Working Paper Series
GRINCOH
Growth-Innovation-Competitiveness
Fostering Cohesion in Central and Eastern Europe

Serie 2
International economic relations
of the CEE countries

Paper No. 2.10

MNEs and Regional R&D Co-operation: Evidence from Post-Transition Economies

Andrea Gauselmann*

* Halle Institute for Economic Research (IWH)

2013

www.grincoh.eu

This paper was funded under the FP7 project "Growth– Innovation – Competitiveness: Fostering Cohesion in Central and Eastern Europe (GRINCOH)" under the Programme SSH.2011.2.2-1: Addressing cohesion challenges in Central and Eastern Europe; Area 8.2.2 Regional, territorial and social cohesion. Project Nr. 290657

Andrea Gauselmann, andrea.gauselmann@iwh-halle.de
Halle Institute for Economic Research (IWH)
www.iwh-halle.de

Please cite as:
Gauselmann A., (2013), 'MNEs and Regional R&D Co-operation: Evidence from Post-Transition Economies', GRINCOH Working Paper Series, Paper No. 2.10

MNEs and Regional R&D Co-operation: Evidence from Post-Transition Economies

Abstract

The aim of this paper is to contribute to the literature by investigating the determinants of R&D co-operation between MNEs' foreign subsidiaries and enterprises in the region of location, thereby leading to a better understanding which firm- and region-specific factors influence this co-operation behavior. Applying a logit model, this paper investigates which firm- and region-specific determinants influence technological co-operation between foreign subsidiaries and suppliers, customers, and research institutions in the region of location. Results suggest that especially the foreign subsidiary's mandate in terms of R&D, its internal technological embeddedness, its technological capability but also the regional knowledge stock are positively associated with these co-operations. The analysis focuses on post-transition economies, using the example of five selected CEE countries and East Germany. We exploit a unique dataset - *the IWH FDI Micro database* - which holds information on 1,245 foreign subsidiaries in this region.

Content

1. Introduction

The technology accumulation approach towards firms' internationalization suggests that foreign subsidiaries have an important role in the generation and diffusion of new technologies in the multinational enterprise (Cantwell 1989 or Cantwell 1995). From an empirical perspective, we know that the majority of multinational enterprises' (MNEs) technological activities is still concentrated in their home countries. There is evidence, however, that important strategic activities such as research and development (R&D) are increasingly organized in geographically dispersed centers and open networks in domestic or foreign locations (Narula and Guimón 2010; Patel and Vega 1999; Le Bas and Sierra 2002; Narula and Zanfei 2005). This allows MNEs to tap into location-specific advantages and enhance the enterprises competitiveness (Dunning 1977, D'Agostino and Santangelo 2012). Due to this development foreign knowledge bases become more and more important to MNEs as sources of knowledge and technology (Meyer, Mudambi, and Narula 2011). At the same time, this increases productivity and industrial upgrading in the location region, where foreign subsidiaries can be considered agents of technological and economic development (Günther and Gebhardt 2005). The evolutionary perspective on technology development (Kim and Nelson 2000) suggests that technology transfer from developed to developing economies is based on technological linkages between the foreign subsidiary and the regional environment (Gentile-Lüdecke and Giroud 2012).

The aim of this paper is to contribute to the literature by investigating the determinants of R&D co-operation between MNEs' foreign subsidiaries and enterprises in the region of location, thereby leading to a better understanding which firm- and region-specific factors influence this co-operation behavior. Traditionally, research in technological activities of MNEs' foreign subsidiaries is concentrated on advanced economies. However, the institutional and economic changes in Central and Eastern Europe (CEE) and East Germany call for an investigation of the patterns of MNEs' technological co-operation behavior in this particular region. Even though the post-transition phase is no longer characterized by institutional change, there are still functional weaknesses and economic differences which arise directly from the former political and economic system and the transition period (*Transition Report* 2009). Recent research shows that MNEs' investment into East European transition economies is dominated by market- and efficiency seeking motives; the search for knowledge and technology is of secondary importance, but has essentially gained importance over time (Gauselmann, Knell, and Stephan 2011). Foreign and domestic technological activities - such as R&D, innovation, and the exchange of knowledge and technology - are an important factors in the catching-up process of transition countries towards knowledge-based economies, which provide a basis for long-term sustainable economic growth (Fu, Pietrobelli, and Soete 2010; Perugini, Pompei, and Signorelli 2008). This paper offers an analysis of a unique dataset on 1,245 foreign subsidiaries based in Poland, Hungary, the Czech Republic, Slovakia, Romania and East Germany.

So far, literature has focused mainly on two aspects of technological linkages. One strand of literature is concerned with the impact of R&D co-operation on firm performance, mainly focusing on developed countries (Cassiman, Veugelers, and Zuniga 2010, Belderbos, Carree, and Lokshin 2004; Yamin and Otto 2004; Almeida and Phene 2004; Damijan, Kostevc, and Rojec 2010) and finds a positive impact on productivity and innovation. For example Belderbos, Carree, and Lokshin (2004) find for Dutch firms that R&D co-operation with competitors and suppliers improve the firm performance and that customers and universities seem to be important sources of knowledge. Almeida and Phene (2004) examine the influence of external knowledge on innovation in subsidiaries

in the U.S. semiconductor industry and find a positive impact of R&D linkages to host country firms on innovation as does Cassiman, Veugelers, and Zuniga (2010) for Belgian firms.

Another strand of literature deals with linkages between MNEs and different kinds of domestic partners in less developed economies (f.e. Giroud, Jindra, and Marek 2012; Gentile-Lüdecke and Giroud 2012; Jindra, Giroud, and Scott-Kennel 2009; Günther, Stephan, and Jindra 2008; Günther, Jindra, and Stephan 2009 Santangelo 2009; Bucar, Rojec, and Stare 2009). Gentile-Lüdecke and Giroud (2012) focus on knowledge transfers from foreign subsidiaries to suppliers of the Polish automotive sector. They find a positive impact of the foreign subsidiary's autonomy and a negative impact of the foreign subsidiary's R&D intensity on knowledge transfer to domestic suppliers. Giroud, Jindra, and Marek (2012) investigate linkages between foreign subsidiaries and domestic suppliers and again find the foreign subsidiary's autonomy and technological embeddedness to be positively associated with knowledge transfer via supplier linkages. Jindra, Giroud, and Scott-Kennel (2009) focus on linkages between foreign subsidiaries and domestic suppliers and customers using survey evidence on foreign subsidiaries in the CEE region. Their results show that the extent of knowledge and technology transfer via supplier and customer linkages is highly related to the foreign subsidiary's mandate, its technological capability and its internal technological networks. Santangelo (2009) focuses on local linkage creation in a peripheral region in Italy. She adds information on knowledge-sourcing mandate of the foreign subsidiary to her investigation and finds empirical evidence that linkages are more likely if the MNE enters the market with a competence-creating strategy. She distinguishes between linkages with local suppliers, customers and research institutions as do Günther, Stephan, and Jindra (2008), who focus on foreign subsidiaries' technology and knowledge sourcing in East Germany and find, too, that a competence-augmenting strategy increases the likelihood for linkages. Additionally, they find that regional factors are associated with MNE's technology and knowledge sourcing, depending on the kind of knowledge sources.

This article adds to the literature in several ways: first, it focuses on determinants of *R&D co-operation* between foreign subsidiaries and domestic firms that is suppliers, customers, and research institutions in the region of investment. Second, it focuses on the underestimated region of *post-transition economies*. We argue that the process of catching-up in post-transition regions can only be supported if a technological interaction between MNEs' subsidiaries and domestic enterprises succeeds. Third, it exploits firm-level data from a unique and very large dataset, the *IWH FDI Micro database*. And fourth, it adds information on the regional knowledge stock to the information on foreign subsidiary's heterogeneity, as research on economic geography has emphasized the importance of the sub-national level when examining technological capabilities. MNE strategies in the CEE countries have been content of former analyses. However, no cross-country research has yet combined the analysis of firm-level with regional determinants to find out more about the interaction of firm and regional characteristics on R&D co-operation between foreign and domestic enterprises.

The paper is structured as follows: in section 2 we give a short overview of the theoretical background and derive hypotheses. In section 3 we introduce the data. Section 4 contains the estimation model and empirical results. In section 5 we discuss and interpret the empirical regression results and policy implications. Section 6 contains the annex.

2. Theoretical background and hypotheses

Cantwell's technology accumulation theory explains the internationalization of enterprises emphasizing the capability increase within an MNE (Cantwell 1989). Within this line of thought, the accumulation of technology means an economic advantage for the MNE (Cantwell and Piscitello 2000), including both the acquisition of new skills and the generation of new technologies (Cantwell 1989; Cantwell 1995; Cantwell 2000). Cantwell (Cantwell 1989; Cantwell 1995) argues that successful MNEs, on the one hand, generate spillover effects to the location of investment, increasing knowledge. On the other hand, they benefit from the technological environment which develops at the affiliates' location (Cantwell and Iammarino 1998, Cantwell and Iammarino 2001, Cantwell and Iammarino 2003). In other words, Cantwell and others (see e.g. Cantwell 1989 or Kogut and Chang 1991; Grant and Baden-Fuller 2004) argue that the investment in foreign R&D is also motivated by the desire to improve the MNE's access to technology and augment the MNE's economic advantage by benefitting from the foreign location's technological environment. Cantwell's theoretic approach is therefore founded on the assumption that technological activities are location- as well as firm-specific (Cantwell 1989; Cantwell 1995). As already mentioned, there is an increasing consensus in literature that linkages to customers, suppliers and research institutions are essential for the accumulation of knowledge in MNEs and MNE subsidiaries (Filippov and Duysters 2011). Thus, the evolution of subsidiaries is part of the MNE's global corporate strategy and the subsidiaries' decision which knowledge resources to access is influenced by the operational mandate within the MNE (Almeida and Phene 2004; Liu 2010 or Santangelo 2009). According to Cantwell (Cantwell 1995), the traditional organization of the MNE with unidirectional transfer of knowledge from headquarter to the foreign subsidiaries, is being successively replaced. Foreign subsidiaries are increasingly tied into a so-called 'double-network' of internal and external linkages in order to transfer knowledge and technology (Cantwell 1995; Zanfei 2000). Internal and external networks can co-exist, reflecting dynamic interdependence and comlementarity (Castellani and Zanfei 2006) and the expansion of MNE's international internal networking increases the exploration potential to transfer knowledge and technology (Cantwell 1995; Figueiredo 2011). In other words, the competence-creating and knowledge-accumulation of the foreign subsidiary depends considerably on the extent of decision-making authority in the subsidiary but also on the embeddedness of its technological activities within the MNE (Cantwell and Mudambi 2000; Frost, Birkinshaw, and Ensign 2002; Grant 1996). Applying these assumptions on R&D co-operation, we hypothesize:

H1a: A foreign subsidiary's mandate in terms of R&D is positively associated with R&D co-operation in the region of location.

H1b: A foreign subsidiary's internal technological embeddedness is positively associated with R&D co-operation in the region of location.

Furthermore, Cantwell and others argue that co-operation behavior is related to strategic entry motivations (Kuemmerle 1997; Cantwell and Mudambi 2005; Dunning and Lundan 2008). They suggest that the subsidiary's competence-seeking mandate increases linkages with the domestic economy (Cantwell and Mudambi 2000). This leads us to hypothesis 2:

H2: A knowledge- and technology-seeking investment motive of the MNE is positively associated with R&D co-operation in the region of location.

When explaining MNE's motives to internationalize R&D the resource-based view of the firm suggests that the position of a subsidiary within the MNE network is not only assigned by the headquarter but also by the subsidiary's own technological capabilities (Birkinshaw, Hood, and Johnson 1998; Jindra, Giroud, and Scott-Kennel 2009) and host country location-specific advantages (Doerrenbaecher and Gammelgaard 2006; Jindra, Giroud, and Scott-Kennel 2009), implying that the subsidiary's capabilities differ at least to some extent from the headquarters capabilities depending on the particular geographic and economic setting they are located in (Birkinshaw and Hood 1998 and Teece, Pisano, and Shuen 1997). Literature on R&D internationalization has documented that highly innovative regions attract more technology-seeking foreign R&D (Cantwell and Mudambi 2005; Dunning and Narula 1995; Kuemmerle 1999; D'Agostino and Santangelo 2012). In other words, the location's knowledge base seems to be a key factor of the subsidiary's linkage behaviour (Filippov and Duysters 2011). According to Cohen and Levinthal's concept of absorptive capacities the firm's own knowledge capability allows the firm to absorb knowledge which is generated in the knowledge base of a region (Cohen and Levinthal 1990; Cantner and Meder 2009).

These theoretic assumptions lead us to the next hypotheses:

H3a: A foreign subsidiary's high technological capability is positively associated with R&D co-operation in the region of location.

H3b: A high regional knowledge stock is positively associated with R&D co-operation in the region of location.

Cohen and Levinthal's argue furthermore, that the regional knowledge base colludes with the firm's own knowledge base to generate new knowledge (Cohen and Levinthal 1990; Cantner and Meder 2009), implying that the combination of a high regional knowledge stock and a foreign subsidiary's high technological capacity should push R&D co-operation. Thus, we hypothesize an interaction between these two terms:

H3c: A foreign subsidiary's high technological capability combined with a high regional knowledge stock is positively associated with R&D co-operation in the region of location.

3. The IWH FDI Micro database

The analysis is based on a unique dataset, the IWH FDI Micro database. It contains the assessment of management personnel of foreign invested firms on relevant determinants of locational factors as well as the organization of R&D and innovation in the foreign subsidiaries.

The data results from field work in 2009 and includes information on foreign subsidiaries in Hungary, Poland, Romania, Slovakia, the Czech Republic and East Germany. These countries were chosen based on the intent to cover a country sample which reflects preferably different socio-political and economic stages of the transition process. Hungary and Poland as big countries where economic convergence is rather advanced and which have been rather successful in attracting and embedding value-adding FDI. The Czech Republic and Slovakia as small countries on a similar stage in the transition process, Romania as a country which is somewhat still in transition and East Germany which is a case of its own, because of the massive financial support it received from the western part of the country after reunification (Gauselmann and Marek 2012; Narula and Guimón 2010; Filippov and Duysters 2011). Following the OECD's definition, a 'foreign owned firm' is defined as a legally independent enterprise with a foreign equity participation of at least 10 per cent and/or an ultimate

owner located abroad (OECD 2008). The East German subsample of foreign investors is supplemented by information on West German multinational investors, since West German investment plays a crucial role in the East German transition process.[1]

3.1 Country composition and representativeness

The database contains data from 1,245 firms with inward foreign direct investment (FDI) (185 from the Czech Republic, 57 from Hungary, 216 from Poland, 128 from Romania, 30 from Slovakia, and 629 from East Germany), with 295,424 employees.[2] The total data set contains 617 (49.5%) foreign subsidiaries in the manufacturing sector (NACE 14-41) and 628 (50.5%) in selected services (NACE 51-74 & 90-93). Not all firms provided information on all questions, hence the database is unbalanced.[3]

We used chi2 tests to check for representativeness of the samples for East Germany and the CEE countries in comparison with the respective total population.[4] Regarding the sample of multinational investors in East Germany, the sample distribution does not differ significantly from the underlying total population with regard to sectors (industry vs. selected services). However, we find significant differences between sample and total population regarding the regional (NUTS-2 level) distribution and subsidiaries' size distribution.

Table 1. IWH FDI Micro database: Country Composition

	No. of subsidiaries	in %	Employment	in %
East Germany	639	50,5	96,317	32,6
CEE countries	616	49,5	199,107	67,4
Czech Republic	185	14,9	33,687	11,4
Hungary	57	4,6	15,122	5,1
Poland	216	17,3	93,974	31,8
Romania	128	10,3	39,563	13,4
Slovakia	30	2,4	16,716	5,7
Total	1,245	100	295,424	100

Source: own calculations; IWH FDI Micro database 2009

The regional sample deviation is mainly driven by the strong underrepresentation of enterprises located in Berlin. It is worthwhile pointing out, that the regional distribution was not part of the sample stratification. Furthermore, there is an underrepresentation in the sample of subsidiaries with more than 250 employees. For the CEE sample we find significant differences in the distribution across the five countries due to underrepresentation of Czech and Polish subsidiaries and corresponding overrepresentation of Hungarian, Slovakian and Romanian subsidiaries. For each individual country sample we find no significant deviation in the regional (NUTS-2 level) or sectoral

[1] See Günther, Gauselmann, et al. 2011 for more detailed information. See also IWH homepage www.iwh-halle.de/Dataandanalysis/IWHFDIMicrodatabase/Dataandmethods.

[2] In the East German sample very small subsidiaries (1-10 employees) were included, due to the very fragmented structure of the East German economy.

[3] See Günther, Gauselmann, et al. 2011 for more detailed information.

[4] The total population of the *IWH FDI Microdatabase* was drawn from Bureau van Dijks MARKUS and AMADEUS databases.

distribution and subsidiaries' size between total population and sample.[5] In general, the results suggest that the basic population and its corresponding samples generate a reliable data set.

3.2 Descriptives

All in all 29.6 % (N=369) of the foreign subsidiaries in the dataset co-operate in the area of R&D with regional partners whereof 15.8 % belong to the manufacturing and 13.8 % to the service sector.[6]

Table 2. The *IWH FDI Micro database*: Foreign subsidiaries' R&D co-operation in total, in East Germany and in the CEE countries and differentiated by R&D co-operation with regional suppliers, customers, and/or research institutions

	No. of subsidiaries	in %
Total R&D co-operation	369	29,6
in East Germany	239	38,0
in the CEE countries	130	21,1
of which is R&D co-operation with regional…		
suppliers	144	39,0
customers	119	32,2
reserach institutions	268	72,6
R&D co-ooperation in East Germany with regional…		
suppliers	90	37,6
customers	83	34,7
reserach institutions	183	76,6
R&D co-operation in the CEE countries with regional		
suppliers	54	41,5
customers	36	27,7
reserach institutions	85	65,4

Source: own calculations; IWH FDI Micro database 2009

The t-test shows that R&D co-operation between foreign subsidiaries and domestic partners in the region of investment is significantly more frequent in East Germany than in the selected CEE countries. Furthermore, R&D co-operation is significantly more frequent between foreign subsidiaries and regional research institution than between foreign subsidiaries and other regional partners (suppliers or customers). It is also significantly more frequent in the manufacturing branch than in selected services. In the manufacturing sector most R&D co-operations are realized by foreign subsidiaries belonging to NACE 24, 25, 28, and 29.[7] In the service sector most R&D co-operations are realized by foreign subsidiaries belonging to NACE 51, 72, and 74.[8] 14.4 % (N=53) of those foreign

[5] See also Representativeness, Survey 2009 and Methodological Note, Survey 2009, www.iwh- halle.de/Data and analysis/IWH FDI Micro database/Data and methods/Representativeness Analysis for more detailled information.

[6] The definitions of all technological activities (such as R&D and innovation), which are surveyed in the dataset, follow OECD standards of the Oslo Manual (OECD and Eurostat 2008).

[7] NACE 24: Manufacture of chemicals and chemical products, NACE 25: Manufacture of rubber and plastic products, NACE 28: Manufacture of fabricant metal products, except machinery and equipment, NACE 29: Manufacture of machinery and equipments.

[8] NACE 51: Wholesale trade and commission trade, except of motor vehicles and motorcycles, NACE 72: Computer and related activities, NACE 74: other business activities.

subsidiaries that co-operated in the area of R&D do not have any R&D employment, most of them co-operated with regional research institutions (9 % (N=34).

4. Empirical analysis

Information from Eurostat on the knowledge stock and the population density of 52 NUTS 2 regions was added to the *IWH FDI Micro database*.[9]

Table 7 in the annex lists the 52 NUTS-2 regions included in the analysis.

4.1 Estimation approach

The dependent variable measures whether a foreign subsidiary did co-operate in the area of R&D with suppliers, customers and/or research institutions in the location region or not. The relation between the dependent variable and the independent variables can be indicated as

$$\boldsymbol{y} = \boldsymbol{X\beta} + \in \qquad (1)$$

In equation (1) **y** is a Ix1-vector describing the observed R&D co-operation with (i=1,...,I) where i is the number of foreign subsidiaries. The IxN-matrix **X** indicates individual characteristics of the independent variables with the number of foreign subsidiaries (i=1,...,I) and the number of observed individual characteristics (n=1,...,N). The Nx1-vector $\boldsymbol{\beta}$ is the coefficients' vector and the vector is individual error term, which includes all unobservable factors. Referring to a single observation this can be noted as:

$$y_i = \boldsymbol{x'_i\beta} + \in_i. \qquad (2)$$

The actual and observable R&D co-operation results from the firm's cost-benefit analysis and is generally described with the random utility function, where two choices are provided (see Greene 2003).

These two choices are denoted *U* 1 and *U* 0, with *U* 1 indicating R&D co-operation and *U* 0 indicating no R&D cooperation. The observed choice between the two reveals which one provides the greater utility, though not the unobservable utilities themselves.

Hence, the observed indicator R&D co-operation between foreign subsidiary and regional innovation system equals 1 if U 1 > U 0 and 0 if U 1 ≤ U 0. A common formulation of this relation is the linear random utility model,

$$\boldsymbol{U^1} = \boldsymbol{x'\beta_1} + \in_{\boldsymbol{1}} \qquad (3)$$

and

[9] NUTS (Nomenclature des unités territoriales statistiques (Nomenclature of territorial units for statistics)) levels are divided in NUTS 0 (national states), NUTS 1 (major socio- economic regions), NUTS 2 (basic regions) and NUTS 3 (small regions). See also www.eurostat.eu/European Commission/Eurostat/NUTS - Nomenclature of territorial units for statistics/Introduction.

$$\boldsymbol{U^0} = \boldsymbol{x'\beta_0} + \in_{\mathbf{0}} \quad (4)$$

The probability of R&D co-operation between foreign subsidiaries and regional innovation system, Y=1, can be interpreted as P rob[U 1 > U 0]. Then, if we denote by Y=1 the foreign subsidiary's choice to cooperate with the regional innovation system in the area of R&D, we have

$$Prob[\boldsymbol{Y} = 1|\boldsymbol{x}] = Prob\left[\boldsymbol{U^1} > \boldsymbol{U^0}\right] = Prob[\boldsymbol{x'\beta} + \in > 0|\boldsymbol{x}] \quad (5)$$

Following Greene (2003), we use a logit model for the estimation which is characterized by the equation

$$Prob(Y = 1|x) = \frac{e^{x\prime\beta}}{1+e^{x\prime\beta}} \quad (6)$$

This leads us to the estimation design and the empirical results of the logit estimations.

4.2 Estimation design

In table 4 on page 16 the results of the logit estimation for the whole data set are shown (column 4 and 5). Here, foreign subsidiaries can have one or more different types of R&D co-operation partners. The first three columns of table 4 contain the regression results for each group of explanatory variables. To control for regional and developmental differences we split the sample into an East German and a CEE sub-sample (column 6 and 7). Columns 8-10 contain the regression estimates for the sub-samples on R&D co-operation with each single kind of partner: regional suppliers, regional customers and regional research institutions (see table 5 on page 17).

The dependent variables:

• *Foreign subsidiary's regional R&D co-operation*: The dependent variable is 1 if the foreign subsidiary co-operates in the area of R&D with suppliers, customers, and/or research institutions in the region of investment. The dependent variable takes 0 for all foreign subsidiaries that do not co-operate. And accordingly for the East German and the CEE sub-sample. For the supplier sub-sample, the dependent variable is 1 if the foreign subsidiary co-operated in the area of R&D with regional suppliers. The dependent variable takes 0 for all foreign subsidiaries that do not co-operate. For the customer sub-sample, the dependent variable is 1 if the foreign subsidiary co-operated in the area of R&D with regional customers. The dependent variable takes 0 for all foreign subsidiaries that do not co-operate. Accordingly, for the research institutions sub-sample, the dependent variable is 1 if the foreign subsidiary co-operated in the area of R&D with regional research institutions. The dependent variable takes 0 for all foreign subsidiaries that do not co-operate.

The explanatory variables:

• *Subsidiary's R&D mandate*: the variable shows the foreign subsidiaries' mandate in terms of R&D. It is 1 if R&D related business function(s) were undertaken only or mainly by the subsidiary and 0 for all other cases.

• *Subsidiary's internal technological embeddedness*: the variable shows the foreign subsidiary's internal R&D co-operation. It is 1 if the foreign subsidiary co-operated in the area of R&D with its own headquarter or another enterprise of its own enterprise group and 0 for all other cases.

• *MNE's technology- and knowledge-seeking investment motive*: the variable is 1 if the strategic motive 'Access to location-bound knowledge and technology' was important or very important for foreign investor and it is 0 for all other cases.

• *Subsidiary's technological capability*: the variable is measured in the foreign subsidiary's R&D intensity (share of R&D employment in total employment in the foreign subsidiary).

• *Regional knowledge stock* on NUTS 2 level: the variable is measured in the region's R&D intensity in the last 5 years before the survey data collection (measured as mean of the share of R&D employment in total employment in the region in the time 2003-2008).

• *Interaction between the subsidiary's technological capability and the regional knowledge stock*
In order to control for the foreign subsidiaries' heterogeneity, we included its size, year and mode of entry, the type of investor, a sectoral dummy and a dummy on the origin of the investor (EU-27 or other) as *control variables*. On the regional level, we added population density to the list of explanatory variables to check for agglomeration effects. Table 3 gives an overview of variables, their sources, and expected impact on the dependent variable.

Table 3. Summary of variables, their sources, and expected impact on the dependent variable

Variable Name	Description	Data source	Expected impact
Subsidiary's R&D mandate	foreign subsidiary's mandate in terms of R&D	IWH	+
Subsidiary's internal technological embeddedness	foreign subsidiary's internal R&D co-operation with headqurter or other enterprise unit	IWH	+
MNE's knowledge and technology seeking investment motive	importance of the investment motive "access to location-bound knowledge and technology" when MNE entered the market (very important/important)	IWH	+
Subsidary's technological capability	subsidiary's share of the R&D employment in total employment	IWH	+
Regional knowledge stock	mean of the region's R&D employment in total employment 2003-2008 on NUTS 2 level	Eurostat	+
Interaction between subsidiary's technological capability and regional knowledge stock	interaction between subsidiary's technological capability and regional knowledge stock	IWH/Eurostat	+
Population density	mean of region's population density 2003-2008 on NUTS 2 level	Eurostat	+
Subsidiary size	foreign subsidiary's number of employees	IWH	+
Year of entry	MNE's year of entry	IWH	-
Mode of entry	MNE's mode of entry: greenfield vs acquisition	IWH	-
Origin of investor	MNE's home country: EU-27 country vs other	IWH	-
Type of investor	foreign subsidiary's type of investor: financial investor vs other	IWH	+
Branch	foreign subsidiary's branch: industry vs selected services according to NACE	IWH	+/-

Source: own calculations; IWH FDI Micro database

Other available regional variables like regional GDP or GDP per capita, endowment with high skilled human capital and private R&D expenditures in the referring NUTS 2 region were excluded from the analysis due to high correlation coefficients among them. On the firm level we decided not to include

information on the innovative activities of the foreign subsidiary, because former studies have come to ambiguous results on the issue whether the causality runs from the foreign subsidiary's technological activities to technological co-operation or vice versa (see f.e. Frost 2001 or Yamin and Otto 2004; Günther, Stephan, and Jindra 2008). A correlation table of the explanatory variables is added on page 23 in the annex (Table 6).

4.3 Empirical results

As we show in table 4 on page 16 and table 5 on page 17, in the complete sample as well as in all other (sub-)samples the **R&D mandate** of the foreign subsidiary is significantly positive associated with the probability of regional R&D co-operation (H1a) and so is the foreign subsidiary's **internal technological embeddedness** (H1b). Thus, H1a and H1b cannot be rejected. The importance of the MNE's strategic market entry **motive 'access to location-bound knowledge and technology'** is not significantly associated with regional R&D co-operation in the whole sample and all sub-samples (H2). Thus, H2 can be rejected. The foreign subsidiary's **technological capability** is positively significantly associated with R&D co-operation in the region of location in the whole sample.

Table 4. Results of the logit estimation on foreign subsidiary's R&D co-operation in the region of location – whole sample

Explanatory variables:	(1) baseline 1	(2) baseline 2	(3) baseline 3	(4) baseline 4	(5) whole sample
Subsidiary's R&D mandate	1.605***			1.625***	1.621***
	(0.211)			(0.216)	(0.217)
Subsidiary's internal technological embeddedness	3.666***			3.647***	3.648***
	(0.295)			(0.309)	(0.309)
MNE's knowledge and technology seeking investment motive	-0.113			-0.146	-0.145
	(0.195)			(0.201)	(0.201)
Subsidiary's technological capability	2.425***			2.716***	2.426**
	(0.491)			(0.530)	(1.203)
Regional knowledge stock		0.231**		0.332**	0.324**
		(0.104)		(0.147)	(0.150)
Interaction between subsidiary's technological capability and regional knowledge stock					0.207
					(0.773)
Population density		-0.000126		-0.000364***	-0.000372***
		(8.85e-05)		(0.000123)	(0.000128)
Subsidiary's size			0.360***	0.300**	0.299**
			(0.107)	(0.147)	(0.147)
Year of entry			-0.164	0.0122	0.0103
			(0.143)	(0.190)	(0.191)
Mode of entry			-0.495***	-0.203	-0.204
			(0.163)	(0.214)	(0.214)
Origin of investor (EU-27 dummy)			-0.581***	-0.707***	-0.703***
			(0.186)	(0.243)	(0.243)
Type of investor			0.275	0.423	0.419
			(0.345)	(0.423)	(0.424)
Branch			0.103	-0.0775	-0.0770
			(0.160)	(0.210)	(0.210)
Constant	-2.745***	-1.348***	-0.850	-2.814***	-2.797***
	(0.208)	(0.136)	(0.532)	(0.749)	(0.752)
Observations	959	959	959	959	959
Pseudo R^2	0,3374	0,0045	0,0341	0,3621	0,3622

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own calculations; IWH FDI Micro database 2009

(H3a). Thus, H3a cannot be rejected. When looking at the sub-samples, it shows that the foreign subsidiary's technological capability has a positively significant coefficient for the supplier, customer, and research institution sub-sample, no such impact in the regional sub-samples for East Germany and the CEE countries, however. The **regional knowledge stock** is also positively significant

associated with the probability of regional R&D co-operation (hence, H3b cannot be rejected) and shows especially significant - with a positive sign - for the CEE sub-sample and for co-operation with customers and research institutions. Our hypothesis that the **combination of the foreign subsidiary's high technological capability and the high regional knowledge stock in the region of investment** is positively associated with R&D co-operation with the regional innovation system can be rejected (H3c) as this variable does not show significant outcomes throughout all samples.

Table 5. Results of the logit estimation on foreign subsidiary's R&D co-operation in the region of location: sub-samples for R&D co-operation in East Germany, in the CEE countries, and R&D co-operation with suppliers, with customers or with research institutions

Explanatory variables:	(6) eg	(7) moe	(8) suppliers	(9) customers	(10) research institutions
Subsidiary's R&D mandate	1.699***	1.574***	2.136***	2.198***	1.485***
	(0.323)	(0.324)	(0.338)	(0.366)	(0.231)
Subsidiary's internal technological embeddedness	3.916***	3.592***	3.870***	3.983***	3.615***
	(0.565)	(0.391)	(0.384)	(0.427)	(0.318)
MNE's knowledge and technology seeking investment motive	0.300	-0.331	-0.251	-0.154	-0.166
	(0.281)	(0.321)	(0.287)	(0.312)	(0.215)
Subsidiary's technological capability	3.346	1.703	2.848**	3.221**	2.497**
	(2.764)	(1.257)	(1.233)	(1.254)	(1.194)
Regional knowledge stock	0.0197	0.644**	0.320	0.431*	0.316**
	(0.451)	(0.267)	(0.202)	(0.221)	(0.159)
Interaction between subsidiary's technological capability and regional knowledge stock	0.278	-0.372	-0.169	-0.627	0.00955
	(1.565)	(0.760)	(0.757)	(0.747)	(0.769)
Population density	-0.000338**	-0.00108**	-0.000295*	-0.000414**	-0.000355***
	(0.000162)	(0.000475)	(0.000163)	(0.000188)	(0.000137)
Subsidiary's size	0.488**	0.494**	0.334	0.331	0.295*
	(0.237)	(0.211)	(0.206)	(0.221)	(0.157)
Year of entry	0.382	-0.703**	-0.193	0.0910	0.0144
	(0.266)	(0.329)	(0.264)	(0.291)	(0.205)
Mode of entry	-0.303	-0.0732	-0.301	-0.0420	-0.168
	(0.297)	(0.342)	(0.300)	(0.327)	(0.230)
Origin of investor (EU-27 dummy)	-0.593*	-0.522	-0.642*	-0.710*	-0.731***
	(0.316)	(0.455)	(0.349)	(0.370)	(0.259)
Type of investor	-0.149	1.275**	0.0736	0.519	0.255
	(0.575)	(0.645)	(0.651)	(0.615)	(0.468)
Branch	-0.354	0.0202	0.0257	0.0458	-0.164
	(0.292)	(0.336)	(0.299)	(0.315)	(0.226)
Constant	-3.218***	-2.280*	-3.764***	-4.927***	-2.745***
	(1.212)	(1.206)	(1.040)	(1.150)	(0.796)
Observations	422	537	833	813	914
Pseudo R^2	0,3878	0,3853	0,4187	0,4132	0,3519

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own calculations; *IWH FDI Micro database* 2009

4.3.1 Control variables

Amongst the **control variables** the estimates show that the foreign subsidiary's size is positively significant associated with regional R&D co-operation. Regarding countries of origin it shows that foreign subsidiaries with headquarters within EU-27 are also less likely to co-operate with the regional economy in the area of R&D. There is no significant effect of a control variable on the origin of investors coming from developing or developed countries, which was added to the analysis at a former stage. This implies that proximity plays a larger role for the probability of R&D co-operation than economic and developmental discrepancies between home and host country of FDI. As we find a significant effect of the EU-27 control variable, this proximity might not only include geographical, but also institutional and cultural proximity or other (Boschma 2005). The agglomeration variable (population density) is significantly negative associated with regional R&D co-operation - with a very low coefficient, however. This variable probably contains a capital-effect, which would imply that foreign subsidiaries outside the national capitals are more likely to co-

operate in the area of R&D. The foreign subsidiary's age, its mode of entry (Greenfield vs. Acquisition) and type of investor (financial investor vs. others) as well as the sectoral differences do not seem to play a considerable role for the foreign subsidiary's R&D co-operation behavior in the region of investment. At a former stage of the analysis we also controlled for sectoral dummies in the sectors NACE 24, 25, 28, 29, 51, 72, and 74 to check for R&D co-operation intensive sectors, but did not find significant differences to outcomes on foreign subsidiaries of other sectors.

5. Discussion and Conclusion

5.1 Summary of results and discussion

Our analysis shows that the generation of new technology does play a role for MNEs to locate in European post-transition economies. The results show furthermore that knowledge exchange is region- as well as firm-specific. There is indeed an interaction in technological activities taking place between the foreign subsidiaries and domestic markets, as 38% of the foreign subsidiaries in East Germany and 21% of the foreign subsidiaries in the selected CEE countries did source and transfer knowledge and technology by R&D co-operation from and to the regional innovation system.

5.1.1 Subsidiary's mandate and internal technological embeddedness

Supporting our first argument, we find that the foreign subsidiary's **mandate in terms of R&D** is positively associated with R&D co-operation in the location region. The results of the all sub-samples confirm this positive impact. The outcomes with regard to the foreign subsidiary's mandate are in line with recent research on less developed economies which emphasize the importance of the foreign subsidiary's autonomy for the creation of linkages or knowledge and technology exchange with the domestic economy (see f.e. Günther, Stephan, and Jindra 2008). Focusing on foreign subsidiaries' linkages to suppliers in the CEE region, Giroud, Jindra, and Marek (2012) for example find an positive influence of the subsidiary's mandate on technological business functions while the level of autonomy over production and operational management has no significant influence. In addition, Jindra, Giroud, and Scott-Kennel (2009) show that the subsidiary's mandate influences both extent and intensity of backward and forward linkages with the domestic environment - with a positive sign regarding autonomy on the extent of backward linkages and regarding autonomy on the extant and intensity of forward linkages. Thus, it can be suggested that it is the rather self-managed foreign subsidiary that absorbs and transfers knowledge in the host economy.

Regarding the **foreign subsidiary's internal technological embeddedness** we find significantly positive impact on R&D co-operation through all samples. These results add to those of existing studies, as Jindra, Giroud, and Scott-Kennel (2009) figure a negative impact of the foreign subsidiary's internal technological embeddedness on the extent of technological linkages with suppliers and customers, but a positive impact on the intensity of supplier and customer linkages. Giroud, Jindra, and Marek (2012), too, find a significant positive effect of the foreign subsidiary's internal technological embeddedness on supplier linkages. However, they find no significant effect on the extent of these linkages. These outcomes suggest that the potential for technological linking is higher for such foreign subsidiaries which are technologically embedded into the MNE's own knowledge base and that there is indeed a relation between the foreign subsidiary's technological co-operation with internal and its technological co-operation with external partners.

5.1.2 MNE's investment motive 'access to location-bound knowledge and technology'

Regarding the **market entry motivation** the empirical evidence does not support our argument: we find no significant relation between the importance of the investment motive 'access to location bound knowledge and technology' and the probability of R&D co-operation. The outcomes of the investment motive variable implies, that the MNE's strategic market entry motivation does play a rather small role in the realization of technological co-operation with the regional economy. These results differ from Santangelo (2012) who find that competence-seeking subsidiaries are better embedded with domestic actors and Günther, Stephan, and Jindra (2008) who tested for a home-base-augmenting strategy of the foreign subsidiary and find that foreign subsidiaries following this strategy are more likely to source technological knowledge from the East German economy. Hence, it seems that the MNE's market entry motivation does play some role when explaining technological interaction between the foreign subsidiary and the domestic economy. In our case, however, the MNE's investment motive is not as strongly related to the foreign subsidiary's R&D co-operation behavior as we assumed. This might be explained by a change in the foreign subsidiary's orientation over the time of its existence: it is possible that the MNE entered the market without an technology-seeking investment motive years ago, it might nonetheless tap into knowledge at present or the other way around. Furthermore, the foreign subsidiary can follow more than one investment strategies at the same time depending on the technological field of investment (Criscuolo, Narula, and Verspagen 2002; Günther, Stephan, and Jindra 2008).

5.1.3 Foreign subsidiary's technological capability, regional knowledge stock and interaction of the two

From an empirical view, results on the impact of the **foreign subsidiary's technological capability are mixed**. Giroud, Jindra, and Marek (2012) and Jindra, Giroud, and Scott-Kennel (2009) find in their paper no significant effect of the foreign subsidiary's technological capability on the extent of linkages with suppliers, but a significant positive effect on the intensity of these linkages. For linkages with customers Jindra, Giroud, and Scott-Kennel (2009) find also a positive significant effect of the foreign subsidiary's technological capability on linkages, and no significant effect on the extent of linkages. Gentile-Lüdecke and Giroud (2012), however, find for the example of the Polish automotive sector a negative relation between the subsidiary's R&D capability and knowledge transfer to domestic suppliers. Our positive outcomes of this variable suggest that the foreign subsidiary's technological capability (or absorptive capacity) positively influences its R&D co-operation behavior in order to augment and pass knowledge and technology. According to our hypothesis we expected that the **regional knowledge stock** is positively associated with foreign subsidiaries' R&D co-operation in the region of location. For the whole sample and the CEE sub-sample, as well as in the case of customers and research institutions we find significantly positive influence on the likelihood of regional technological co-operations. Empirical studies confirm that knowledge sourcing is influenced by the quality of knowledge sources. Filippov and Duysters (2011) find that subsidiaries accumulate knowledge and competences from interaction with their environment whereas universities and research centers serve as sources of knowledge especially for R&D. Günther, Jindra, and Stephan (2009) find empirical evidence that knowledge skills and technology are relevant for foreign subsidiaries located in CEE and East Germany. Our results support for example Frost (2001) and March (1991) in the suggestion that adaption and advancement of knowledge and technology might indeed be motivated by the host country's regional capabilities, as suggest the positive coefficients of the region's knowledge stock in our analysis. The interaction between the subsidiary's

technological capability and the regional knowledge stock has not been empirically tested so far. However, the outcome of this variable does not confirm our assumption, that the combination of these two conditions increases the likelihood of R&D co-operation.

5.2 Policy implications

Our results suggest that both, the technological competences of the foreign subsidiary and the regional knowledge base are important for knowledge and technology transfer between incoming FDI and the host economy. Thus, governments ought to concentrate on policy tools that attract and reward technological active foreign enterprises and support technological linkages with domestic firms. Technological 'catch-up' is especially important in (post-)transition economies, not least in the CEE countries where the domestic economy has to deal with the challenge of external competition only rather recently and technological upgrading has not yet been completed (Jindra, Giroud, and Scott-Kennel 2009; Dries and Swinnen 2004). Therefore the encouragement of inter-firm R&D co-operations could be one important policy strategy; the consideration of the domestic knowledge base's importance could be another. As our results show, the technological capability and absorptive capacity of the domestic economy is positively associated with knowledge and technology transfer. Thus, the national education system and the endorsement of technological activities - such as R&D and innovation and R&D co-operation - in domestic firms should be content of the government's efforts, too.

5.3 Conclusion

A country's position in the catching-up process to industrialization does not only depend on the quantitiy but also on the character of incoming FDI (Gauselmann and Marek 2012). The ability of the European post-transition countries to link with value-adding FDI and raise their technological capabilities are the essential issues to guarantee increasing productivity and industrial upgrading in the long term (Narula and Guimón 2010). MNEs have located their general economic activities across regions and countries, especially manufacturing and sales in the European regions. In recent years this internationalization has more and more included R&D activities. R&D units which have mainly been centrally organized at headquarters in the past become now further geographically dispersed on the subsidiary level (Narula and Guimón 2010). Thus, increased competition and technological complexity encourages MNEs to relocate R&D investments and co-operate with firms and institutions in the target location. In sum, the regression results based on 2009 survey evidence show that firm- as well as region-specific determinants influence the heterogeneity of foreign subsidiaries' R&D co-operation with the regional economy. Results suggest that especially the foreign subsidiary's mandate in terms of R&D, its embeddedness in the MNE's internal knowledge base, its own technological capability and the regional knowledge stock are positively associated with these linkages.

The European post-transition regions seem to catch up as target locations for knowledge and technology sourcing of MNEs. The regression results in the selected post-transition regions show little difference to the explanatory determinants of studies on developed countries. This suggests that the European post-transition countries have developed towards knowledge-based economies. Further research on regional determinants seems reasonable. It might also be worthwhile to investigate the impact of technological intra-firm relationships between foreign subsidiary and MNE to find out more about linkage creation.

Annex

Table 6. Correlation table of explanatory variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Subsidiary's R&D mandate	1												
(2) Subsidiary's internal technological embedd.	0,0777	1											
(3) MNE's inv. mot. "technology seeking"	0,0085	0,0947	1										
(4) Subsidiary's technological capability	0,1577	0,2032	0,1271	1									
(5) Regional knowldg. stock	0,0085	0,051	0,0037	0,0944	1								
(6) Interaction term	0,1531	0,1996	0,1132	0,8824	0,237	1							
(7) Population density	0,0317	0,0399	0,0093	0,1103	0,6298	0,2331	1						
(8) subsidiary's size	-0,0264	0,1855	0,0611	-0,174	-0,173	-0,1558	-0,1629	1					
(9) Year of entry	0,0681	-0,086	-0,0119	0,0661	0,0115	0,0781	0,0213	-0,0886	1				
(10) Mode of entry	-0,1303	-0,074	-0,0193	-0,049	-0,011	-0,043	-0,0001	-0,1361	-0,2542	1			
(11) Origin of investor	-0,0555	-0,015	-0,0556	-0,101	-0,122	-0,1346	-0,1457	0,0051	-0,0581	0,0954	1		
(12) Type of investor	0,0465	-0,03	-0,063	0,0226	0,0278	0,0406	0,0052	-0,0272	0,166	-0,0925	-0,0634	1	
(13) Branch	-0,0022	-0,03	0,0214	0,1139	0,2602	0,1293	0,1915	-0,2842	0,0819	0,0929	-0,0061	0,0297	1

Source: own calculations; IWH FDI Micro database 2009

Table 7. The 52 NUTS-2 regions included in the dataset

East Germany

1 Berlin
2 Brandenburg-Nordost
3 Brandenburg-Südwest
4 Mecklenburg-Vorpommern
5 Chemnitz
6 Dresden
7 Leipzig
8 Sachsen-Anhalt
9 Thüringen

Hungary

10 Dél-Alföld
11 Dél-Dunántúl
12 Közép-Dunántúl
13 Közép-Magyarország
14 Nyugat-Dunántúl
15 Észak-Alföld

Slovakia

16 Bratislavský kraj
17 Stredné Slovensko
18 Východné Slovensko
19 Západné Slovensko

Czech Republic

20 Jihovýchod
21 Jihozápad
22 Moravskoslezsko
23 Praha
24 Severovýchod
25 Severozápad
26 Strední Cechy
27 Strední Morava

Romania

28 Bucuresti - Ilfov
29 Centru
30 Nord-Est
31 Nord-Vest
32 Sud - Muntenia
33 Sud-Est
34 Sud-Vest Oltenia
35 Vest

Poland

36 Dolnoslaskie
37 Kujawsko-Pomorskie
38 Lubelskie
39 Lubuskie
40 Lódzkie
41 Malopolskie
42 Mazowieckie
43 Opolskie
45 Podkarpackie
46 Podlaskie
47 Pomorskie
48 Slaskie
49 Swietokrzyskie
50 Warminsko-Mazurskie
51 Wielkopolskie
52 Zachodniopomorskie

Bibliography

Almeida, P. and A. Phene, 2004: Subsidiaries and Knowledge Creation: The Influence of the MNC and host country on Innovation. In: Strategic Management Journal 25, pp. 847–864.

Belderbos, R., M. Carree, and B. Lokshin, 2004: Cooperative R&D and firm performance. In: Research Policy Vol. 33, pp. 1477–1492.

Birkinshaw, J. M., N. Hood, and S. Johnson, 1998: Building firm-specific advantages in multinational corporations: The role of subsidiary initiative. In: Strategic Management Journal Vol. 19(3), pp. 221–242.

Birkinshaw, J. and N. Hood, 1998: Multinational subsidiary evolution: capability and charter change in foreign-owned subsidiary companies. In: Academy of Management Review Vo. 23(4), pp. 773–795.

Boschma, R. A., 2005: Proximity and Innovation: A Critical Assessment. In: Regional Studies Vol. 39.1, pp. 61–74.

Bucar, M., M. Rojec, and M. Stare, 2009: Backward FDI linkages as channel for transferring technology and building innovation capability: the case of Slovenia. In: European Journal of Development Research Vol. 21, pp. 137–153.

Cantner, U. and A. Meder, 2009: Regional effects on cooperative innovative activities and the related variety of regional knowledge bases. In: Jena economic research papers No. 064.

Cantwell, J., 1989: Technological innovation and multinational corporations. B. Blackwell.

Cantwell, J., 1995: The globalization of technology: what remains of the product cycle model? In: Cambridge Journal of Economics 19(1), pp. 155–174.

Cantwell, J., 2000: Multinational Corporations and the location of technological innovation in the UK regions. In: Regional Studies 34(4), pp. 317–332.

Cantwell, J. and S. Iammarino 1998: MNCs, technological innovation and regional systems in the EU: some evidence in the Italian case. In: International Journal of Economics od Business 5(3), pp. 383–408.

Cantwell, J. and S. Iammarino, 2001: EU Regions and Multinational Corporations: Change, stability, and the strengthening of comparative technological advantages. In: Industrial and Corporate Change 10(4), pp. 1007–1037.

Cantwell, J. and S. Iammarino, 2003: Multinational Corporations and European Regional Systems of Innovation. Routledge.

Cantwell, J. and R. Mudambi, 2000: The Location of MNE R&D Activity: The Role of Investment Incentives. In: Management International Review Special Issue, pp. 127–148.

Cantwell, J. and R. Mudambi, 2005: MNE Competence-Creating Subsidiary Mandates. In: Strategic Management Journal 26, pp. 1109–1128.

Cantwell, J. and L. Piscitello, 2000: Accumulating technological competence: its changing impact on corporate diversification and internationalization. In: Industrial and Corporate Change 9(1), pp. 21–51.

Cassiman, B., R. Veugelers, and P. Zuniga, 2010: Diversity of science linkages and innovation performance: Some empirical evidence from Flemish firms. In: Economics: The Open-Access, Open-Assessment E-Journal Vol. 4 (33).

Castellani, D. and A. Zanfei, 2006: Multinational firms, innovation and productivity. Edward Elgar Publishing.

Cohen, W. and D. Levinthal, 1990: Absorptive capacity: a new perspective on learning and innovation. In: Administration Science Quarterly Vol. 35(1), pp. 128–152.

Criscuolo, C., R. Narula, and B. Verspagen, 2002: The relative importance of home and host innovation systems in the internationalisation of MNE R&D: a patent citation analysis. In: MERIT-Infonomics Research Memorandum series Vol. 026, pp. 1–26.

D'Agostino, L. and G. D. Santangelo, 2012: Do Overseas R&D Laboratories in Emerging Market Contribute to Home Knowledge Creation? An Extension of the Double Diamond Model. In: Management International Review 52, pp. 251–273.

Damijan, J., C. Kostevc, and M. Rojec, 2010: Does a foreign subsidiary's network status affect its innovation activity? ecvidence from post-socialist economies. In: Economics and business review Vol. 12 No. 3, pp. 167–194.

Doerrenbaecher, C. and J. Gammelgaard, 2006: Subsidiary role development: The effect of micro-political headquarters' subsidiary negotiations on the product, market and value-added scope of foreign-owned subsidiaries. In: Journal of International Management Vol. 12 (3), pp. 266–283.

Dries, L. and J. Swinnen, 2004: Foreign direct investment, vertical integration, transaction linkages, and local suppliers: Evidence from the Polish dairy sector. In: World Development Vol. 32(9), pp. 1525–1544.

Dunning, H. and R. Narula, 1995: The R&D activities of foreign firms in the United States. In: International Studies of Management & Organization Vol. 25 (1-2), pp. 39–73.

Dunning, J. H., 1977: "The international allocation of economic activity." In: ed. by B. O. et al. London: Macmillan. Chap. Trade, location of economic activity and the MNE: A search for an eclectic approach, pp. 395–431.

Dunning, J. and S. Lundan, 2008: Multinational enterprises and the global economy. Edward Elgar Publishing.

Figueiredo, P., 2011: The Role of Dual Embeddedness in the Innovative Performance of MNE Subsidiaries: Evidence from Brazil. In: Journal of Management Studies 28:2, pp. 417–440.

Filippov, S. and G. Duysters, 2011: Competence-building in foreign subsidiaries: The case of new EU member states. In: Journal for East European Management Studies Vol. 4, pp. 286–314.

Frost, T., 2001: The geographic sources of foreign subsidiaries' innovation. In: Strategic Management Journal 22, pp. 101–123.

Frost, T., J. M. Birkinshaw, and P. C. Ensign, 2002: Centers of Excellence in multinational corporations. In: Strategic Management Journal Vol. 23, pp. 997–1018.

Fu, X., C. Pietrobelli, and L. Soete, 2010: The Role of Foreign Technology and Indigenous Innovation in Emerging Economies: Technological Change and Catching Up. In: Inter-American Development Bank IDB-TN-166, pp. 1–24.

Gauselmann, A., M. Knell, and J. Stephan, 2011: What drives FDI in Central-Eastern Europe? Evidence from the *IWH FDI Micro database*. In: Post-Communist Economies Vol. 23, No. 3, pp. 343–357.

Gauselmann, A. and P. Marek, 2012: Regional Determinants of MNE's Location Choice in Transition Economies. In: Empirica Vol. 39(4), pp. 487–511.

Gentile-Lüdecke, S. and A. Giroud, 2012: Knowledge Transfer from TNCs and Upgrading of Domestic Firms: the Polish Automotive Sector. In: World Development Vol. 40, No. 4, pp. 796–807.

Giroud, A., B. Jindra, and P. Marek, 2012: Heterogeneous FDI in Transition Economies - A Novel Approach to Access the Developmental Impact of Backward Linkages. In: World Development Vol. 40(11), pp. 2206–2220.

Grant, R. M., 1996: Toward a Knowledge-Based Theory of the Firm. In: Strategic Management Journal 17, pp. 109–122.

Grant, R. and C. Baden-Fuller, 2004: A knowledge accessing theory of strategic alliances. In: Journal of Management Studies 41(1), pp. 61–84.

Greene, W., 2003: Econometric analysis. Vol. 5. Prentice Hall Upper Saddle River, NJ.

Günther, J., A. Gauselmann, B. Jindra, P. Marek, and J. Stephan, 2011: An Introduction to the IWH FDI Micro database. In: Schmollers Jahrbuch / Journal of Applied Social Science Studies Bd. 131 (3), pp. 529–546.

Günther, J. and O. Gebhardt, 2005: Eastern Germany in the Process of Catching Up. The Role of Foreign and West German Investors in Technological Renewal. In: Eastern European Economics of Transition 43, no. 3, pp. 78–102.

Günther, J., B. Jindra, and J. Stephan, 2009: Does Local technology Matter for Foreign Investors in Central and Eastern Europe? Evidence from the *IWH FDI Micro database*. In: Journal of East-West Business Vol. 15, pp. 210–247.

Günther, J., J. Stephan, and B. Jindra, 2008: Foreign Subsidiaries in the East German Innovation System - Evidence from Manufacturing Industries. In: Applied Economics Quarterly 59, pp. 137–165.

Jindra, B., A. Giroud, and J. Scott-Kennel, 2009: Subsidiary roles, vertical linkages and economic development: Lessons from transition economies. In: Journal of World Business Vol. 44(2), pp. 167–179.

Kim, L. and R. Nelson, 2000: Technology, learning, and innovation. Cambridge University Press.

Kogut, B. and S. Chang, 1991: Technological capabilities and Japanese FDI in the United States. In: Review of Economics and Statistics 73(3), pp. 401–413.

Kuemmerle, W., 1997: Building effective R&D capabilities abroad. In: Harvard Business Review Vol. 75, No. 2, pp. 61–70.

Kuemmerle, W., 1999: Foreign Direct Investment in industrial Research in the pharmaceutical and electronic Industries: Results from a Survey of Multinational Firms. In: Research Policy Vol. 28(2/3), pp. 179–193.

Le Bas, C. and C. Sierra, 2002: Location versus home country advantages in R&D activities: some further results on multinationals' location strategies. In: Research Policy Vol. 31, pp. 589–609.

Liu, B. J., 2010: MNE and local linkages: Evidence from Taiwanese affiliates. In: World Development Vol. 39(4), pp. 633–647.

March, J. G., 1991: Exploration and exploitation in organizational learning. In: Organization Science 2, pp. 71–87.

Meyer, E., R. Mudambi, and R. Narula, 2011: Multinational Enterprises and Local Contexts: The opportunities and Challenges of Multiple Embeddedness. In: Journal of Management Studies 48, pp. 235–252.

Narula, R. and J. Guimón, 2010: The R&D activity of Multinational Enterprises in peripheral Economies: Evidence from the new EU member States. In: United Nations University (UNU) Working Paper 048, pp. 1–32.

Narula, R. and A. Zanfei, 2005: "The Oxford Handbook of Innovation." In: ed. by J. Faberberg, D. Mowery, and R. Nelson. Chap. Globalization of Innovation: Role of Multinational Enterprises, pp. 318–345.

OECD, 2008: OECD Benchmark Definition of Foreign Direct Investment.

OECD and Eurostat, 2008: The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological innovation data.

Patel, P. and M. Vega, 1999: Patterns of internationalization of corporate technology: location vs. home country advantages. In: Research Policy 28, pp. 145–155.

Perugini, C., F. Pompei, and M. Signorelli, 2008: FDI, R&D and human capital in Central and Eatsern Eurpean Countries. In: Post-Communist Economies 20:3, pp. 317–345.

Santangelo, G. D., 2009: MNCs and linkage creation: Evidence from a peripheral area. In: Journal of World Business 44(2), pp. 192–205.

Santangelo, G. D., 2012: The tension of information sharing: Effects on subsidiary embeddedness. In: International Business Review 823, pp. 1–16.

Teece, D. J., G. Pisano, and A. Shuen, 1997: Dynamic capabilities and strategic management. In: Strategic Management Journal Vol. 18, pp. 509–534.

Transition Report, 2009. European Bank for Reconstruction and Development.

Yamin, M. and J. Otto, 2004: Patterns of knowledge flows and MNE innovative performance. In: Journal of International Management Vol. 10, pp. 239–258.

Zanfei, A., 2000: Transnational firms and the changing organization of innovative activities. In: Cambridge Journal of Economics 24, pp. 515–542.