EG competitors at entry	10,96	15,07	72,60	1,37
EG competitors at today	10,96	24,66	63,01	1,37

Note: *Affiliates indicated 3 = important, 4 = very important, or 5 = extremely important.
**Affiliates indicated 1 = not important or 2 = little important.

Source: Source: IWH FDI micro database (2007), Author's calculations.

CODEBOOK
IWH FDI MICRO DATABASE
Survey 2007

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Part A: Information about your foreign investor

A “foreign investor” holds a minimum of 10% of equity of another company abroad. The “Foreign investor network” or “Multinational Enterprise (MNE) group” comprises the “foreign parent enterprise” or “headquarter” and other units (domestic and foreign) of the foreign investor. The following questions are related to your firm as a subsidiary or affiliate of the foreign investor. Some questions also relate to your foreign investor itself. In case there are more than one foreign investors owners in your firm, the questions relate to the largest foreign investor in terms of equity or board members today.

V1 **NACE (4-digit)** (based on most important product in terms of share in total sales)

V2 **Please indicate the year of the entry of your foreign investor into your firm?**

V3 **Please indicate the total share in equity held by your foreign investor.**

V3_1 At initial entry

V3_2 2002

V3_3 Today

Important: For Croatia V3_2 refers to 2003.

V4 **Please indicate the type of foreign investor in your firm.** Please choose one option!

1 Multinational Enterprise Group

2 National Enterprise Group[24]

3 Enterprise (single entity)

4 Foreign individual or family

V5 **Please indicate the home country (HQ location) of your foreign investor.**

Important: ISO 3166 2-digit country codes

[24] A national enterprise group is composed of different units in the home country, however, its only foreign unit is your firm.

V6 Please indicate which of the following types of owners currently hold equity or have voting rights in your firm. Please tick the appropriate box for each type of owner. Please consider all owners including the foreign investor.

V6_1 Foreign large MNE group(s) (more than 250 employees or 50 mil Euros in turnover)

V6_2 Small and medium-sized foreign firm(s)

V6_3 Foreign financial investor(s) (bank and/or investment fund)

V6_4 Domestic government or entity(-ies) under state control

V6_5 Domestic financial investor(s) (bank and/or investment fund)

V6_6 Domestic manager(s) or employees of your own firm

V6_7 Unnamed shareholders

Codes: 1 yes, 0 no, 9 no answer

Important: Please note that variable V6_7 is not avaialbe for Croatia and Slovenia.

V7 Please indicate what describes best the initial entry mode of your foreign investor.

V7_1 Partial/full acquisition of a state owned firm as part of the privatisation process

V7_2 Partial/full acquisition of a domestic privately owned firm

V7_3 Partial/full acquisition from another prior foreign investor

V7_4 Partial/full ownership in/of a completely new enterprise

Codes: 1 = partial, 2 = full, 7 = does not apply

V8 Please rank the importance each of the following strategic motives pursued by the foreign investor at initial entry and today. Please fill in all cells.

V8_1	To access a new market or to increase the existing share on your domestic market (at entry)
V8_1h	Today
V8_2	To follow foreign key clients that moved to your country (at entry)
V8_2h	Today
V8_3	To increase efficiency across the foreign owner network (at entry)
V8_3h	Today
V8_4	To access location-bound natural resources
V8_4h	Today
V8_5	To access location-bound knowledge, skills, technology-
V8_5h	Today

Codes: 1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important, 9 no answer

Part B: Information about your firm

V9 Please approximate the structure of your sales according to the location of your buyer(s) (in %). Please fill in all cells that apply, otherwise enter 0.

V9_1	Exports to your foreign investor network (HQ and other foreign units) -------
V9_2	Exports to other foreign buyers ---
V9_3	Sales to other domestic subsidiaries of your foreign investor -------------------
V9_4	Sales to other domestic buyers --

V10 Please approximate the structure of your supplies according to the location of the respective supplier(s) (in %) Please fill in all cells that apply, otherwise enter 0.

V10_1 Imports from your foreign investor network (HQ and other foreign units)-------

V10_2 Imports from other foreign suppliers ---

V10_3 Supplies from other domestic subsidiaries of your foreign investor ----------------

V10_4 Supplies from other domestic suppliers ---

V11 Please approximate the following general information about your firm

V11_1a Total number of employees 2002---

V11_1b Total number of employees 2005---

V11_2a Number of R&D personnel 2002---

V11_2b Number of R&D personnel 2005---

V11_3a Value of total assets (in Euro) 2002------------------------------------

V11_3b Value of total assets (in Euro) 2005------------------------------------

V11_4a Value of total sales (in Euro y) 2002------------------------------------

V11_4b Value of total sales (in Euro) 2005---------------------------------------

V11_5a Share of intermediate inputs/supplies (as % of total sales) 2002

V11_5b Share of intermediate inputs/supplies (as % of total sales) 2005

Important: Please note for CroatiaV11refer to 2003 and 2006 respectively.

V12 Please indicate the magnitude of the changes of the categories below over the last three years. Please provide an answer for each category.

V12_1	Earnings before interest and taxes
V12_2	Share of exports (in total sales)
V12_3	Value added per employee
V12_4	Market share on your most relevant market
V12_5	Competition within foreign investor network

Codes: 1 = considerable reduction, 2 = reduction 3 = no change 4 = increase; 5 = considerable increase, 9 = no answer

V13 Does your firm (not you foreign investor) control own subsidiaries abroad? If yes, please indicate the number and the respective location(s).

13a	Number
V13_1	North America
V13_2	European Union - 15
V13_3	New EU-member countries
V13_4	Former Soviet Union
V13_5	Asia
V13_6	South East Europe
V13_7	other locations

Codes: 1 = Yes, 2 = No, 9 = no answer

Part C: THE RELATIONSHIP BETWEEN YOUR FIRM AND THE FOREIGN INVESTOR

V14 Please indicate to which degree the following business functions are currently undertaken either by your firm or the foreign owner network (HQ/other unit)**.**

V14_1 Production and operational management

V14_2 Market research and marketing

V14_3 Basic and applied research

V14_4 Product development[25]

V14_5 Process engineering[26]

V14_6 Strategic management and planning

V14_7 Investment projects and finance

Codes: 1= only your firm, 2 = mainly your firm, 3 = mainly foreign investor network, 4 = only foreign network, 9 = no answer

V15 Please indicate the extent of responsibilities transfer from headquarters and/or other units to your firm since entry of the foreign investor in the follwing areas.

V15_1 New geographical markets

V15_2 New products

V15_3 New business functions (refers to business function listed in V14)

Codes: 1 = no transfer, 2 = limited transfer, 3= considerable transfer, 4 = full transfer, 9 = no answer

[25] **Product development** refers to product innovations,which are new or significantly improved goods or services with respect to their characteristics (technical specifications, components, materials, incorporated software) or intended uses (user-friendliness etc.). The product must be new to your firm not necessarily to the market!

[26] **Process engineering** refers to new or improved production methods (e.g. computer-assisted design) or delivery methods (e.g. bar-coded goods-tracking system.) including changes in techniques, equipment and/or software.

V16 Please indicate to which extent you expect such a transfer in the future.

V16_1 New geographical markets

V16_2 New products

V16_3 New business functions (refers to business function listed in V14)

Codes: 1 = no transfer, 2 = limited transfer, 3= considerable transfer, 4 = full transfer, 9 = no answer

V17 Please estimate the intensity of internal competition within your foreign investor network/ multinational group (i.e. between your firm and other domestic/foreign units or HQ of your foreign investor) **with regard to the following areas.**

V17_1 Serving markets

V17_2 Particular or new business lines

V17_3 Business functions (see question 14)

Codes: 1= no competition, 2 = weak intensity, 3 = strong intensity, 4 = very strong intensity

Important: Please note that variable V17 is not available for Croatia and Slovenia.

Part D: RESEARCH & DEVELOPMENT (R&D) AND INNOVATION IN YOUR FIRM

V18 Please indicate whether your firm has undertaken any of the below listed types of innovation over the last three years. If "yes", please indicate the innovation intensity in comparison to your competitors in the relevant market.

V18_1 Product innovation[27] ---

V18_1a Product innovation intensity---

V18_2 Process innovation[28]--

V18_2a Process innovation intensity --

V18_3 Marketing innovation[29] --

V18_3a Marketing innovation intensity ---------------------------------------

V18_4 Organisational innovation[30] --

V18_4a Organisational innovation intensity-----------------------------------

Codes: Innovation type: 1 = Yes, 2= No, 9 = no answer

Innovation intensity: 1 = very low, 2 = below average, 3 = average, 4 = above average, 5 = very high, 7= does not apply, 9 = no answer

V19 Please approximate the annual expenditures on R&D and innovation (including external R&D services)**.** Please indicate the total value in Euro or as a share of total sales. If it does not apply, please indicate ”0”.

V19_1a 2002 (in % of total sales)

V19_1b 2005 (in % of total sales)

V19_2a 2002 (in EURO)

V19_2b 2005 (in EURO)

Important: For Croatia V19 refers to 2003 and 2006 respectively.

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[27] **Product innovation:** new or significantly improved good or service. The product must be new to your firm not necessarily to the market!

[28] **Process innovation:** new or improved production or delivery methods including e.g. changes in techniques,
equipment and/or software.

[29] **Marketing innovation:** significant changes in product design, packaging, product placement, product promotion or pricing etc.

[30] **Organisational innovation:** new organisational method in the firm’s business practices, workplace organisation, or external relations etc.

V20 Please approximate the share of new or significantly improved products in your firm's total sales. Please enter "0" if it does not apply to your firm.

V20a 2002 (in % of total sales)

V20b 2005 (in % of total sales)

Important: Please note for CroatiaV11refer to 2003 and 2006 respectively.

V21 Please indicate the importance of the below listed sources for R&D and innovation in your firm?

V21_1a Acquisition and purchase of external knowledge from abroad

V21_1b Acquisition and purchase of external knowledge domestically

V21_2a Cooperation with other units of the MNE-network abroad

V21_2b Cooperation with other units of the MNE-network domestically

V21_3a Cooperation with other firms abroad

V21_3b Cooperation with other firms domestically

V21_4a Cooperation with other organisations abroad

V21_4b Cooperation with other organisations domestically

21_5 Access to public and open information

Important: 21_1a to 21_4b are not available for East Germany (EDE and EDE_west)

V21_1EDE Acquisition and purchase of external knowledge (for example licences and R&D services)

V21_2EDE Cooperation (for example with other units of the MNE network, other firm or organisations such as research institutes)

Important: 21_1/2EDE are only available for East Germany (EDE and EDE_west)

Codes: 1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important, 9 = no answer

V22 Please evaluate the importance of the following sources of technological knowledge for R&D or innovation in your firm both, at entry of your foreign investor and today.

V22_1a	Existing technology of your MNE group embodied in products you already produce without substantial adjustments (at entry)
V22_1b	today
V22_2a	R&D carried out on your own (at entry)
V22_2b	today
V22_3a	R&D carried out at the HQ of your foreign investor network (at entry)
V22_3b	today
V22_4a	R&D carried out by another unit of foreign investor network (at entry)
V22_4b	today
V22_5a	R&D carried out in collaboration with suppliers abroad (at entry)
V22_5b	today
V22_6a	R&D carried out in collaboration with local suppliers (at entry)
V22_6b	today
V22_7a	R&D carried out in collaboration with customers abroad (at entry)
V22_7b	today
V22_8a	R&D carried out in collaboration with local customers (at entry)
V22_8b	today
V22_9a	R&D carried out in collaboration with competitors (strategic alliance) (at entry)
V22_9b	today
V22_10a	R&D carried out in collaboration with scientific institutions abroad (at entry)
V22_10b	today
V22_11a	R&D carried out in collaboration with local scientific institutions (at entry)
V22_11b	today

Codes: 1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important, 9 no answer

Important: *Variables V22_5 to V22_9 are* <u>*not*</u> *available for the Slovenian and Croatian dataset. In the East German dataset (EDE and EDE_west) „domestic“ or „local“ corresponds to East Germany only.*

V23 Please evaluate the importance of your own firm as a source of technological knowledge for R&D or innovation for others both, at entry of the foreign investor and today.

V23_1a	Headquarters of your MNE group
V23_1b	today
V23_2a	Other units or subsidiaries of your MNE group
V23_2b	today
V23_3a	Your suppliers abroad
V23_3b	today
V23_4a	Your local suppliers
V23_4b	today
V23_5a	Your customers abroad
V23_5b	today
V23_6a	Your local customers
V23_6b	today
V23_7a	Your competitors abroad
V23_7b	today
V23_8a	Your local competitors
V23_8b	today

Codes: 1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important, 9 = no answer

Important: *In the Slovenian and Croatian dataset the values for customers and suppliers are identical (V23_3a/b = V23_5a/b, 23_4a/b = 23_6a/b). In the East German dataset (EDE and EDE_west) „local" corresponds to East Germany only. In addition V23_7a/b "abroad" refers to foreign and West German competitors.*