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Does Local Technology Matter for Foreign Investors in Central and Eastern Europe? Evidence from the IWH FDI Micro Database

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This article analyzes investment motives, scope, and intensity of R&D and innovation, in foreign affiliates and the extent and determinants of linkages to the host country's scientific institutions. The analysis uses the IWH FDI micro database that offers evidence for 809 foreign affiliates in Central and East Europe. Foreign direct investment into the region seems to be still dominated by market- and efficiency-seeking motives. Tapping into localized knowledge, skills, and technology seems to be of secondary importance. Yet, the majority of foreign affiliates actively engage in R&D and innovation, although fewer foreign firms build technological linkages with local scientific institutions.

KEYWORDS Central East Europe, East Germany, foreign direct investment, innovation, R&D

INTRODUCTION

Ever since the outset of economic transition in Central and Eastern Europe, including East Germany, Western multinational enterprises (MNEs) have been

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present with different types of investment activities in these economies. In the course of time, market entry and operational strategies have of course changed. In the early stages of transition, MNEs often undertook joint ventures with local firms to undertake production activities and secure market shares. Participation in the privatization processes also offered market entry possibilities for MNEs. Later on, wholly foreign-owned affiliates became more important, especially based on greenfield investments, and also increasingly operating in technological activities (Hunya 2000, Stephan 2006).

After nearly two decades of market reforms and transition, this article scrutinizes investment strategies of MNEs present in the region today. It raises the question as to why Western companies do engage in foreign direct investment (FDI) in these countries: Are FDI projects still dominated by a low-wage, labor-intensive strategy that could be characterized as "extended workbenches?" Or do investors mainly seek access to the European market, or in some cases, large and dynamically growing domestic markets. Do MNEs benefit from other locational advantages such as localized knowledge and technological capability? In fact, the latter motive could be particularly important in terms of long-term and sustainable competitive advantages of foreign affiliates in the region. Therefore, the article describes the extent to which foreign investors perform technological activities in terms of R&D and innovation. Finally, we analyze firm-, country-, and industry-level determinants of external technological interaction of foreign subsidiaries with host country scientific institutions. Strong external linkages could be an indicator that any technological advantage is increasingly interwoven with host country specific advantages.

The empirical analysis is made possible by unique firm-level data, the "IWH FDI micro database." This newly created micro database has been constructed by field work to which 809 foreign affiliates with about 214,000 employees contributed in a selection of CEE countries and regions, namely East Germany, Slovenia, Poland, Croatia, and Romania. The survey was conducted in 2007 by an international consortium involving national teams in the respective countries and regions. The survey provides a rich dataset on internationally harmonized technological indicators, a number of variables related to governance structures of MNEs, and internal and external cooperation activities of affiliates—information that is not available in any existing micro datasets. Furthermore, the combination of countries in the survey is unique and valuable for the comparative perspective, including East Germany as a "special case" of transition economies, Slovenia and Poland as examples of advanced Central European transition economies, and Croatia and Romania as South East European transition countries that are still economically lagging behind.

The article reveals a number of interesting results: Overall, FDI into the region is still dominated by market- and efficiency-seeking motives, with some country differences of course. Tapping into localized knowledge, skills,

and technology seems to be of secondary importance. However, the majority of foreign affiliates undertake R&D and innovation activities in the host economies. This clearly stimulates diffusion of knowledge and technological development of host economies, despite the fact that there is a substantial amount of heterogeneity at the country level. However, we find that rather few foreign affiliates build technological linkages with local scientific institutions. This could potentially limit competitiveness of foreign affiliates in the longer term. Yet, the extent of such linkages is also governed by a substantial amount of firm level heterogeneity. After controlling for country and industry level effects, we can show that, in line with theory, firms pursuing a technological asset-augmenting strategy source more intensively local technological knowledge than firms following an asset-exploiting strategy. Furthermore, foreign affiliates that enjoy greater autonomy over technology-related business functions are more likely to maintain such linkages to host country scientific institutions. The article starts with a theoretical overview of the organization of technological activities in MNEs, followed by a description of the IWH FDI micro database. Afterward, the article follows two interrelated objectives: Section 4 provides a descriptive comparison across countries of various technological indicators of foreign affiliates. Section 5 then analyzes the determinants of linkages to host country scientific institutions of technologically active foreign affiliates in the framework of a set of ordered Probit-estimations. The article closes with a discussion of the results and concludes with an outlook for future research.

THEORETICAL BACKGROUND AND DEVELOPMENT OF HYPOTHESES

From an organizational perspective, the locus of technological innovation resides not only within the boundaries of the firm but outside, at the interfaces between firms, universities, research laboratories, suppliers, and customers (Powell, Koput, and Smith-Doerr 1996). Many innovations intrinsically require collective efforts, involving different stakeholders to act cooperatively to generate new knowledge and ideas (Chesbrough 2003). This point of view is related to the idea that innovation emanates from the recombination of existing knowledge (Kogut and Zander 1993, Nonaka 1994). The use of multiple sources of technological knowledge both augments technological opportunities (Klevorick et al. 1995) and leads to complementarities and synergies between knowledge sources (Leiponen and Helfat, forthcoming). For example, academic research provides knowledge central to industrial innovative activity, yet it generally does not provide solutions to the more applied sort of problems on which firms tend to focus on (Mansfield 1991, Pavitt 1998). Agreements between firms concentrate more on product-specific developments of basic research discoveries

(Arora and Gambardella 1990). Users (i.e., firms or individual consumers that expect to benefit from using a product) are potentially able to provide knowledge regarding problems or desired modifications of existing products (von Hippel 1976, 2005). Suppliers provide producers with knowledge regarding inputs, including raw materials, plants and equipment, product components, and subsystems relevant to technological processes.

What does that mean for technological processes in foreign subsidiaries of MNEs? It has been suggested that the traditional advantages of centralization of R&D and innovation activities in home economies—often connected to economies of scale and scope in R&D—seem to be increasingly counterbalanced by those advantages associated with decentralization of technological activities (Howells and Wood 1993; Miller 1994; Pearce and Singh 1992). Decentralization offers linkages between technological activity and foreign production, local markets, suppliers and clients, and the exploitation of technological fields of excellence in host economies of subsidiaries (Cantwell 1992, 1993; Cantwell and Iammarino 2003; Dunning and Wymb 1999; Von Zedtwitz and Gassmann 2002). However, firms have not internationalized their innovative activity proportionally to the growth in their overall production activities (Patel and Pavitt 1991, 1999; Zanfei 2000). This could be associated—inter alia—with the complex nature of systems of innovation, the embeddedness of the firms' technological activities in the home environment (Narula 2002), and the need for internal cohesion within the firms (Blanc and Sierra 1999; Zanfei 2000).

Overseas technological activities, on the one hand, can be associated with adapting and modifying firms' existing technological assets in response to demand conditions. This has been labeled as "home-base exploiting" (Kuemmerle 1997) or "competence-exploiting" behavior (Cantwell and Piscitello 1999; Cantwell and Mudambi 2005). On the other hand, foreign subsidiaries can be used by MNEs to augment existing technological assets by actively absorbing technological spillovers, either from the local knowledge base in general (public infrastructure or to benefit from agglomerative effects in a specific sector), or from specific firms in particular (see, e.g., Cantwell and Janne 1999; Dunning and Narula 1995; Patel and Vega 1999). This strategy has been labeled as "home-base augmenting" (Kuemmerle 1997), or "competence augmenting" (Cantwell and Piscitello 1999; Cantwell and Mudambi 2005). Criscuelo, Narula, and Verspagen (2002) hold that most foreign firms simultaneously engage in both competence-exploiting and competence-augmenting activities, because products are multi-technology-based; therefore, any given foreign affiliate has a need for a variety of technologies, and any given host location may possess a relative technological advantage in one area but not in another. In sum, subsidiaries' capacities to exploit or augment technological competences are functions not only of its own resources but also of the capabilities to utilize complementary resources associated with the relevant local innovation system (Criscuelo et al. 2002).

For a home base augmenting strategy to take effect, foreign affiliates drawing from the host economy's knowledge base obviously need some extent of autonomy of their own business functions: Affiliates can be assumed to have access to information about the best sources of local knowledge and the most productive mode of tapping those resources. The literature on foreign investment affiliates' embeddedness hence suggests that the greater the extent of autonomy of the affiliate, the better its ability to form external linkages with other companies and institutions in the local environment (Andersson and Forsgren 2000; Birkinshaw, Hood, and Jonsson 1998). It is hence the most strategically independent foreign affiliate that cooperates most intensively with other firms and so utilizes its autonomy as a means of leveraging local technological assets to enhance the competitive advantages of the enterprise group as a whole (Andersson et al. 2002, Cantwell and Mudambi 2005).

The existing theory on the question under what conditions foreign subsidiaries draw on local knowledge sources is still fairly limited (Criscuelo et al. 2002; Frost 2001). First and foremost, for host economy knowledge assets to be utilized, technological activity of FDI projects have to be sufficiently decentralized to grant the affiliates some mandate to be technologically active: Frost proposes that the greater the innovation activity of a foreign subsidiary, the greater the likelihood that its innovations will draw upon technical ideas originating in the host economy. However, there are also studies arguing that the reverse is true: The existence of local external innovation networks fosters foreign subsidiaries' technological capability (Birkinshaw and Ridderstrale 1999; Holm and Fratocchi 1998) and innovation activity (Andersson, Forsgren, and Holm 2002; Pearce and Papanastassiou 1999; Yamin and Otto 2004). There seems to be an unresolved issue in the literature with regard to the question of whether the causality runs from subsidiaries' technological capability (R&D and innovation) to external technological sourcing or vice versa.

Criscuelo and colleagues (2002) state that home base augmenting activities are primarily undertaken with the intention to acquire and internalize technological spillovers that are location-specific in the host economy. In contrast, a home base exploiting strategy reinforces the existing knowledge base of the corporation through reproduction and incremental extension (Frost 2001). The focus on refinement and adaptation is more likely to preserve the existing search routines of the entire corporation, which are strongly associated by internal knowledge flows and the parent firm's existing external network in the home country (Frost). The primary function of subsidiaries with competence-exploiting mandates is to serve the local market. Their role is predominantly demand-driven. In line with the previoously discussed literature on the decentralization of R&D activities within MNEs (Cantwell 1989; Cantwell and Piscitello 1999; Cantwell and Mudambi 2005, etc.) and the "augmenting" versus

"exploiting" strategies (Frost; Kuemmerle 1997, etc.), we come to the following hypothesis:

> H1: Foreign affiliates following a competence augmenting strategy are more likely to source technological knowledge from local scientific institutions, than foreign affiliates following a competence exploiting strategy.

As discussed, the mandate of the foreign affiliate is of high importance for local interaction to become real. Related to the issue of tapping knowledge and skills from external networks (Kogut and Zander 1993) is the question of autonomy. The literature suggests that a high level of autonomy of foreign affiliates allows them to make best use of local technological assets (Andersson and Forsgren 2000; Anderson et al. 2002; Birkinshaw et al. 1998; Cantwell and Mudambi 2005; Marin and Bell 2006). Therefore, we hypothesize:

> H2: The higher the autonomy of a foreign affiliate, the more likely it is to source technological knowledge from local scientific institutions.

In the early stage of presence in the host economy, the investment decision is typically characterized by uncertainty and caution. This usually results in less freedom for the foreign affiliate and more control through the headquarters (Giroud 2003). In the course of time, however, control over foreign affiliates, which causes substantial transaction costs, becomes more and more inefficient (Castellani and Zanfei 2006). This suggests that the duration of presence impacts on the extend of local interaction. In this sense, Frost (2001) also argues that older foreign affiliates (i.e., those with more time and resources to gain a reputation for cooperative behavior) are more likely to have access to local sources of knowledge than their younger counterparts who might suffer from the "liability of newness" (Stinchcombe 1965; Venkataraman and Van de Ven 1998) in the host economy environment. Therefore, we hypothesize that:

> H3: The longer the foreign affiliate is established in the host economy, the more likely it is to source technological knowledge from local scientific institutions.

In our analysis below, we compare the main technological characteristics of foreign affiliates across the set of five post-socialist host economies in Central East Europe and East Germany. Furthermore, we test the foregoing hypotheses with respect to the determinants of technological interaction between foreign affiliates (performing R&D and innovation) and local scientific institutions. This not only allows us to compare between the different

host economies but informs us on the strategies that are most intensively associated with local technological activity.

The IWH FDI Micro Database

To provide some answers to the research questions outlined earlier, information at the level of the foreign affiliate is needed. In late 2007, a European consortium, financially supported by the EU in its 6th Framework Programme, conducted coordinated field work projects interrogating manufacturing foreign affiliates in East Germany, Slovenia, Poland, Romania, and Croatia. This survey forms part of the IWH FDI micro database and has been used as the data source for the subsequent analysis. Starting in 2007, the IWH FDI micro database has been generated by annual surveys of foreign affiliates in East Germany and biannual surveys of foreign affiliates in selected countries of Central and East Europe. Since 2008, the IWH FDI micro database covers in addition to manufacturing firms also selected services and domestic firms with outward FDI. However, owing to the typically fairly small total population of FDI foreign subsidiaries in the region and the recent start of the project, the IWH FDI micro database still forms a series of cross-sections and does not constitute a panel data set.

The survey questionnaire was centrally designed in 2006, whereas the survey implementation was organized and decentralized during 2007. In Croatia, Slovenia, Romania, and Poland, the implementation followed in principal the same pattern: All firms from the population were approached in writing or by phone; firms received the questionnaire either by post, fax, or as an electronic version. In Romania, owing to the large size of the total population of foreign affiliates, a random sample was drawn from the population. All firms in the sample received the questionnaire by post, yet the interviews were realized face-to-face. In East Germany, all firms from the population were contacted by phone and invited to take part in the survey. Most interviews were realized directly by phone; only few companies preferred to fill in the questionnaire in written form. The project deliberately allowed the country teams to choose the most appropriate method and timing individually. The survey implementation was concluded in June 2007.

The total population consists of foreign owned manufacturing firms located in Croatia, Slovenia, Poland, Romania, and East Germany in 2006. The selection of these regions in economic transition tries to balance country size, geographic location, and level of economic development. A "foreign-owned firm" is defined as a legally independent enterprise with a foreign equity participation of at least 10% and/or an ultimate owner located abroad. For East Germany, the survey also included West German multinationals that own at least 10% of equity and/or are the ultimate owner of a legally independent firm located in East Germany. As a multinational enterprise, these firms are industrial firms that undertook FDI in at least one country

outside Germany. From our point of view, it is important to consider both foreign and West German multinational owned firms to reflect the full extent of "foreign" direct investment in East Germany.

The populations of foreign-owned firms in Poland, Romania, and East Germany were drawn from several sources, some directly to the researchers conducting the field work. The basis for the total population, however, is drawn from the Amadeus database (edition 2006). The Polish and East German populations were supplemented with data from the respective foreign investment agencies (Invest in Germany [IIG], Invest in Poland [PAIZ]). The East German population data was further supplemented with information from the European Investment Monitor (edition 2006)[1] and the 2006 EU Industrial R&D Investment Scoreboard (EU 2006). The Croatian population was provided by the Institute for Business Intelligence (Zagreb/Croatia). In the Slovenian case, the population was supplied to the researchers of that national team by the Bank of Slovenia.

The total population across the five countries consist of 6,833 firms with about 1.1 million employees (Table 1). The large share of Romanian firms in the population is related to differences in the completeness and quality of country datasets drawn from the Amadeus database. In principal, no restriction in terms of firms' size was introduced, yet the Croatian and Romanian participants decided to include only foreign owned firms with a minimum of 10 employees into their population.

The population is restricted to manufacturing industries (NACE Rev 1.1: 15 to 37). In terms of number of firms, the three largest sectors in the total population are manufacturing of food products and beverages (NACE 15), manufacture of wearing apparel and dressing (NACE 18), and manufacture of fabricated metal (NACE 28). In terms of employment, the three largest sectors are again food (NACE 15), wearing apparel (NACE 18), and this time manufacturing of motor vehicles, trailers and semi-trailers (NACE 34; see Appendix Table A1 and A2). It is important to note,

TABLE 1 Country Composition of Total Population

	No. firms	In % of Total population	Employment	In % of Total population
East Germany	1,412	20.66	266,373	23.69
Slovenia	365	5.34	40,791	3.63
Poland	1,511	22.11	211,055	18.77
Croatia	220	3.22	56,033	4.98
Romania	3,325	48.66	550,361	48.94
Total	6,833	100.00	1,124,622	100.00

Note: The extraordinarily large share of Romanian foreign affiliates in the total population is probably distorted upward: Even the latest editions of the Amadeus database include firms that have ceased to exist.
Source: The IWH FDI micro database.

however, that the sectoral composition of the total population is somewhat dominated by the Romanian population of foreign firms. There are substantial differences in the Top 3 sectors between the countries (see Appendix Table A3 and Table 2).

The sample of foreign-owned firms holds information from 809 enterprises. These foreign affiliates account in total for about 214,000 employees across the five countries (see Table 2). The sample constitutes in terms of number of firms 11.84% of the total population. In terms of employment, the sample covers 19.05% of the total population. The sample response rates vary across countries. They range, in terms of number of firms, from 6.62% in Poland to 65.45% in Croatia. In terms of employment, they range from 16.22% for Romania to 65.97% in Croatia. Such differences in response rates are mainly explained by the differences in the sizes of the respective total populations (i.e., the relatively large populations of Romania, Poland, and East Germany tend to show lower response rates). The deviations of the sample from the distribution of the population across manufacturing industries range up to 3% , if we consider the number of firms. If we take the employment per industry, it varies up to 5% (see Appendix Table A1 and A2). In terms of firm distribution across size classes (in terms of employees), the sample is underrepresented for micro- (1–9) and small enterprise (10–49), and consequently over-represents medium-sized (50–249) and large (above 250) firms (see Appendix Table A4).

Descriptive Analysis of Investment Motives and Technological Activity

We first provide some stylized facts about the dominant investment motives as viewed from the perspective of the foreign affiliate. We distinguished between five strategic motives and asked the foreign affiliates to rank the importance each of the strategic motives pursued by the foreign investor—once for

TABLE 2 The IWH FDI Micro Database: Country Composition and Response Rates

	No. firms	In %	Employment	In %	Response rate for no. firms	Response rate for employment
East Germany	295	36.46	39,876	18.61	27.06%	20.40%
Slovenia	40	4.94	9,686	4.52	10.96%	23.75%
Poland	110	13.60	38,408	17.93	7.28%	18.20%
Croatia	144	17.80	36,963	17.25	65.45%	65.97%
Romania	220	27.29	89,292	41.68	6.62%	16.22%
Total	809	100.00	214,225	100.00	12.43%	20.33%

Source: The IWH FDI micro database.

the point of time of initial entry into the market and once for the time of the interview:

- To access a new market or to increase the existing share on the domestic market
- To follow foreign key clients that moved to the host country
- To increase efficiency across the foreign owner network
- To access location-bound natural resources
- To access location-bound knowledge, skills, technology

The ranks offered in the questionnaire range from 1 for "not important" to 2 for "little important," 3 for "important," 4 for "very important," and 5 for "extremely important."

Table 3 lists means and corresponding standard deviations of averages of importance attached by foreign affiliates to strategic motives according to host economies and for the time of the interview. The results are surprisingly clear: From the perspective of the foreign affiliate, access to new markets or the increase of an existing market share turns out be the dominant strategic motive in all economies but in Slovenia (here, it is to increase efficiency across the foreign owner network). The efficiency-related strategic motive turns out to be the second most important one for Poland, Croatia (by a very small margin), and Romania.

Our main interest here is in the strategic motive to tap the local host economy knowledge base in terms of existing knowledge, skills of personnel, and available technology. This motive appears to be particularly important for East German foreign affiliates (second only to the market motive) but less so for Slovenia, Croatia, and Romania (all third rank). For Polish foreign

TABLE 3 Average Importance of Strategic Motives of Investment by Host Economies

	Market		Follow client		Efficiency		Natural resources		Knowledge, skills, technology	
	Avg	(SD)	Avg	(SD)	Avg	(SD)	Avg	(SD)	Avg	(SD)
East Germany	3.3	(1.3)	1.9	(1.3)	2.8	(1.3)	1.7	(1.2)	3.0	(1.3)
Slovenia	3.0	(1.6)	2.0	(1.2)	3.2	(1.4)	1.5	(1.0)	2.7	(1.2)
Poland	3.8	(1.1)	2.3	(1.3)	3.3	(1.1)	2.5	(1.4)	2.5	(1.0)
Croatia	3.5	(1.4)	2.1	(1.2)	3.5	(1.3)	2.2	(1.4)	3.1	(1.2)
Romania	3.4	(1.4)	2.6	(1.4)	3.3	(1.3)	2.5	(1.5)	3.0	(1.4)
Total	3.4	(1.4)	2.2	(1.3)	3.2	(1.3)	2.1	(1.4)	2.9	(1.3)

Note: Averages are calculated as means over the country-groups of foreign affiliates without individual weights for foreign affiliates. Large and small foreign affiliate projects are treated equally. SD presented in brackets denotes standard deviations. The number of firms are for East Germany, 257; Slovenia, 40; Poland, 107; Croatia, 106; and Romania, 213. Deviation to the total sample size of 809 is due to missing values.
Source: The IWH FDI micro database.

affiliates, access to local knowledge and skills and technology appears to be the least important motive on average. Over all foreign affiliates in our sample, this motive is ranked third after market access and increasing efficiency. Importantly, the picture does not change much when we consider the strategic motives that prevailed at the time of the initial entry of the foreign investor: The mean for local knowledge base has then been slightly lower, down from 2.5 to 2.2 for foreign investors into Poland, also in the case of Croatia from 3.1 to 2.8, and Romania from 3.0 to 2.8. The ranking, however, remained unchanged in those latter cases. Standard deviations appear to be low enough to warrant a robust interpretation of results. Therefore, it seems justified to conclude that FDI into the region seems still to be dominated by market- and efficiency-seeking motives. Tapping into localized knowledge, skills, and technology seems to be of secondary order. Yet, local technology seeking became more important over time, and there seems to be a good deal of country heterogeneity in investment motives.

The second issue analyzed here pertains to the technological activity of foreign affiliates. With our database, we are able to compare across host countries' foreign affiliates both the share of foreign affiliates that are technologically active and the intensity of firms' technological activity. As indicators for technological activity, we use R&D activity (both in expenditure and personnel) as well as innovation (Figure 1).

R&D activity is typically used as an indication of the input for innovation, itself treated as output of technological activity. However, R&D not only stimulates innovation but develops the firm's ability to identify, assimilate, and exploit outside knowledge (Cohen and Levinthal 1989). Moreover, the

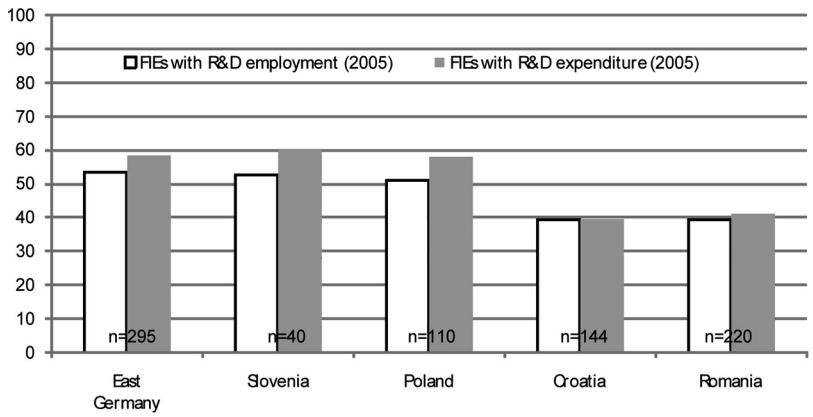

FIGURE 1 Share of foreign affiliates (in %) with R&D activity across host economies. *Note*: The shares presented here are the firms that provided the information that they do have R&D employment and R&D expenditure respectively. *n* is the total number of foreign affiliates per host economy. *Source*: The IWH FDI micro database.

literature on decentralization of R&D in FDI shows that foreign investment networks allocate parts of their R&D projects among their foreign affiliates. This assigns foreign affiliates an active role in the foreign investors' technological activities even if strategic motives followed by the foreign investor are focused mainly upon markets, efficiency, or key clients.

From Figure 1, there emerge two principle categories of foreign affiliates across countries: The share of foreign affiliates that undertake R&D turns out to be around 50% for East German, Slovenian, and Polish foreign affiliates. R&D activity appears to be much less common in the cases of Croatian and Romanian foreign affiliates; here the share of R&D active foreign affiliates is around 40% (Figure 2).[2]

Three different indicators of R&D intensity largely confirm the differences in R&D activity (see Figure 2). Yet, intensity of R&D expenditure (measured as share of turnover and as share of gross value added[3]) seems extraordinarily high for Croatian foreign affiliates; however, the share of firms considered for this measure only includes a small fraction of all interrogated affiliates. Thus, we would be cautious about this high level of R&D intensity. Leaving Croatia aside, we find that East German foreign affiliates appear to spend most on R&D per turnover and per gross value added, followed by Slovenia, Poland, and Romania. In terms of R&D personnel, the same ranking is upheld. This time, however, the item-response rate is

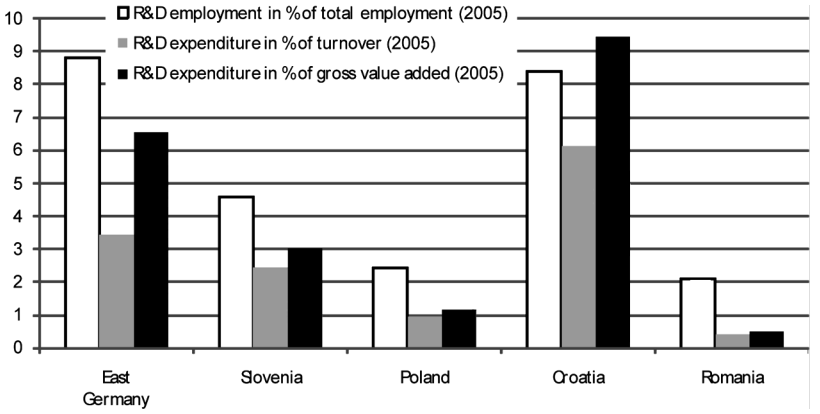

FIGURE 2 R&D intensities of R&D-active foreign affiliates: Aggregated averages over three indicators across host economies. *Note*: Averages are calculated as aggregated means over the country-groups of foreign affiliates that provided information on R&D activity (i.e. with individual weights for foreign affiliates and excluding n/a). In the cases of East Germany and Romania, one statistical outlier each had to be removed. The corresponding number of affiliates (n) that provided answers on the items for R&D employment in % of total employment, R&D expenditure in % of total turnover, and R&D expenditure in % of gross value added are, respectively, East Germany 158, 166, 144; Slovenia 21, 21, 9; Poland 56, 62, 31; Croatia 56, 49, 26; and Romania 87, 58, 22. Further deviation to the total sample size of 809 is owing to missing values. *Source*: The IWH FDI micro database.

higher also among Croatian foreign affiliates, and the indicator turns out to be largely the same level as for East German affiliates. It is important, however, to notice that standard deviations are quite high, in most cases higher than the averages.

In terms of innovative activity of foreign affiliates, we employ data on the share of foreign affiliates that have undertaken innovations (yes or no) and the intensity of innovations. The innovation questions were specified as innovations undertaken over the last 3 years (2002–2005) and differentiated into product, process, marketing, and organizational innovations. The former two belong to the group of technological innovations, the latter to non-technological innovations. In line with the OECD Oslo-manual, innovations were defined to be not necessarily new to the market but new to the affiliate in order to avoid a too narrow definition of innovation.

Overall, it emerges that foreign affiliates are to a very large extent active in different types of innovation across all countries (see Figure 3). The level of innovation activity is substantially higher compared to R&D activity. The technological types of innovation are more often implemented than non-technological ones. Polish foreign affiliates appear to be particularly innovative: Nearly 80% of the Polish affiliates have undertaken product innovations, a share much higher than for foreign affiliates of other countries (East Germany 69%, Slovenia 65%, Croatia 59%, Romania 56%). For process innovations, the Polish affiliates are only second after Slovenian affiliates, for marketing innovations third, and for organizational innovation again first.

To measure innovation intensity, we asked firms that have undertaken product innovations to compare their intensity of product innovations with those of their competitors in the relevant markets. The share of firms that

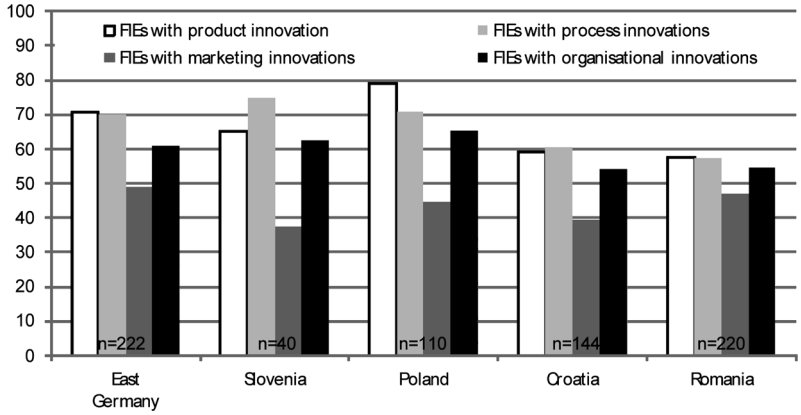

FIGURE 3 Share of foreign affiliates (in %) with innovative activity across countries and types of innovation. *Note*: The shares presented here are calculated only from the set of firms that answered the innovation-related questions (equals *n*). *Source*: The IWH FDI micro database.

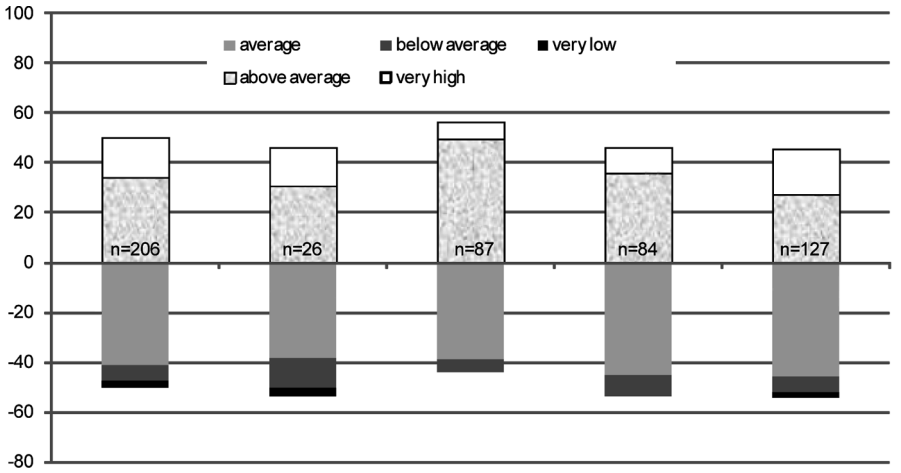

FIGURE 4 Innovation intensities of foreign affiliates with product innovation across host economies. *Note*: Cumulative bars represent the shares of product innovation-active foreign affiliates that compare their intensity of product innovations with those of their competitors in the relevant markets to be very low, below average, and average in negative bars, and as above average and very high in positive bars. *n* denotes the number of affiliates that have generated product innovations. *Source*: The IWH FDI micro database.

consider their own innovative activity as above average or even as very high are marked in cumulative positive bars in Figure 4. The share of firms with average, below average, and very low comparative innovation intensities are marked in cumulative negative bars.

The results again show Poland with the highest share of affiliates with above-average product innovation intensities (cumulated positive bars) and likewise the lowest share of average and below-average intensity foreign affiliates (cumulated negative bars). The positive result, however, appears to be mainly attributable to a high share of affiliates with above average intensities, not to very high comparative intensities: Here, the share is in fact particularly low (7%), exceeded by all other country-groups of foreign affiliates (18% for Romanian foreign affiliates, 15% for Slovenian and East German foreign affiliates, 11% for Croatian ones).

The Polish foreign affiliates appear to assume a rather comfortable upper-middle ground in their own comparison with competitors, while a larger share of foreign affiliates in the other countries appear to belong to the technological envelope. The category of average innovation intensity accounts for approximately 40% of foreign affiliates in all countries and Croatia and Romania with slightly higher shares. Stronger differences appear again for the categories of below average and very low product innovation intensities: Though the latter does not exist amongst Polish and Croatian foreign affiliates, it is highest among Slovenian foreign affiliates followed by Croatian ones.

If we were to amalgamate this information in country-groups and classifications of foreign affiliates into one composite indicator that provides increasing values for the categories according to their implied intensities and in equal steps (weights are for very low: 0.1; below average: 0.2; average: 0.3; above average: 0.4; very high: 0.5), Polish and East German foreign affiliates would achieve the highest intensities for product innovations, followed by Romanian foreign affiliates, and finally Slovenian and Croatian ones.

We have to keep in mind that this indicator of innovation intensity does not convey any information about the technological level at which innovation activities are locally conducted. It is basically firm-specific and relates most likely to competitors and markets of very different nature. Therefore, we additionally measure the effectiveness of innovation in terms of performance by foreign affiliates' share of sales attributable to new or significantly improved products (product innovations). The analysis shows that product innovation activities in East German affiliates appear to translate most effectively into turnover (Figure 5). The Polish foreign affiliates' high intensity of innovation observed earlier did not fully materialize into performance. The foreign affiliates of Croatia and Slovenia again turn out to be ranked lowest. Yet, the productiveness of innovative activity seems to have increased for foreign affiliates across all countries between 2002 and 2005. Again, we should interpret the results somehow cautiously as standard deviations are quite high, in all cases higher than the averages.

In the next step, we differentiate foreign affiliates with respect to technological asset exploiting and augmenting strategies; our data allow

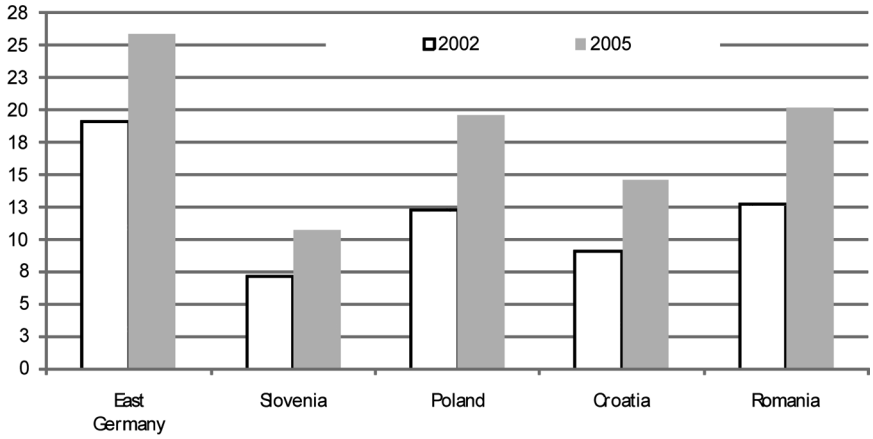

FIGURE 5 Aggregated share of sales (in %) attributable to new or significantly improved products across countries. *Note*: The aggregate shares presented here are the sum of sales attributable to new or significantly improved products per the sum of firms' sales. The corresponding number of affiliates (n) that provided answers on the share of innovative output for 2002 and 2005 are, respectively, East Germany 130, 193; Slovenia 40, 40; Poland 102, 109; Croatia 111, 124; and Romania 203, 209. *Source*: The IWH FDI micro database.

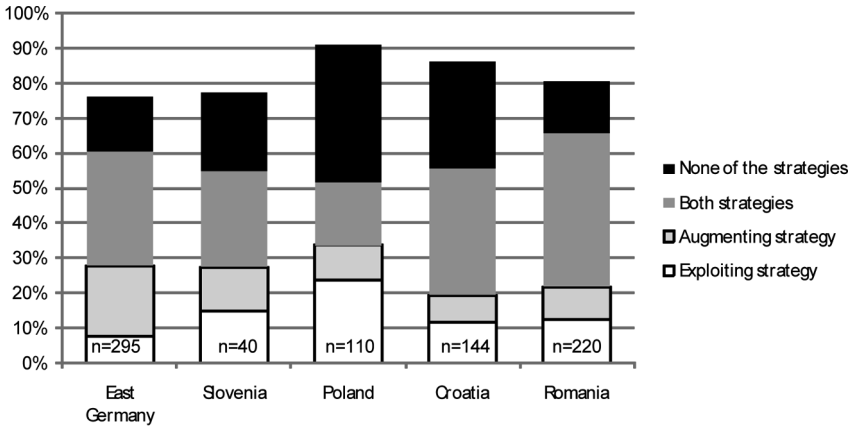

FIGURE 6 Importance of exploiting and augmenting strategies across countries. *Note*: The information is provided in shares of firms per host economy that value the exploiting or the augmenting strategies as important, very important, or extremely important. The shares not adding up to 100% represent those firms that have not provided the information. *n* is the number of firms that have provided information on the questions used to proxy the strategies. *Source*: The IWH FDI micro database.

us to distinguish which strategy is dominant and/or whether the strategies in fact are complementary. Foreign affiliates were asked to evaluate the importance of the foreign parent network as a source of technological knowledge for locally performed R&D or innovation. This seems to be an appropriate proxy for technology exploitation. In turn, foreign affiliates also indicated to which extent they consider themselves as an important source of technological knowledge of the foreign owner network, which is a good proxy for technology augmenting behavior of the foreign affiliate. The results (Figure 6) show that foreign affiliates in fact often envisage both strategies as complementary: The shares of foreign affiliates attaching importance to both strategies at the same time evolve around 30% nt among East German and Slovenian Foreign affiliates, around 20% for Polish foreign affiliates, around 35% for Croatian, and with the highest share of around 45% among Romanian foreign affiliates. Foreign affiliates with a dominant exploiting strategy can be found for mainly the Polish and Croatian FDI projects, whereas foreign affiliates with a dominant augmenting strategy are mainly located in East Germany. Interesting also is the fact that among the Polish FDI projects, a large share of around% 40 (Croatian around 30%) do not attach any particular importance to either augmenting or exploiting.

Finally, we turn to the importance of local scientific institutions as a source of knowledge for R&D and innovation performed locally by the foreign affiliate as an indicator of technology sourcing from the host country environment (Figure 7). This indicator relates only to foreign affiliates that

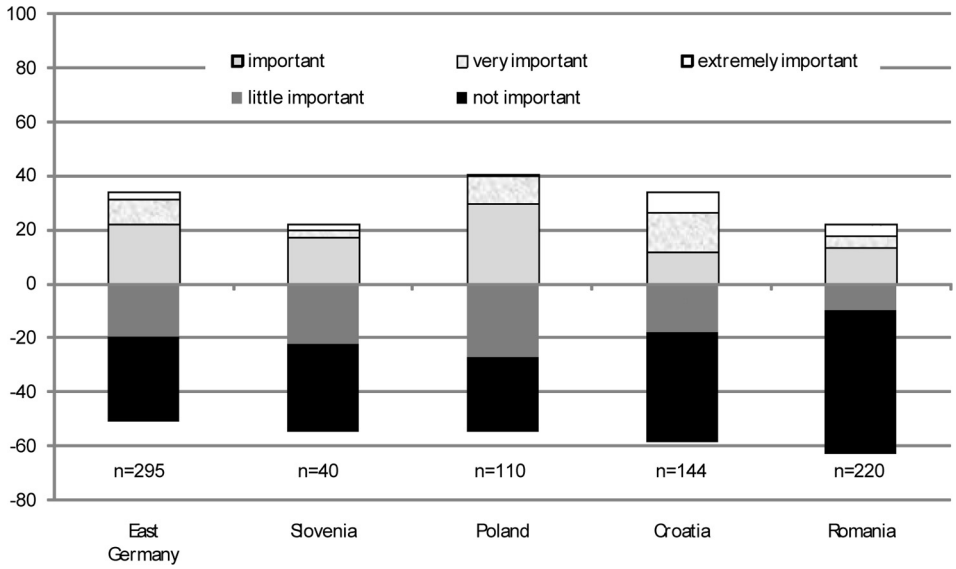

FIGURE 7 Intensities of cooperation with local scientific institutions across host economies. *Note*: Cumulative bars represent the shares of foreign affiliates that consider local research institutions to be not important, little important (negative bars), important, very important, or extremely important (positive bars) for their own technological activities. *n* denotes the total number of foreign affiliates. Deviation to total sample size of 809 owing to missing values. *Source*: The IWH FDI micro database.

are technologically active in terms of R&D and innovation. The results show that the share of foreign affiliates in all countries valuing local scientific organizations as little or of no importance is higher than the share valuing such as important, very important, or even extremely important. The positive bars never exceed 40%. The Polish foreign affiliates appear to value their own national research institutions most frequently as important, followed by Croatian and East German foreign affiliates.

Summarizing the results of this country comparison of local technological activity, it seems that East German affiliates appear to be technologically most active in terms of R&D and innovation. Slovenian and Croatian foreign affiliates may be considered strong in terms of R&D but not so in terms of innovation. Polish foreign affiliates appear strong in innovations but less so for R&D and, finally, Romanian foreign affiliates are comparatively weaker in R&D and rather average for innovations.

In total, it is interesting, that a large share of affiliates indicate technology-exploiting and -augmenting behavior. Most affiliates endowed with a technology-seeking mandate seem to be present in East Germany. However, across all countries, surprisingly few foreign affiliates seem to attach importance to local scientific institutions. Therefore, overall, foreign affiliates are to a large extent involved in local technological

activities; however, by and large not in conjunction with local scientific institutions.

Econometric Analysis of the Determinants of Local Technology Sourcing

The country-specific characterization does already hint at the fact that the host economy alone cannot explain differences in strategic motives and technological activities between foreign subsidiaries. Rather, we have to also take into consideration heterogeneity at the firm level. In the final step of analysis, we hence turn to firm-level analysis to assess determinants of technological interaction of foreign affiliates with local scientific institutions. To test the hypotheses developed earlier and to be able to control for additional firm-specific differences between foreign subsidiaries, we use a set of ordered probit estimations.

Because we measure the importance of scientific institutions as a source of technological knowledge (the dependent variable) in a five-point rating scale (ranging from not important, little important, important, very important, to extremely important), we follow Wooldridge (2002) and Greene (2003) and apply an ordered probit method for our regression models. The dependent variable gives information about a ranking of different outcomes, where distances between outcomes are not necessarily identical or known. Therefore, we build the model as follows:

$$y^* = x'\beta + \varepsilon \tag{1}$$

Where y^* is the unobserved endogenous variable, β is the parameter vector, and ε is the error term. The real y is unobserved because the answers are given only in some discrete value that best fits the real y of the person interviewed. Therefore, we observe only whether an answer falls into a particular category or not in the following way:

$$\begin{aligned} y &= 0 \quad \text{if} \quad y^* \leq 0, \\ y &= 1 \quad \text{if} \quad 0 < y^* \leq \mu_1, \\ &\vdots \\ y &= J \quad \text{if} \quad \mu_{J-1} \leq y^* \end{aligned} \tag{2}$$

Where μ_j are the unknown parameters to be estimated with β. These are also termed as J^{-1} cut off points. Greene (2003) argues that it is a sufficient assumption that the distribution is known and continuous alike for all maximum likelihood estimations. However, in probit models, we also assume that ε is normally distributed with a mean equal to zero and variance

equal to unity. Thus, we get a likelihood function of the following form:

$$\begin{aligned} &\Pr(y = 0 \mid x) = \Phi(-x'\beta), \\ &\Pr(y = 1 \mid x) = \Phi(\mu_1 - x'\beta) - \Phi(-x'\beta) \\ &\vdots \\ &\Pr(y = J \mid x) = 1 - \Phi(\mu_{J-1} - x'\beta) \end{aligned} \tag{3}$$

The previously outlined relies on the assumption that the residuals are homoscedastic and normally distributed. Therefore, we estimate with heteroscedasticity robust standard errors. The following equation shows the specification tested:

$$\begin{aligned} p(y = J \mid x) = 1 - \rho(\mu_{J-1} - (&\beta_1\ \textit{Expl} + \beta_2\ \textit{Augm} + \beta_3\ \textit{Auton} + \beta_4\ \textit{d\_market} \\ &+ \beta_5\ \textit{d\_clients} + \beta_6\ \textit{d\_efficiency} + +\beta_7\ \textit{d\_natural\_res} \\ &+ \beta_8\ \textit{d\_knowledge} + \beta_9\ \textit{d\_greenf} + \beta_{10}\ \textit{Age} + \beta_{11}\ \textit{Size} \\ &+ \beta_{12\ to\ 24}\ \textit{d\_industry} + \beta_{25\ to\ 29}\ \textit{d\_host\_economy} + \epsilon)). \end{aligned}$$

Parameter β_1 indicates to which extent the foreign affiliate follows a competence or home base augmenting strategy (for information on exact measurement, see Table 4), parameter β_2 captures the extent to which the foreign affiliate follows a competence or home base exploiting strategy. The parameter β_3 accounts for the effect of foreign affiliate's autonomy. β_4 to β_8 control for the effect of strategic investment motives, proxied by dummies, β_9 for foreign affiliates being greenfield investments, β_{10} captures firm-specific effects related to foreign affiliate's age, and β_{11} foreign affiliate's size (measured in employment). $\beta_{12\ \text{to}\ 24}$ are the parameters for the 12 industry dummies (leaving out NACE DC (manufacture of leather and leather products) and NACE DF (manufacture of coke, refined petroleum products, and nuclear fuel), $\beta_{25\ \text{to}\ 29}$ the parameters for the four host economy dummies (leaving out the Slovenian as reference group).

To evaluate whether the models as such are significant, we performed a Wald-test under the assumptions of consistency and asymptotic normality (White 1982). We also present the McFadden-R^2, but because we are dealing with a non-linear model, it is not bounded by zero and unity. Therefore, the value of the Pseudo-R^2 can be interpreted as an absolute value only, where the introduction of the covariance matrix in the model increases the probability of the event occurring.

Before we conduct the regressions, we test for multicollinearity by pairwise correlating all independent variables (see Table 5). The results show that none of the significant correlations are at levels that would raise problems for the regression analysis. The highest and significant correlation coefficients result between the exploiting strategy and the proxy for

TABLE 4 Variable Measurement

Variable	Measurement	Question no. (see Appendix B)
Technology sourcing from local science institutions	Question: Please evaluate the importance of local scientific institutions as source of technological knowledge for R&D or innovation in your firm today. (Scale: 1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important)	V22_11b
Augmenting strategy	Question: Please evaluate the importance of your own firm as a source of technological knowledge for R&D or innovation for the headquarters of your foreign investor today. (Scale as above)	V23_1b
Exploiting strategy	Question: Please evaluate the importance of the headquarters of your foreign investor as source of technological knowledge for R&D or innovation in your firm today. (Scale as above)	V22_3b
Autonomy	Question: Please indicate to which degree the following business functions are currently undertaken either by your firm or the foreign owner network. (Scale: 1 = only your firm, 2 = mainly your firm, 3 = mainly foreign investor, 4 = only foreign investor). Average for three different business functions: Basic and applied research, product development, and process engineering.	V14_3 V14_4 V14_5 V8_1
Investment motives	Question: Please rank the importance each of the following strategic motives pursued by the foreign investor at initial entry: (1) to access a new market or to increase the existing share on your domestic market, (2) to follow foreign key clients that moved to your country, (3) to increase efficiency across the foreign owner network (at entry), (4) to access location-bound natural resources, and (5) to access location-bound knowledge, skills, and technology (Scale: 1 = not important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important)	V8_2 V8_3 V8_4 V8_5 V2
Age	Years since entry of the foreign investor	V2
Size	Total number of employees in 2005.	V11_1b

Source: The IWH FDI micro database questionnaire.

technological autonomy with a negative sign (which is not surprising) with −.46 and between the exploiting strategy and the augmenting strategy with a positive sign (suggesting that both strategies appear to be followed simultaneously by a number of firms).

TABLE 5 Pairwise Rank Correlation of All Independent Variables

	Exploit	Augment	Autonomy	D_market	D_client	D_efficiency	D_nat. res.	D_knowl.	D_greenf.	Age
Augment	.44	1.00								
Autonomy	−.41	−.12	1.00							
D_market	.23	.14	−.07	1.00						
D_client	.10	.10	−.10	.26	1.00					
D_efficiency	.22	.20	−.20	.18	.15	1.00				
D_nat. res.	.09	.06	.02	.18	.10	.15	1.00			
D_knowl.	.03	.16	.06	.06	.03	.18	.21	1.00		
D_greenf.	.01	−.12	−.15	−.05	.09	.01	−.02	−.08	1.00	
Age	.07	−.01	−.10	−.08	−.01	.01	.06	−.04	.13	1.00
Size	.08	.03	−.04	−.04	.02	.10	.12	−.09	−.21	.07

Note: All pairwise correlations were conducted as Spearman rank correlations using casewise deletion, where observations are ignored if any of the variables in the list of variables are missing: obs = 504. Significant correlations are marked in bold figures.

Source: The IWH FDI micro database.

To test for the robustness of the estimation results, we test different specifications of the regression model: Model 1 includes all determinants that we assume to have an impact (and where we have data from our database), including country dummies and industry dummies at the two-digit NACE level. Model 2 is estimated without controlling for the strategic motives, model 3 without industry dummies, model 4 without country dummies, and finally model 5 is tested without either country, industry, or strategic motives dummies. Because the regression assumes a direction of causality, we decided to reduce our sample to technologically active foreign affiliates to thereby avoid the problem of endogeneity between technological activity and local technology sourcing as described earlier. Therefore, all five models consider only those foreign subsidiaries that have undertaken any product innovations over the last 3 years.

According to the estimation results (see Table 6), all models tested are significant overall. Model 1 has the highest pseudo R^2 (about .08), which is typically a result of including dummies. As expected, the model with the lowest number of determinants tested also results in the lowest pseudo R^2 of approximately .06. The number of observations is somewhat lower than the 566 technologically active foreign affiliates in the database; the regression analysis is able to use only 500 foreign affiliates wing to missing values.

Importantly, the resulting significant and insignificant determinants appear to be rather consistent across the five model specification—one indication of robustness of results. In fact, of the six determinants controlled for in each of the model specifications (not including the industry and host economy dummies), three are consistently significant, and one is significant in three of the five specifications. Changes in signs never occurred.

With regard to our hypotheses, we can find some support for H(1) and can safely assume that with increasing importance of the competence augmenting strategy, foreign affiliates also increasingly attach importance to technological sourcing from local scientific institutions. This implies that foreign subsidiaries actively search for new knowledge beyond the established knowledge base of the foreign investor (Frost 2001), and furthermore that foreign parents mandated foreign affiliates with a home base augmenting approach to innovation and technology development to enhance the firm specific advantages of the entitre corporation (Cantwell and Mudambi 2005).

However, H1 also assumed that foreign affiliates following a competence exploiting strategy are less likely to source technological knowledge from local scientific institutions. Alas, our results refute this by finding significant support for the opposite. This evidence may reinforce the argument of Criscuelo et al. (2002): Foreign subsidiaries can follow both competence augmenting and exploiting strategies, for different technologies at the same time. In other words, sourcing knowledge from the parent in one technological field does not exclude external technological interaction in another.

We further held in H2 that, according to the literature (Andersson et al. 2002; Andersson and Forsgren 2000; Birkinshaw et al. 1998) on subsidiary

TABLE 6 Determinants of Interaction of Product Innovation-Active Foreign Affiliates with Local Scientific Institutions (Ordered Probit Estimation Results)

	Model 1 Coeff.	Model 2 Coeff.	Model 3 Coeff.	Model 4 Coeff.	Model 5 Coeff.
Exploit	.30*** (.064)	.32*** (.064)	.30*** (.062)	.29*** (.057)	.31*** (.055)
Augment	.10* (.055)	.14** (.054)	.10* (.055)	.13** (.052)	.15** (.052)
Autonomy	.01*** (.001)	.01*** (.002)	.01*** (.002)	.01*** (.002)	.01*** (.002)
D_market	.00 (.114)	—	.01 (.111)	.04 (.110)	—
D_client	.20 (.136)	—	.18 (.131)	.10 (.133)	—
D_efficiency	.15 (.108)	—	.14 (.105)	.12 (.108)	—
D_nat. res.	.26* (.142)	—	.22 (.138)	.17 (.140)	—
D_knowl.	.22* (.118)	—	.21* (.114)	.20* (.115)	—
D_greenf.	−.17 (.109)	−.18* (.108)	−.17 (.108)	−.23** (.109)	−.24** (.106)
Age	−.01 (.010)	−.01 (.010)	−.01 (.010)	−.01 (.010)	−.01 (.010)
Size	.00 (.000)	.00 (.000)	.00 (.000)	−.00 (.000)	−.00 (.000)
D_industry	Yes	Yes	—	Yes	—
D_host country	Yes	Yes	Yes	—	—
N	500	500	500	500	500
Wald χ^2	121.38	88.71	98.70	107.24	62.91
Prob > χ^2	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.0881	0.0763	0.0781	0.0749	0.0568

Note: Coefficients: ***$p < .001$; **$p < .05$; *$p < .1$.

Figures in brackets denote robust standard errors. Deviation to the total sample size of 809 is due to missing values.

Source: The IWH FDI micro database.

roles and embeddedness, higher autonomy of foreign affiliates should result in increased ability to form external technology linkages. Affiliates indicated the level of autonomy enjoyed by them vis-à-vis control by the foreign owner with regard to (1) basic and applied research, (4) product development,[4] (5) process engineering.[5] We reduced the information available to an unweighted average over the thee technology-oriented business functions. The influence of foreign affiliate-autonomy is in fact tested positively, and H(2) cannot be rejected in the regression analysis: With increasing autonomy in the three technology-related business functions, foreign affiliates also appear to interact more intensively with local scientific research institutions (Andersson et al.; Andersson and Forsgren; Birkinshaw et al.).

Finally, we hypothesized with Frost (2001), Stinchcombe (1965), and with Venkataraman and Van de Ven (1998) that foreign subsidiaries with a longer history in the region (reputation) are more likely to have access to local sources of knowledge than their younger counterparts (liability of newness) in the host economy environment. Our analytical results at the firm level, however, find no support for H3: The coefficients for "age" remain insignificant throughout all model specifications.

In an attempt to account for further firm-specific heterogeneity, we additionally control for strategic investment motives, for greenfield investments, the size of the foreign affiliate, and industry and country effects. Though the dummies for the strategic investment motives of market access, following key clients, and increasing efficiency remained insignificant, the motives of tapping natural resources turned out to be significant and positively related to interaction with local research institutions in one regression model, and the motive of tapping localized knowledge in all models that considered the motive-dummies, always with a positive sign. The dummy for greenfield investments turned out to be significant in three of the five model specifications and with a consistent negative sign: We find some weak support for the assumption that greenfield investments are less likely to intensively interact with local scientific institutions. Finally, controlling for the size of the foreign affiliate never produced significant coefficients.

CONCLUSIONS

First and foremost, our analysis of the IWH FDI micro database clearly shows that localized knowledge skills and technology matter for foreign affiliates based in Central East Europe and East Germany. This despite the fact that market- and efficiency-seeking motives are still predominant. The majority of foreign affiliates can be considered as being locally technologically active. However, across all countries, surprisingly few foreign affiliates seem to attach importance to local scientific institutions. Therefore, we could conclude that foreign affiliates are to a large extent involved in local technological activities.

However, by and large, this type of activity is detached from the host country environment.

The empirical investigation unearthed considerable heterogeneity across countries mainly in terms of level, intensity, and effectiveness of local technological activities and strategies adopted. East German affiliates appear to have a higher intensity of R&D activity among the host economies compared. The differences between countries in terms of innovative activities are less pronounced, with Polish and East German foreign affiliates leading the ranks. The most distinct differences between the countries can be recorded for the economic effect of innovations in terms of sales attributable to new or significantly improved products, where affiliates in East Germany clearly dominate the other foreign affiliates. Across all those descriptive indicators for technological activity, the Slovenian foreign affiliates turn out to be surprisingly active whereas the data for the Croatian and Romanian foreign affiliates remain somewhat inconclusive. A large share of affiliates indicate technology-exploiting and -augmenting behavior; however, the highest share of technology asset–augmenting behavior is found among the East German affiliates. The econometric results, however, also suggest that a characterization of foreign subsidiaries does not hinge only upon host economy–specific factors; firm-heterogeneity has an important role to play. Our regression analysis robustly shows that both home base–augmenting and competence-exploiting strategies, and the level of autonomy from parent investors, raise the probability that the foreign affiliate is firmly embedded in the host economy innovation system, here exemplified by local scientific institutions. As expected, the effect is stronger for subsidiaries following a technology asset–augmenting strategy.

From our point of view, the results carry some important policy implication: First, foreign affiliates contribute to technological development through knowledge diffusion related to locally performed R&D and innovation. Second, technology related investment motives are still of secondary order; therefore, there should be scope for enhanced policy instruments supporting scope and intensity of R&D and innovation at the firm level. Third, there is a lack of local technology linkages with host country scientific institutions. This is one of the factors that limit technological upgrading of foreign affiliates (and domestic firms alike). Though in East Germany the public science sector has been fundamentally transformed after reunification and a rich and highly modernized science infrastructure is available today, Central and East European countries still lack behind in this respect (McGowan, Radosevic, and von Tunzelmann 2004; Meske 2004). This could prove a powerful policy tool to safeguard future competitive advantage of firms in Central and East European countries.

NOTES

1. Amadeus and European Investment database are commercial databases that offer access via DVD or online.

2. In the cases of East German and Croatian foreign affiliates, the item non-response rates are quite high and raise some doubts to the robustness of these data. In the former, 100 of the 295 foreign affiliates have not answered the question for R&D expenditure; in the latter, 78 of the 144 foreign affiliates have not answered the question on R&D employment.

3. Owing to the fact that R&D expenditure shares in total turnover tend to underestimate the intensity for larger affiliates, we additionally use the share of R&D expenditure in total gross value added. Here the item-response rates turn out to be much smaller, and yet, the ranking order is similar.

4. The questionnaire specifies "product development" as referring 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 has to be new to the foreign affiliate but not necessarily new to the market.

5. Process engineering was defined as referring 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.

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APPENDIX A

TABLE A1 Sectoral Distribution of Population and Sample—Number of Firms

	IWH FDI Micro Database 2007				
	Population		Sample		
NACE 2	no .	in %	no.	in %	Deviation in % points
15	795	11.63	84	10.38	−1.25
16	19	0.28	0	0.00	−0.28
17	354	5.18	39	4.82	−0.36
18	629	9.21	48	5.93	−3.27
19	346	5.06	26	3.21	−1.85
20	385	5.63	30	3.71	−1.93
21	159	2.33	23	2.84	0.52
22	279	4.08	20	2.47	−1.61
23	22	0.32	3	0.37	0.05
24	337	4.93	56	6.92	1.99
25	398	5.82	43	5.32	−0.51
26	440	6.44	71	8.78	2.34
27	159	2.33	26	3.21	0.89
28	592	8.66	69	8.53	−0.13
29	465	6.81	79	9.77	2.96
30	59	0.86	2	0.25	−0.62
31	290	4.24	45	5.56	1.32
32	135	1.98	22	2.72	0.74
33	188	2.75	24	2.97	0.22
34	215	3.15	26	3.21	0.07
35	97	1.42	18	2.22	0.81
36	397	5.81	41	5.07	−0.74
37	73	1.07	14	1.73	0.66
Sum	6,833	100	809	100	
Response rate (in %)		11.84%			

Source: The IWH FDI micro database.

TABLE A2 Sectoral Distribution of Population and Sample—Number of Employees

	IWH FDI Micro Database 2007				
	Population		Sample		
NACE 2	Employment	in %	Employment	in %	Deviation in % points
15	97,752	8.69	18,060	8.43	−0.26
16	6,090	0.54	0	0.00	−0.54
17	52,079	4.63	7,190	3.36	−1.28
18	114,782	10.21	12,264	5.72	−4.48
19	53,820	4.79	15,281	7.13	2.35
20	37,221	3.31	5,942	2.77	−0.54
21	20,295	1.80	9,805	4.58	2.77
22	16,710	1.49	5,066	2.36	0.88
23	25,525	2.27	2,117	0.99	−1.28
24	77,966	6.93	11,103	5.18	−1.75
25	44,052	3.92	7,486	3.49	−0.42
26	50,061	4.45	16,716	7.80	3.35
27	72,786	6.47	10,321	4.82	−1.66
28	49,211	4.38	8,108	3.78	−0.59
29	70,253	6.25	17,883	8.35	2.10
30	8,683	0.77	37	0.02	−0.75
31	79,401	7.06	23,218	10.83	3.77
32	33,506	2.98	5,084	2.37	−0.61
33	16,836	1.50	3,409	1.59	0.09
34	97,294	8.65	7,285	3.40	−5.25
35	42,738	3.80	11,764	5.49	1.69
36	52,449	4.66	12,773	5.96	1.30
37	5,112	0.45	3,383	1.58	1.12
Sum	1,124,622	100	214,295	100	
Response rate (in %)			19,05%		

Source: The IWH FDI micro database.

TABLE A3 Top 3 Industries (NACE) per Country—According to Employment Shares

Croatia	Slovenia	Poland	Romania	East Germany	EG WG MNEs
23	29	34	18	24	34
15	24	36	15	31	29
31	25	15	31	15	24

Source: The IWH FDI micro database.

TABLE A4 Distribution in Population and Sample across Classes According to Number of Employees

	Population		Sample		
	No. of firms	in %	No. of firms	in %	Deviation in % points
Micro (1 bis 9)	336	5.83	40	4.99	−0.84
Small (10 bis 49)	2,292	39.76	222	27.68	−12.08
Medium (50 bis 249)	2,067	35.86	332	41.40	5.54
Large (above 249)	1,099	19.07	208	25.94	6.87
Total number of firms	5,794		802		

Source: The IWH FDI micro database.

APPENDIX B

Codebook

IWH FDI Micro Database (Survey 2007)

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PART A: INFORMATION ABOUT YOUR FOREIGN INVESTOR

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

V4 Please indicate the type of foreign investor in your firm. Please choose one option!

1 Multinational Enterprise Group
2 National Enterprise Group
3 Enterprise (single entity)
4 Foreign individual or family

V5 Please indicate the home country (HQ location) of your foreign investor.

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

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 <u>all</u> cells.

V8_1 To access a new market or to increase the existing share on your domestic market (at entry)
V8_1 h Today
V8_2 To follow foreign key clients that moved to your country (at entry)

V8_2 h Today
V8_3 To increase efficiency across the foreign owner network (at entry)
V8_3 h Today
V8_4 To access location-bound natural resources
V8_4 h Today
V8_5 To access location-bound knowledge, skills, technology-
V8_5 h 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 (headquarters 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 (headquarters 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

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

V14_5 Process engineering
V14_6 Strategic management and planning
V14_6 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

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

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 _____
V18_1a Product innovation intensity _____
V18_2 Process innovation _____
V18_2a Process innovation intensity _____
V18_3 Marketing innovation _____
V18_3a Marketing innovation intensity _____
V18_4 Organisational innovation _____
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)

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)

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

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 headquarters 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

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