

Sourcing Knowledge?

Knowledge Flows between Multinational Enterprises and National Innovation Systems

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Abstract:

This paper wants to gain insight how MNE affiliates draw on knowledge from their host countries. We examine differences between foreign-owned and domestic firms in Austria with respect to their propensity to enter into co-operative arrangements and their valuation of various information sources. Our results show that foreign-owned enterprises still rely to a high degree on knowledge internal to the group and form less co-operative arrangements in the innovation process. However, the differences between foreign-owned and domestic firms are small in a number of cases and we also found a surprisingly high share of foreign affiliates to tap into local knowledge. Moreover, differences in co-operative behaviour seem to be related to the parent company's home country to some degree.

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Introduction³

The international business literature considers knowledge spillovers from foreign affiliates to domestic enterprises to be one of the major benefits a host economy can derive from the presence of multinational enterprises (MNEs). This paper deals with the opposite case and wants to measure to what extent innovative MNEs utilize the knowledge base of their host countries. There is only little empirical evidence on these kinds of flows in the international business literature, since most empirical studies on spillovers in this tradition concentrate on the effects of MNE presence on *domestic* industries (Blomström and Kokko 1998). However, recent studies in the innovation studies literature suggest that MNEs increasingly locate R&D facilities in host countries not only to support production and marketing, but to absorb spillovers from the host economy and actively increase their knowledge base.

Evidence for the existence of spillovers from the host country to foreign affiliates is relevant from a theoretical point of view since the models employed in international business literature (for example Markusen 2002) tell only little about such a phenomena. In fact, the main stream of knowledge transfer goes from the parent company to the affiliates in these models, and affiliates just utilizes technologies and products developed in the home country. Therefore, our paper may contribute to a more interactive view of the relations between MNEs and their business environment in the host country.

Our question is also relevant for policy since multinational enterprises account for a large share of employment, production and R&D expenditures in the OECD countries; this share is expected to increase in the future. In 2001, foreign affiliates accounted for 15% to 20% of total manufacturing R&D in France, Germany and the United States; between 30% and 50% in Portugal, the Netherlands, Spain, Sweden and the United Kingdom; and between 50 and 70% in the Czech Republic, Hungary and Ireland (OECD 2004, p. 172). In the case of Austria, around 40% of all patents invented in Austria are possessed by foreign enterprises (Dachs and Schibany 2004). The fact that foreign enterprises are main contributors to the technological performance of these countries has raised fears that the ongoing relocation of MNE production from Western Europe to Asia of Central and Eastern Europe may some day also affect MNE R&D activities in these countries

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and lead to a reduction of these activities in Western Europe. We can only judge if these concerns are justified if we know how 'deep' MNE innovative activities are embedded in the National Innovation Systems of their host countries. An important indicator for the degree of 'embeddedness' of MNE affiliates are external relations to the knowledge base of their host countries. The innovation systems literature interprets innovation as an interactive process; if interactions of innovative MNE affiliates mainly happen between the affiliate and the parent company, we may conclude that, in the absence of other major incentives, MNEs one day may find it more attractive to move their research and development units to other locations. If, on the other hand, we find strong linkages to domestic enterprises and universities, this may be an indication that the innovative activities of MNEs are less 'footloose' than critics of globalization assume.

The paper is organized as follows: chapter 2 presents some theoretical considerations and empirical results on knowledge spillovers and foreign enterprises. Chapter 3 presents our data source. The methodology and results of the empirical analysis are laid out in chapter 4. Finally, chapter 5 draws some conclusions from the results for theory as well as policy.

1 Theoretical background and research hypothesis

There are two quite distinct bodies of literature in economics which deal with spillovers between foreign-owned and domestic firms; one is the international business literature which focuses on explaining foreign direct investment and the existence of multinational enterprises. The other strand are studies in the neo-Schumpeterian tradition which regards knowledge diffusion between various actors as crucial to explain innovation and technological change.

Knowledge is central to the microeconomic approach in the international business literature (see, for example, Markusen 2002); foreign direct investment, exports, licensing etc. are seen as alternate ways of utilizing superior, firm-specific assets like technology, products, brands, or superior management skills. These assets (or 'knowledge capital' in Markusen's terminology) may be the result of innovative activity in the home country. Superior assets give MNEs an advantage over incumbent firms and enable them to enter foreign markets. To adapt existing products and technologies to local needs, tastes, and regulation, MNEs locate research and development (R&D) facilities abroad.

When MNEs make use of these assets by setting up affiliates and produce and sell products outside of their home countries, parts of their superior assets spill over⁴ to domestic enterprises; this seems to be unavoidable, since these assets are non-rival and non-exclusive to a certain degree. Moreover, there are numerous and very different channels for these knowledge flows like labour mobility, demonstration effects, imitation and reversed engineering, formal and informal co-operation, supplier-customer-relationships, etc. Spillovers that diffuse from the affiliates of MNEs to domestic enterprises are assumed to be a major benefit for the host economies from FDI and have found broad recognition in the international business literature (see Blomström and Kokko 1998; Keller 2004 for a review). According to Blomström and Kokko (2003), these spillovers are the strongest argument why countries should try to attract inward investment.

Opposite to this view on knowledge diffusion via FDI found in the international business literature, a number of studies in the neo-Schumpeterian tradition suggest that knowledge diffuses also in the opposite direction, from the host countries to MNE affiliates. MNE affiliates activities abroad are increasing, instead of just utilizing the existing stock of knowledge of the company. Evidence on such flows is given by studies following very diverse approaches: a number of authors have employed patent citation data or used patents to compare the technological specialization of the firm and the host country (Almeida 1999; Cantwell and Piscitello 2002; le Bas and Sierra 2002); others investigated the motives of location decisions of overseas MNEs R&D activity (for example Cantwell and Mudambi 2000; Kumar 2001) and showed the importance of the scientific and technological specialization of the host country. Studies based on survey data (Kuemmerle 1999; Håkanson and Nobel 2001; Veugelers and Cassiman 2002) have also confirmed the existence of such flows. Moreover, a large number of case studies in the economics of innovation and the economic geography literature report that MNEs locate R&D facilities in host countries which possess specialized clusters, industrial districts, regional systems of innovation or similar hi-tech agglomerations (a recent example is Lorenzen and Mahnke 2002).

As a consequence, the competences of overseas MNE R&D facilities seem to have extended in the past decades (see Veugelers et al. 2005 for an empirical overview). Beside adjusting and customizing existing parent-company technologies, foreign affiliates increasingly create complete new technologies and products or absorb new technological or market trends by acting as 'surveillance outposts' (Miller 1994) or 'antennas' (Florida 1997). A number of enterprises even

⁴ Readers should note that knowledge or technology spillovers are used in a very general sense in the international business literature and include both, market-mediated and non-mediated knowledge diffusion.

formed 'technology centres' or 'global centres of excellence' which concentrate the company's research activities in one specific technology or product group. Decentralisation, however, is not costless and includes some trade-offs as described in a model by Sanna-Randaccio and Veugelers (2003): MNEs have to organize the transfer and distribution of knowledge internally throughout the organisation; these flows may be two-way which incurs further cost and losses; central research departments may lose some economies of scale in R&D; decentralized R&D will increase the possibility of knowledge spillovers from research activities to local competitors. Moreover the decentralization of the innovative activities of MNEs also implies a higher degree of independence for affiliates to form external relationships with local firms and universities in their host countries (Zanfei 2000).

The two approaches to spillovers found in the literature are summarized by a very telling distinction brought forward by Kuemmerle (1999) who distinguished two basic modes of how foreign affiliates innovate and interact with their environment:

- 'Home-base exploiting' (HBE), where foreign affiliates are mostly exploiting existing knowledge to support foreign production by doing minor development work in adjusting existing technologies and products. Knowledge relevant for the innovative activity at the affiliate mainly originates from within the multinational group, from the parent company or affiliates in other countries. External linkages to firms, universities or public laboratories in the host country are only of minor importance for the innovative outcome of the affiliate. The most important information sources that contribute to innovative performance of the affiliate reside inside the MNE.
- 'Home-base augmenting' (HBA), where foreign affiliates are actively contributing to the stock of knowledge and the range of products of the group as a centre of excellence. Knowledge relevant for the innovative activity of the affiliate originates from within the group, but also from its environment in the host country. Therefore, external linkages to firms, universities or public laboratories in the host country are of a much larger importance and foreign and domestic enterprises are in a more dynamic and vivid exchange than in the HBE mode. We may also assume that direct linkages to various external information sources like universities or public research centres are more important than in HBE.

Starting from these two modes, our research question is quite straightforward: which one of the two modes is prevailing? A comparable or even higher degree of knowledge exchange between foreign affiliates and their environment than Austrian enterprises would point to HBA. If HBE is more frequent, we will find a lower level of interaction.

The theoretical arguments presented above as well as empirical evidence suggest that we may expect to find evidence in favour of the HBE strategy. Previous studies with patent data (Patel and

Vega 1999; le Bas and Sierra 2002) has shown that the HBE strategy is more frequent than HBA; in the majority of cases MNEs locate their affiliates in host countries which are less specialized in the MNE's technological strengths. HBA (MNE and host country are both specialised in a certain technology) is found only rarely.

A second question refers to differences in the external knowledge relationships which may be related to the country of origin of the parent company. Our hypothesis is that enterprises from one of Austria's German-speaking neighbouring countries (Germany, Liechtenstein and Switzerland – referred to as GLS in the text) may find it easier to access local knowledge in Austria than enterprises from other countries. This suggestion is supported by a recent re-interpretation of the distinction between tacit and codified knowledge in the literature (Cowan et al. 2000; Breschi and Lissoni 2001). These authors point out that technical and scientific knowledge may be considered as tacit not because it cannot be articulated but because of its specificity which allows exchange only between a group of people ('epistemic community') who share a common vocabulary or 'codebook'. A common language, cultural similarities (including a similar style of corporate governance), and long-standing business relations between the three countries⁵ may facilitate the construction of such a common codebook, but also make other channels of transmission more easily accessible. Our hypothesis that German, Liechtenstein or Swiss enterprises may find an easier access to local knowledge in Austria is also supported by empirical evidence on co-patenting (Guellec and van Pottelsberghe de la Potterie 2001) which shows that geographical proximity and a common border language significantly explain mutual patenting activities at the national level. German and Swiss enterprises are indeed largest foreign owners of patents invented in Austria by far.

The questions raised require the investigation of the companies innovation behaviour in two dimensions: (1) The companies' collaboration behaviour, where we have to differentiate between the location of the collaboration partners (2) The companies' knowledge sources for innovation, where we have to differentiate between sources from within the corporate group and from outside the corporate group. In addition to the two dimensions of innovation behaviour we have to discriminate foreign owned firms based on the MNE's home country to be able to investigate the effect language and corporate governance styles exert on the innovation activities.

5 Some German and Swiss affiliates in Austria have a very long history, like Siemens Austria which started operations in 1859, or Novartis, whose predecessor Ciba Geigy is present in Austria since 1935

2 Data

The analysis draws on the results from the third and most recent wave of the Community Innovation Survey (CIS 3). CIS 3 is a survey based on a common questionnaire administered by Eurostat which aims at assessing various aspects of firms' innovative behaviour and performances. The method and types of questions used in innovation survey are described in the OECD Oslo Manual (OECD 1997). CIS data is increasingly used as a key data source in the study of innovation at the firm level in Europe, Canada and Australia. We have chosen the Austrian data because Austria is one of the most internationalized countries with respect to the presence of multinational enterprises.

Foreign-owned firms are identified in the questionnaire by a question about the country of head office location in the case the enterprise is part of a group (Eurostat 2001, question 1). Our sample consists of 618 enterprises which belong to a group of enterprises and 669 which do not. 390 of the group members are Austrian-owned, another 118 are owned by a German, Swiss or Liechtenstein based parent company (Table 1).

In contrast to most existing empirical studies where spillovers are measured indirectly, by relating productivity changes in a domestic industry to the degree of presence of foreign firms, CIS data provides direct measures of knowledge transfer. We look at two potential channels for the diffusion of knowledge between foreign affiliates and domestic firms:

- *Innovation co-operation* is described in the questionnaire as 'active participation in joint innovation and R&D projects with other organisations (either enterprises or non-commercial organisations)' (Eurostat 2001, question 8). Pure contracting out of work, where there is no active collaboration, is not defined as co-operation in the survey. Innovation co-operation can be differentiated according the partner (partner from the group, external firms, universities, research centres) and the geographical scope (domestic partner or foreign partner)

- *Sources of information* that have been used in the firm's innovation activities are differentiated between *internal* sources (within the enterprise or other enterprises of the group), *market sources* (suppliers, customers, competitors, consultants or commercial R&D), *science sources* (universities and public laboratories) and *other sources* (conferences, exhibitions etc).

Table 1 Distribution of ownership in the sample

Ownership	Number of observations
Part of a group:	618
... Austrian-owned	390
... German-Liechtenstein-Swiss-owned (GLS)*	118
... Anglo-Saxon-owned (AS)**	53
... European-owned (EU)***	47
... Others (OTH) ****	10
All Foreign-owned (FO)	228
Austrian-owned, not group member	669

Note: * includes DE, CH, LIE; ** includes CA, IE, UK, US, ZA; *** includes BE, FI, FR, IT, LU, NL, NO, PT, SE, SI; **** excluded from the analysis.

Source: own calculations

Since the transfer of knowledge between various actors is a keystone in the concept of innovation systems (see Edquist 2005 for a recent review), there exists a vast literature on the magnitude, the determinants and impacts of these linkages (Schartinger et al. 2002; Tether 2002; Caloghirou et al. 2003), and we will refrain from a further discussion of the various diffusion channels. However, readers should note that innovation co-operations are formal agreements on a contractual basis which include not only knowledge exchange but allow to share the risks of innovation projects or exploit scale economies to R&D. In contrast to the conception of spillovers in the international business literature where knowledge is only transferred in one way, from the MNEs to the local firm, co-operative arrangements involve an exchange in both directions and mutual learning. Moreover, as co-operative activities help to build up trust and to create a common 'codebook' that eases the exchange of knowledge over 'tacit' channels discussed above. Co-operative arrangements may also be pre-requisite and a starting point for other types of knowledge exchange. Since co-operative arrangements constitute a certain degree of commitment, they require a high degree of independence of the affiliate.

Information sources relevant for the firm's innovation activities on the other hand are far less formal and encompass various channels of knowledge transfer like demonstration effects, imitation and reversed engineering, loose supplier-customer-relationships. They may imply a less intense exchange, but seem to be closer to the concept of spillovers used in the international business

literature (see Blomström and Kokko 1998, p 3), since we can assume that most information flows do not include an adequate compensation.

3 Empirical analysis

The research question posed essentially amounts to assessing the impact of foreign ownership on the companies co-operation and sourcing behaviour for innovation.

3.1 Methodology

3.1.1 Estimation of the counterfactual

Before we assess the impact of foreign ownership on the foreign owned companies' external relations we have to consider a fundamental problem connected to such questions. To assess the impact we have to contrast the *actual* behaviour of a foreign owned firm with the *counterfactual*, yet unobservable, behaviour of the same firm in the case of Austrian ownership. This section discusses how we are going to deal with this missing data problem.

Let us illustrate the problem by examining the following equation:

$$E(\Delta) = E(\pi_F) - E(\tilde{\pi}_F)$$

π_F denotes the behavioural variable for the foreign-owned companies, $\tilde{\pi}_F$ is the counterfactual behaviour of the foreign owned enterprise in the case of domestic ownership. $E(\Delta)$ is the impact of foreign ownership as it describes the difference in behaviour between the company in the state of foreign ownership compared to its behaviour in the counterfactual situation of Austrian ownership. As $\tilde{\pi}_F$ is not observable, it has to be estimated. Fundamentally, the estimation of $\tilde{\pi}_F$ has to control for a potential selection bias as foreign ownership and membership of a corporate group cannot be thought of being a random event. Essentially this means that companies being part of a corporate group are different from companies not being part of a corporate group in various dimensions such as size or investment behaviour. It also means that companies being part of a foreign owned group are different to companies being part of an Austrian group.

Table 2 shows that foreign-owned companies are indeed significantly different from the Austrian companies. Foreign-owned companies are larger and invest a lower share of their turnover than the

Austrian owned companies in the sample. Companies with under foreign ownership tend to be more frequent in the high technology sector.

Table 2: Average characteristics by ownership

Variables	Group	Independent		For. owned	Austrian	
empl	0.283	0.062	***	0.252	0.150	***
empl2	0.475	0.027	***	0.339	0.221	
invest	0.070	0.080		0.049	0.081	**
seht	0.129	0.060	***	0.184	0.074	***
smelt	0.097	0.099		0.075	0.103	
selt	0.084	0.227	***	0.079	0.176	***
sekis	0.325	0.049	***	0.110	0.197	***
seos	0.364	0.565	***	0.553	0.450	***
apprcond	1.248	1.166	***	1.211	1.204	
seexchr	0.199	0.166	***	0.262	0.164	***
speed	0.410	0.465	***	0.466	0.433	**
N	618	669		228	1059	

Note: Equality of means is tested by a t-test assuming unequal variances. * (**, ***) indicates significance at the 5%, (1%, 0.1%) level. The variables are described in the appendix.

Source: own calculations

The counterfactual behaviour $\tilde{\pi}_1$ of a foreign-owned firm cannot be estimated by the outcome π_0 of the observations of domestically-owned firms as $E(\pi_1) \neq E(\pi_0)$ due to the selection bias. Rubin (1977) introduces the conditional independence assumption (CIA) helping to solve the selection problem. Briefly, in our context, this assumption states that knowledge sourcing behaviour is independent of companies' ownership as long as the compared companies share the same exogenous characteristics \mathbf{x} . Given the validity of the assumption it follows that $E(\tilde{\pi}_1, \mathbf{x}) = E(\pi_0, \mathbf{x})$.

Hence the counterfactual outcome can be estimated using the observed outcome of domestically-owned companies as long as the foreign-owned and the domestically-owned company share the same exogenous characteristics \mathbf{x} . The average effect of ownership is

$$E(\Delta) = E(\pi_1, \mathbf{x}) - E(\pi_0, \mathbf{x})$$

To estimate the counterfactual situation for a foreign owned company, one has to balance the sample of Austrian owned companies such as to resemble the sample of foreign owned companies

concerning the characteristics \mathbf{x} . In the literature on the construction of matching samples one can find several approaches to construct the counterfactual group. Supposing \mathbf{x} contains only one variable, it would be intuitive to look for an Austrian owned company that has exactly the same value in \mathbf{x} as the foreign owned company. However, if the number of matching criteria is large, it would hardly be possible to find any such Austrian observation - the curse of dimensionality. As a solution, Rosenbaum and Rubin (1983) introduced propensity score matching. The idea is to collapse the number of matching criteria into a low dimensional measure.

In our exercise here we use three dimensions to match the companies: (1) the probability to be part of a corporate group based on exogenous company characteristics captured by a propensity score measure (2) the probability to be foreign owned based on exogenous company characteristics also captured by the propensity score, (3) the size of the company. The probabilities to be part of a corporate group and the probability to be foreign owned are estimated on the whole sample. The estimation is documented in Appendix A. The sample of foreign owned companies and the sample of Austrian owned companies are then comparable in their probability (distribution) to be part of a corporate group and to be foreign owned. They are also comparable in their size distribution. Eventually both sample are comparable in all the variables used to determine the propensity scores.

3.1.2 Kernel based matching

In this analysis, we apply a kernel based matching⁶ which estimates the counterfactual based on the whole sub-sample of Austrian companies. The counterfactual behaviour for a foreign owned company i is generated as a convex combination of the behaviour of all observed domestically owned companies. The weights for the convex combinations are determined by a kernel regression on the distances in matching criteria space between the foreign owned company i and the Austrian owned companies. As matching criteria we use both the propensity score for the foreign ownership dummy (*forown*) and the propensity score obtained by regressing the group membership dummy (*gp*) on the exogenous variables.⁷ This selection of matching criteria ensures that foreign-owned and domestically-owned companies are equally likely to be a member of a corporate group as well as

6 Recently matching estimators been applied and discussed, amongst others, by Heckman et al. (1998a; 1998b). Most recent contributions in the field of innovation studies include Almus and Czarnitzki (2003), Czarnitzki and Fier (2002; 2003) and Czarnitzki, Ebersberger and Fier (2004).

7 For the analysis of case 1 we only use the propensity score for the foreign ownership.

being foreign owned. Additionally, we use the company size as matching criteria. The distance in the matching criteria space is measured by the Mahalanobis metric. In the kernel regression, we employ a Gaussian kernel and a bandwidth suggested by a modified Silverman's rule of thumb (Silverman 1986; Bergemann et al. 2001). The Appendix contains the technical details of the kernel based matching.

3.2 Results

The first step of the discussion focuses on the effect foreign ownership has on the collaboration and sourcing behaviour of foreign-owned companies. In the second step we turn to the analysis of how much the home country of the MNE matters.

Table 3 presents the results of the analysis of foreign-owned companies disregarding the home country of the MNE. The effect indicates whether foreign ownership affects the propensity to cooperate positively (+) or negatively (-).

Foreign ownership does not affect the general propensity of the companies to cooperate for innovation (Table 4). Hence, the effects we observe further down below are not caused by a generally higher likelihood of foreign owned companies to enter collaborations for innovation. Note also that the counterfactual group consists of Austrian-owned companies which are part of a corporate group. So, group ownership cannot be the reason for the differences to be observed. Furthermore, the quality indicators for the matching procedure, which we allude to in the appendix, suggest that the matching procedure indeed generated comparable samples of foreign-owned and Austrian-owned companies. Ownership is the only firm specific characteristic which differs for the two samples. Hence we can argue that the differences in collaborative behaviour are caused by foreign ownership.

Table 3: Effect of foreign ownership

		Effect			Effect
Collaboration in general	co	.			
Domestic collaboration	copdom	-	International collaboration	copglo	.
Dom vertical coll	coverd	-	Int vertical coll	coverg	.
Dom coll with customers	coclcd	-	Int coll with customers	coclg	-
Dom coll with suppliers	cosd	-	Int coll with suppliers	cosg	.
Dom horizontal coll	cohord	.	Int horizontal coll	cohorg	.
Dom science coll	coscid	-	Int science coll	coscig	.
Dom coll with universities	cound	-	Int coll with universities	coung	.
Dom coll with gov research	cogd	.	Int coll with gov research	cogg	.
Dom coll with consultants	coctd	.	Int coll with consultants	coctg	.
Sourcing of knowledge					
Group internal knowl. sourc.	sgrpa	+			
Ext. sourcing from companies	sext	-			
Sourcing from science	ssci	.			
Sourcing from fairs, exhibit.	sfair	-			
Internal vs. External sourcing	sintern	+			

Note: '.' indicates no significant effect. '+' indicates a positive effect of public ownership, while '-' denotes a negative effect significant at the 10% level.

Source: own calculations

Although not observing a difference in collaboration behaviour in general, we observe distinct patterns of collaboration once we disaggregate the collaboration partners into Austrian and international collaboration partners.

The analysis shows a significant lower propensity for foreign enterprises to enter into co-operation agreements with *national* partners. The finding that domestic collaboration, i.e. collaboration with national collaboration partners is less frequent among foreign owned firms is caused by their reduced propensity to collaborate with vertical partners and with the national science system. It is not caused by the differences in horizontal collaboration or collaboration with consulting companies. The effect that foreign ownership causes reduced collaboration within the national science system stems from its impact on the companies likelihood to cooperate with Austrian universities for innovation. The likelihood to collaborate with Austrian governmental or non-profit research institutes seems to be rather unaffected by ownership. The impact foreign-ownership has on vertical innovation

collaboration is supported by a reduced propensity to collaborate with any type of national vertical partner.

The knowledge sourcing for innovation of foreign-owned companies focuses more on group internal sources than on external sources. Information sources from within the corporate group are more used and appreciated among the foreign owned companies than they are among their Austrian owned counterparts. Foreign ownership has an adverse effect on usage of knowledge from external sources. Yet, the sourcing from the science system is not significantly affected by foreign ownership.

The observation that foreign owned firms tend to collaborate less with domestic partners and rely on group internal sources for information rather than on external sources is the first evidence that MNEs follow a **home base exploiting** strategy with their Austrian subsidiaries.

Table 4 reports the effects of foreign ownership on the collaboration behaviour of foreign-owned firms disaggregated for the home countries of the MNEs. German, Liechtenstein and Swiss ownership results in companies reducing their likelihood to collaborate with Austrian suppliers and customers, which is caused by a different collaboration pattern among vertical partners. GLS-owned firms collaborate either with customers or with suppliers; comparable Austrian owned companies, however, collaborate with both types of partners simultaneously.

The overall observation that companies owned by a foreign MNE tend to exert a different collaboration behaviour – a different embeddedness in the national innovation system – is mainly driven by Anglo-Saxon-owned companies and only to lower degree by GLS owned companies. The sample of other European-owned companies does not contribute to this observation. By and large companies which are part of an Anglo-Saxon MNE collaborate less frequently with partners in the Austrian innovation system. This concerns all types of collaboration such as vertical, horizontal or science collaboration at all levels of partners. We also observe that Austrian companies under Anglo-Saxon ownership do not collaborate significantly more frequently with international partners.

By and large international collaboration is neither positively nor negatively affected by the companies' ownership. Only collaboration for innovation with international customers seems to be lower among foreign-owned firms than among their comparable Austrian owned counterparts. This effect is clearly caused by companies owned by German, Liechtenstein or Swiss companies. There we also observe a significantly lower likelihood of collaboration with international customers.

Table 4: Effects of foreign ownership disaggregation on home countries of MNEs

		FO	EU (incl. GLS)	EU (excl. GLS)	GLS	AS
Collaboration in general	co					-
Domestic collaboration	copdom	-	.	.	.	-
Dom vertical coll	coverd	-	.	.	.	-
Dom coll with customers	cocld	-	.	.	-	-
Dom coll with suppliers	cosd	-	.	.	-	-
Dom horizontal coll	cohord	.	.	.	.	-
Dom science coll	coscid	-	.	.	.	-
Dom coll with universities	cound	-	.	.	.	-
Dom coll with gov research	cogd	.	.	.	-	-
Dom coll with consultants	coctd	.	.	.	.	-
International collaboration	copglo	.	.	.	.	.
Int vertical coll	coverg	.	.	.	.	.
Int coll with customers	coclg	-	.	.	-	.
Int coll with suppliers	cosg	.	.	.	.	.
Int horizontal coll	cohorg	.	.	.	.	.
Int science coll	coscig	.	.	.	.	.
Int coll with universities	coung	.	.	.	.	.
Int coll with gov research	cogg	.	.	-	.	.
Int coll with consultants	coctg	.	.	.	.	.
Sourcing of knowledge						
Group internal knowl. sourc.	sgrpa	+	+	+	+	+
Ext. sourcing from companies	sext	-	-	.	-	-
Sourcing from science	ssci	.	.	.	.	-
Sourcing from fairs, exhibit.	sfair	-	-	.	-	-
Internal vs. External sourcing	sintern	+	+	.	+	+

Note '.' indicates no significant effect. '+' indicates a positive effect of public ownership, while '-' denotes a negative effect significant at the 10% level..

Source: own calculations

The sourcing behaviour of foreign-owned firms in Austria shows a rather robust pattern across the country groups. Group internal sources of knowledge are more used and appreciated than external sources of knowledge. The use and appreciation of knowledge from scientific sources is rather unaffected by foreign ownership. Only Anglo-Saxon ownership exerts a negative effect on the sourcing of scientific knowledge.

We find the second hypothesis that the MNE home country matters for external relations only partly supported by the results. It matters for the collaboration with Austrian domestic partners and for knowledge sourcing; it does not matter for the collaboration with international partners, though. Still this finding lends some evidence towards the home base exploiting motive of MNEs economic activities in Austria.

The only evidence we find that would support the hypothesis of homebase augmenting motives is that foreign owned enterprises, in particular the GLS-owned and the European-owned companies do not differ from Austrian-owned companies in their propensity to collaborate with the science sector.

Table 5: Likelihood of foreign and domestic enterprises to enter co-operative arrangements

Type of co-operations	All foreign-owned	Austrian		
All co-operations	0.307	0.355		
Domestic co-operations	0.228	0.333		
International co-operations	0.238	0.249		
Type of co-operations	European (incl GLS)	Austrian	European (without GLS)	Austrian
All co-operations	0.364	0.361	0.400	0.321
Domestic co-operations	0.299	0.339	0.300	0.305
International co-operations	0.273	0.249	0.350	0.207
Type of co-operations	Anglo-Saxon	Austrian	GLS	Austrian
All co-operations	0.125	0.333	0.351	0.374
Domestic co-operations	0.000	0.306	0.298	0.350
International co-operations	0.125	0.247	0.246	0.264

Source: own calculations

Although there is evidence for the Home Base Exploiting strategy is the predominant case, we find also a surprisingly high degree of foreign affiliates to enter into co-operative arrangements. Table 5 shows the likelihood of foreign and domestic enterprises to form research joint ventures. There is indeed a lot of activity, even if it is significantly lower in the case of co-operations domestic partners. This observation points to a certain degree of embeddedness into the Austrian innovation system. Moreover, GLS-owned companies and enterprises owned by MNEs from other European countries (excl. Anglo-Saxon countries) have nearly the same likelihood to co-operate with international partners like Austrian enterprises. This result indicates that these enterprises enjoy a relatively high level of independence in their innovative activities; otherwise, co-operations with partners outside of Austria would have been formed by the affiliate in the country of the partner or by the central R&D department of the parent company itself.

Only the Anglo-Saxon owned companies seem to be the odd man out among the Austrian companies. There is no collaboration activity with Austrian partners of what ever type. Also collaboration with international partners is fairly rare lending even more support to the hypothesis of home base exploiting motive of Anglo-Saxon MNEs in Austria.

To sum up, the results confirm rather the 'Home Base Exploiting' than the 'Home Base Augmenting' view for domestic co-operation. Foreign-owned firms in Austria prefer to rely on MNE internal sources rather than on external knowledge absorbed by formal co-operation or informal channels. We are not surprised about this result, since such a behaviour is predicted by the international business literature: MNEs have some natural disadvantages in foreign markets compared to domestic firms, which may also include their ability to tap into local knowledge. Moreover, theory predicts that MNEs may have a lower incentive to tap into local knowledge, anyway; first, because MNEs may *already* possess knowledge superior to that accessible in the country, second because the transfer of these knowledge from the affiliate to the parent company is not cost-free.

Home country effects

In Table 6 we assess the effects of the home countries on the collaboration and knowledge sourcing behaviour. We ask, given the foreign ownership, whether Anglo-Saxon or other European ownership has an effect on the behaviour of firms relative to GLS ownership. If the foreign owned companies had not been Anglo-Saxon-owned but GLS-owned they would have collaborated more with any given type of domestic partner. Relative to GLS ownership Anglo-Saxon ownership has a negative effect on the domestic collaboration of foreign owned companies. A negative effect on embeddedness in the national system of innovation results. Other home countries of foreign-owned companies, however, have a positive effect on the companies' propensity to collaborate with domestic vertical partners. It has also a positive effect on the collaboration with governmental research institutes and consulting companies. Assuming that GLS is closest to Austria in terms of language and culture and that the cultural proximity matters in terms of the collaboration and knowledge sourcing we expect a comparable pattern of effects of Anglo-Saxon and other European ownership on foreign owned companies. However, from the analysis we cannot observe a comparable pattern. The pattern of the effects for both types of ownerships are rather dissimilar. From this we are inclined to conclude that if language and culture matter, it does not matter significantly. Rather, we would argue that the Anglo-Saxon style of corporate governance drives the rather dissimilar results for Anglo-Saxon-owned companies.

Table 6: Effects among foreign owned companies

		AS	EU
Collaboration in general	co	-	.
Domestic collaboration	copdom	-	.
Dom vertical coll	coverd	-	+
Dom coll with customers	cocld	-	.
Dom coll with suppliers	cosd	-	.
Dom horizontal coll	cohord	-	.
Dom science coll	coscid	-	.
Dom coll with universities	cound	-	.
Dom coll with gov research	cogd	.	+
Dom coll with consultants	coctd	-	+
International collaboration	copglo	.	.
Int vertical coll	coverg	.	.
Int coll with customers	coclg	.	.
Int coll with suppliers	cosg	.	.
Int horizontal coll	cohorg	.	.
Int science coll	coscig	.	.
Int coll with universities	coung	.	.
Int coll with gov research	cogg	.	.
Int coll with consultants	coctg	.	.
Sourcing of knowledge			
Group internal knowl. sourc.	sgrpa	+	+
Ext. sourcing from companies	sext	.	.
Sourcing from science	ssci	.	.
Sourcing from fairs, exhibit.	sfair	.	.
Internal vs. External sourcing	sintern	.	.

Note '.', indicates no significant effect. '+' indicates a positive effect of public ownership, while '-' denotes a negative effect significant at the 10% level..

Source: own calculations

4 Conclusions

Foreign-owned enterprises still rely to a high degree on knowledge internal to the group and form less co-operative arrangements in the innovation process. 'Home Base Exploiting' seems to be dominant; however, the differences between foreign-owned and domestic firms are small in some cases and we also found a surprisingly high share of foreign affiliates to tap into local knowledge. From a theoretical point, these results indicate that the internal co-ordination of knowledge generation and dissemination may be more complicated than the models in the international business literature suggests. Moreover, the outcome of our analysis is also an indication that foreign affiliates actively and independently contribute to the generation of new knowledge and innovation within the MNE.

With respect to policy, the results suggest that the R&D activities of foreign firms in Western Europe are less mobile than some may fear, simply because they rely to a certain degree on local knowledge and expertise of their host countries. Moreover, we can also expect that domestic organisations benefit from the presence of foreign affiliates since co-operative arrangements usually imply mutual exchange of knowledge and intense contacts increase the probability for spillovers. In this perspective, fears raised in the late 1980's that foreign firms could keep their know-how secret and/or restrict their affiliates to import know-how developed elsewhere, as cited by Sanna-Randaccio and Veugelers (2003, p. 18), do not prove true. In contrast, there seems to be a lively exchange of knowledge between foreign enterprises and domestic and international partners going on.

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Appendix A.

Kernel based matching

To estimate the counterfactual we use a kernel based matching. Kernel based matching estimates the counterfactual situation as a convex combination of all observations in the control group.

$$\tilde{\pi}_i = \sum_{j \in I_A} \lambda_{ij} \pi_j \text{ with } \sum_{j \in I_A} \lambda_{ij} = 1 \text{ and } i \in I_F$$

where we denote the estimated counterfactual of the observation i by $\tilde{\pi}_i$. The index set of foreign (Austrian) owned observations is denoted $I_{F(A)}$. As the counterfactual is estimated using the entire group of Austrian owned units we perform a non-parametric regression to determine the weight λ_{ij} . The weights are specified as

$$\lambda_{ij} = \frac{K(d_{ij})/h}{\sum_{k \in I_o} K(d_{ik})/h} \quad i \in I_F; j \in I_A$$

where $K(d_{ij})$ is a kernel function which monotonically decreases in d_{ij} . As d_{ij} is the distance between observation i and observation j , $K(d_{ij})$ downweights observations j that are further away from observation i . Due to the dimensionality $k > 1$ of \mathbf{x} we use the Mahalanobis metric to measure d_{ij}

$$d_{ij} = (\mathbf{x}_i - \mathbf{x}_j)^t \Omega^{-1} (\mathbf{x}_i - \mathbf{x}_j)$$

where \mathbf{x}_i is the vector of the relevant exogenous characteristics. We use the Gaussian kernel:

$$K(d_{ij}) = (2\pi)^{-0.5} e^{-0.5(d_{ij}/h)^2}$$

We choose the bandwidth h according to Silverman's rule of thumb:

$$h = k(0.9n^{-0.2})^2$$

where n is the number of observations and $k > 1$ is the dimensions of the \mathbf{x} .

Regression on group membership and foreign ownership

Table 7 displays the results of the Heckman probit regression regression taking account of the fact that only firms which are part of a corporate group can by definition be foreign owned. The propensity scores to be used as matching criteria are computed from this Heckman probit regression. In the Heckman probit we use several firm-specific as well as sector-specific exogeneous variables: *ORCH*⁸ as an indicator for organizational change within the company, *EMPL* and *EMPL (squared)* as size variables for the number of employees and the squared employees, and *INVEST* as the company's investment expenditure. The sector specific-variables are *SEHT*, *SEMLT*, *SEKIS* and *SEOS* which refer to the sectoral affiliation, appropriability conditions (*APPRCOND*), innovation dynamics (*SPEED*) and the export orientation of the sector (*SECEXHSR*) which relate to 2-digit NACE sectors

Table 7 Bivariate probit regression

⁸ Organizational change is only used in the group membership equation of the Heckman probit.

Dependent	FOROWN			GP		
Variable	Coef.	Std.Err.	Sig.	Coef.	Std.Err.	Sig.
ORCH	-	-		0.252	0.075	***
EMPL	0.381	0.227	*	2.178	0.239	***
EMPL ²	-0.063	0.046		-0.280	0.042	***
INVEST	-0.131	0.229		0.122	0.173	
SEHT	0.400	0.349		1.042	0.399	***
SEMLT	-0.083	0.221		0.450	0.157	***
SEKIS	0.957	0.272	***	2.046	0.187	***
SEOS	1.018	0.194	***	0.604	0.135	***
APPRCOND	0.242	0.236		0.586	0.195	***
SECEXSHR	1.845	0.276	***	1.138	0.200	***
SPEED	0.333	0.328		-0.763	0.260	***
CONST	-2.833	0.449	***	-1.975	0.332	***
Wald	81.74	***		LR	5.82	**
Note: * (**, ***) indicates significance at the 5%, (1%, 0.1%) level. The likelihood ratio test rejects the correlation coefficient ρ to be zero at the 1% level.						

Quality of the matching

The quality of the matching is assessed on the basis of how good size of the company, its share of highly educated employees, its export share, its appreciation of formal and strategic protection mechanisms, its sectoral affiliation can jointly explain foreign ownership vs. domestic ownership. XX shows that before matching foreign ownership vs. domestic ownership can be jointly explained by the exogenous company characteristics. After the matching the joint explanatory power vanishes. The matching succeeded in removing the selection bias.

Variables in the analysis

Company characteristics

Organizational change	dummy	Company has undergone organizational change
Size of the company Size of the company (squared)		Size of the company measured by the number of employees in 1,000.
Investment		Gross investment in tangible goods (acquisition of machinery, equipment, buildings and land) relative to sales of the company.
High technology manufacturing sector	dummy	Company's major activity is in a high technology or medium high technology manufacturing sector.
Medium low technology manufacturing sector	dummy	Company's major activity is in a medium low technology manufacturing sector
Knowledge intensive services	dummy	Company's major activity is in a knowledge intensive service sector
Other services	dummy	Company's major activity is in an other service sector
Appropriability conditions ¹		Relevance of competitors knowledge for own innovation. Average across the 2-digit sectors.
Openness of the sector ¹		Export share of the sectors sales
Innovation dynamic ¹		Share of product innovations in the sector that are new to the market

Innovation behaviour

Innovation activity	dummy	Company has commercialized a product innovation, introduced a process innovation or have conducted innovation activities..
Innov input	innovexp	Innovation expenditure relative to company's sales.
Innov output	innoprod	Sales generated by new products per employee.
Labor productivity	lprod	Sales per employee.

Collaboration behavior²

Collaboration	dummy	Company has collaborated for innovation with any partner,
Domestic collaboration	dummy	Company has collaborated for innovation with any domestic partner.
Dom vertical coll	dummy	Company has collaborated for innovation with Austrian suppliers or with customers and clients.
Dom coll with customers	dummy	Company has collaborated for innovation with Austrian customers and clients
Dom coll with suppliers	dummy	Company has collaborated for innovation with Austrian suppliers
Dom horizontal coll	dummy	Company has collaborated for innovation with Austrian competitors
Dom science coll	dummy	Company has collaborated for innovation with any Austrian science institution.
Dom coll with universities	dummy	Company has collaborated for innovation with Austrian universities.
Dom coll with gov research	dummy	Company has collaborated for innovation with Austrian governmental or non-profit research institutes.
Dom coll with consultants	dummy	Company has collaborated for innovation with Austrian consulting companies.
International collaboration	dummy	Company has collaborated for innovation with any international partner
Int vertical coll	dummy	Company has collaborated for innovation with international suppliers, customers and clients.
Int coll with customers	dummy	Company has collaborated for innovation with international customers and clients
Int coll with suppliers	dummy	Company has collaborated for innovation with international suppliers.
Int horizontal coll	dummy	Company has collaborated for innovation with international competitors

Int science coll	dummy	Company has collaborated for innovation with international scientific institutions
Int coll with universities	dummy	Company has collaborated for innovation with international universities.
Int coll with gov research	dummy	Company has collaborated for innovation with international governmental or non-profit research institutes
Int coll with consultants	dummy	Company has collaborated for innovation with international consulting companies

Knowledge sourcing

Group internal kn.src. appr	dummy	Company used and appreciated knowledge from within the corporate group to suggest new innovation projects or to implement existing projects..
External sourcing from comp	dummy	Company used and appreciated knowledge from other companies to suggest new innovation projects or to implement existing projects
Sourcing from science	dummy	Company used and appreciated knowledge from within the science system to suggest new innovation project or to implement existing projects
Sourcing from fairs, exhib	dummy	Company used and appreciated knowledge fairs, exhibitions and conferences to suggest new innovation project or to implement existing projects
Internal vs. External sourcing	dummy	Company used and appreciated knowledge sources from within the corporate group to suggest new innovation project or to implement existing projects but DID NOT use and appreciate knowledge from outside the corporate group.

Verteiler

01 – 05	Erste Zeile
06 – 10	Beiratsmitglieder
11	Belegsexemplar

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