The Impact of Subsidiary Autonomy on Reverse Knowledge Transfer: Moving from Single to Interdependent Explanations

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Abstract

In response to an increased need of balancing pressures for global integration and local responsiveness, foreign subsidiaries are demanded to play a prominent role in creating knowledge, valuable for the MNE as a whole. In this context, a key managerial problem pertains to the balance between subsidiary autonomy—necessary to foster local innovation—and effective knowledge flows from the subsidiary to the parent company; i.e. reverse knowledge transfer. We argue that in order to understand the interdependences between subsidiary autonomy and the use of different vertical linkages—e.g. person-based and electronic-based mechanisms—it is crucial to put forward new insights pertaining to the impact of subsidiary autonomy on reverse knowledge transfer. Using a data set consisting of about 300 dyads between foreign subsidiaries and their parent companies, we find that two distinctive configurations positively affect the extent of knowledge transfer from foreign subsidiaries to their parent companies. The first is the combination of a high degree of subsidiary autonomy and greater use of person-based mechanisms, and the second is the combination of low subsidiary autonomy and greater use of electronic-based mechanisms.

Key words: reverse knowledge transfer, person-based mechanisms, electronic-based mechanisms, subsidiary autonomy

INTRODUCTION

The international management literature highlights foreign subsidiaries' ability of creating, developing and integrating knowledge by means of both their internal and external networks (Andersson, et al., 2002, Phene & Almeida, 2008, Zanfei, 2000). Drawing upon the existing knowledge pool in the local environment (Almeida, 1996, Frost, 1998), foreign subsidiaries play a prominent role in MNE innovation (Iwasa & Odagiri, 2004, Subramaniam & Venkatraman, 2001, Venaik, et al., 2005, Yamin &

Forsgren, 2006) and contribute directly to enhance the MNE strategic competitive advantage (Ambos, et al., 2006, Bartlett & Ghoshal, 1989, Cantwell, 1995). Given this importance of the subsidiaries to the MNE competitiveness, researchers are increasingly examining how intra-MNE transfer of knowledge is likely to significantly influence the value these firms can create and appropriate (Bresman, et al., 1999, Gupta & Govindarajan, 2000, Kogut & Zander, 1993, Schulz, 2001, Tsai, 2001).

The governance of knowledge flows from the foreign subsidiary to its parent company (i.e. reverse knowledge transfer) is one of the areas of intra-MNE knowledge transfer that has recently received attention (Ambos, et al., 2006, Frost & Zhou, 2005, Ghoshal, et al., 1994, Gupta & Govindarajan, 2000, Håkanson & Nobel, 2001, 2000, Yang, et al., 2008). There are different reasons why parent companies might benefit from knowledge transferred from their foreign subsidiaries. Parent companies can use subsidiary knowledge to better coordinate a global strategy, to improve the development of new products, technologies or services (Ambos, et al., 2006), to control and monitor subsidiaries' power (Yamin & Forsgren, 2006). Parent companies might also play a role in channeling knowledge to the appropriate MNE unit, orchestrating knowledge transfer processes in their own network (Criscuolo & Narula, 2007, Phene & Almeida, 2008).

Theoretically and empirically it has been shown that a subsidiary's ability to create and develop knowledge is achieved by granting higher degrees of autonomy to the foreign unit (Ghoshal & Nohria, 1989, Gupta & Govindarajan, 1991, Nohria & Ghoshal, 1994, Persaud, 2005, Taggart & Hood, 1999, Venaik, et al., 2005). However, the literature has also highlighted that under conditions of high autonomy, a subsidiary's knowledge may become more context specific (Andersson, et al., 2002, Phene & Almeida, 2008), and pressures for local control of exclusive knowledge might rise (Mudambi & Navarra, 2004). In addition, the connection to the parent company can decrease (Andersson & Forsgren, 2000). Accordingly, on the one hand, high autonomy is assumed to be a prerequisite for a subsidiary's knowledge development, but, on the other hand, it is expected to inhibit the extent of reverse knowledge transfer. This seems in line with earlier empirical findings showing little consensus on the effect of subsidiary autonomy on reverse knowledge transfer (Gammelgaard, et al., 2004, Ghoshal, et al., 1994, Schulz, 2001). In view of

that, we first argue that a key managerial problem pertains to the understanding of the balance between subsidiary autonomy—necessary to foster local innovation—and effective reverse knowledge transfer—indispensable for the parent company to capture and benefit from its foreign subsidiaries' knowledge.

The choice of vertical linkages maintained between the subsidiary and parent company has been recognized to be very important in understanding the knowledge transfer phenomena within MNEs (Almeida, et al., 2002, Ambos & Ambos, 2009, Björkman, et al., 2004, Chini, 2004, Ghoshal, et al., 1994, Gupta & Govindarajan, 2000, Hansen, et al., 1999, Persaud, 2005, Schulz, 2001, Tsai, 2002). Essentially, two types of linkages have been identified: *person*-based and *electronic*-based mechanisms (Ambos & Ambos, 2009, Haas & Hansen, 2005, Hansen, et al., 1999, Persaud, 2005). We expect to confirm and extend on previous findings, observing a positive direct effect of both person- and electronic-based mechanisms on reverse knowledge transfer. However, we also argue that considering the two types of linkages has important implications for understanding the balance between subsidiary autonomy and effective reverse knowledge transfer. Accordingly, departing from the distinct logic and characteristics of the two groups of linkages (Daft & Lengel, 1986), we analyze the extent to which subsidiary autonomy and person- and electronic-based mechanisms are interdependent in explaining reverse knowledge transfer. In other words, we argue that in order to comprehend the balance between subsidiary autonomy and effective reverse knowledge transfer we cannot neglect the prominent role played by the vertical linkages.

As we limit our discussion to the extent of reverse knowledge transfer, the unit of analysis is a dyad involving a focal foreign subsidiary and its parent company. Our primary concern in this paper is the extent to which parent companies acquire and use knowledge from their overseas subsidiaries, with knowledge defined as "either expertise (e.g., skills and capabilities) or external market data of strategic value." (Gupta & Govindarajan, 1991, p. 773).

Based on 299 parent company-foreign subsidiary dyads, we find that subsidiary autonomy shows a significant impact on reverse knowledge transfer only after controlling for its interdependence with the two different communication mechanisms. Moreover, two distinctive configurations positively affect the

extent of knowledge transfer from foreign subsidiaries to their parent companies. The first is the combination of a high degree of subsidiary autonomy and the use of person-based mechanisms, and the second is the combination of low subsidiary autonomy and the use of electronic-based mechanisms.

LITERATURE REVIEW AND THEORY DEVELOPMENT

Reverse Knowledge Transfer and Subsidiary Autonomy

A greater degree of autonomy is often considered positively related with subsidiaries' knowledge creation and development (Ghoshal & Nohria, 1989, Gupta & Govindarajan, 1991, Nohria & Ghoshal, 1994, Persaud, 2005, Venaik, et al., 2005), based on the idea that independent subsidiaries have strategic mandates (Birkinshaw, et al., 1998) that favor local responsiveness (Bartlett & Ghoshal, 1989) and knowledge development by tapping into local knowledge bases (Andersson, et al., 2002, Cantwell, 1995, Zanfei, 2000). Although opposite results have also been found (Brockhoff & Schmaul, 1996, Frost, et al., 2002), management scholars tend to agree on the idea that the autonomy solution enhances the subsidiary's ability to learn from the local system of innovation and allows the MNE to benefit from new knowledge developed by independent subsidiaries (Cantwell & Mudambi, 2005, Foss & Pedersen, 2002, Nobel & Birkinshaw, 1998, Taggart & Hood, 1999). Further, when a subsidiary's ability to create and develop new knowledge increases, it is obviously more likely that the subsidiary owns valuable knowledge for the parent company and for the MNE as a whole (Cantwell & Mudambi, 2005). This would suggest that subsidiaries with a higher degree of autonomy are more likely to transfer knowledge to the other MNE units (Foss & Pedersen, 2002, Ghoshal, et al., 1994, Tsai, 2002).

Nevertheless, the subsidiaries' ability to create and develop new knowledge may inhibit reverse knowledge transfer. First, the creation and development of new knowledge by foreign subsidiaries might be based on intensive information and knowledge exchange with local organizations that leads to more context specific and complex knowledge (Andersson, et al., 2002). Under these conditions, it will be more difficult to apply the subsidiary knowledge in the parent company. Second, high level of subsidiary autonomy are often coupled with high levels of internal competition, for instance for resource allocation.

Competitive units will, in fact, react negatively (i.e. less innovative effort) toward tight control by the parent company, as they may suspect that the center will sacrifice some units' interests and make decisions in favor of other units (Tsai, 2002). When subsidiaries are exposed to major internal competition and when knowledge is a crucial source of their competitive advantage (Birkinshaw & Hood, 1998), subsidiaries may choose to make the knowledge they control excludable and they will be prevented from engaging in reverse knowledge transfer (Foss & Pedersen, 2002, Gupta & Govindarajan, 2000, Mudambi & Navarra, 2004). Finally, when foreign activities receive greater autonomy to increase their connections with the external research community, thereby increasing their own knowledge, a lack of balance between internal and external linkages may be induced, generating an autonomy-control tension with the parent company as well as with the other units (Asakawa, 1996, 2001). Hence, when a too high level of autonomy is granted to the subsidiary, the connections and dependency between the parent company and the subsidiary might decrease, and reciprocal trust can be reduced, thus diminishing the transfer of knowledge to the other units of the MNE (Forsgren, et al., 2000, Gammelgaard, et al., 2004). In line with the previous considerations we expect that:

> Hypothesis 1a: A parent company will transfer more knowledge from a foreign subsidiary that has a lower level of autonomy than from one that has a higher level of autonomy.

Knowledge Transfer Mechanisms

The strategic management research concerning the processes through which knowledge is transferred within MNEs and factors affecting such transfers has grown dramatically in the last decade (Bartlett & Ghoshal, 1989, Björkman, et al., 2004, Bresman, et al., 1999, Chini, 2004, Foss & Pedersen, 2002, Frost, 1998, Gupta & Govindarajan, 2000, Minbaeva, 2007, Mudambi, 2002, Schulz, 2001, Singh, 2005, Szulanski, 1996, Tsai, 2001). The conventional literature on intra-MNE knowledge transfer deals extensively with knowledge flows from the parent company to the subsidiaries. However, more recently we observed an increased attention towards the analysis of reverse knowledge transfers (Ambos, et al., 2006, Frost, 1998, Frost & Zhou, 2005, Gupta & Govindarajan, 2000, 2001, Håkanson & Nobel, 2000,

Yang, et al., 2008). This recent trend is in line with a greater recognition that also foreign subsidiaries can be sources of primary innovations (Birkinshaw, et al., 1998, Papanastassiou & Pearce, 1997, Pearce & Papanastassiou, 1999) that can be transferred to and used by their parent companies, contributing to the creation of the firm's competitive advantage (Ambos, et al., 2006).

In this context, the literature has highlighted that the use of vertical linkages between parent company and foreign subsidiary plays an important role on the extent of intra-MNE knowledge transfer. Fundamentally, two types of linkages can be identified: *person*-based and *electronic*-based mechanisms (Ambos & Ambos, 2009, Haas & Hansen, 2005, Hansen, et al., 1999).

A vast bulk of the literature has focused on the impact of formal and informal person-based relationships on knowledge transfer (Björkman, et al., 2004, Gupta & Govindarajan, 2000, Schulz, 2001, Singh, 2005, Tsai, 2002). Researchers have suggested that successful development of relations between individuals from two distinct units of an MNE would facilitate the transfer of knowledge within the MNE (Bartlett & Ghoshal, 1989, Kostova, 1999, Nonaka & Takeuchi, 1995). Accordingly, Nohria and Ghoshal (1997) conceptualized the idea that an MNE is a bunch of interpersonal ties that hold the differentiated and geographically dispersed MNE's units all together. The interpersonal network makes knowledge exchange possible between interconnected units. Specifically, inter-unit trips and visits, international committees, teams, task forces, and training involving participants from multiple units, facilitate the MNE integration and favor knowledge transfer (Björkman, et al., 2004, Bresman, et al., 1999, Chini, 2004, Ghoshal, et al., 1994, Gupta & Govindarajan, 2000, Hansen, 1999, Nobel & Birkinshaw, 1998, Tsai, 2001).

Consensus also exists on the role played by mechanisms based on the electronic media in the international transfer of knowledge (Almeida, et al., 2003, Almeida, et al., 2002, Ambos & Ambos, 2009, Andersen & Foss, 2005). Specifically, electronic communication systems, from electronic mail to more sophisticated systems, enable communication among managers of different units and the sharing of different types of documents (DeSanctis & Fulk, 1999, Niederman, 2005, Persaud, 2005, Sambharya, et al., 2005). Information systems are designed to support and augment organizational knowledge

management and need to complement and enhance the communication ability of the firm (Alavi & Leidner, 2001). While not all knowledge management strategies—in particular person-based strategies—involve a wide implementation of information and communication technology (ICT), many knowledge management initiatives rely on ICT as an important enabler (Haas & Hansen, 2005).

The impact of both person- and electronic-base mechanisms on reverse knowledge transfer has been explicitly investigated by a few studies. To our knowledge, only Ambos and Ambos (2009) have analyzed the impact of both the two groups of mechanisms on knowledge flows from a foreign subsidiary to headquarters or other MNE units. Although their study adds a lot to our understanding, they do not distinguish the knowledge transfer mechanisms' effects among the two types of reverse knowledge transfer: the one where the parent company is the knowledge recipient and the one where the recipient is another subsidiary. On the other hand, other studies that have previously analyzed the impact of person-based mechanisms on reverse knowledge transfer (Frost & Zhou, 2005, Ghoshal, et al., 1994, Gupta & Govindarajan, 2000, Schulz, 2001) did not consider the impact of electronic media.

In line with the theoretical and empirical findings of the impact of person- and electronic-based mechanisms on intra-MNE knowledge transfer, we expect that when reverse knowledge transfer in concerned, the following hypotheses should hold:

> Hypothesis 1b: A parent company will transfer more knowledge from a foreign subsidiary which uses a higher level of person-based mechanisms than from one which uses a lower level of such mechanisms.
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> Hypothesis 1c: A parent company will transfer more knowledge from a foreign subsidiary which uses a higher level of electronic-based mechanisms than from one with which uses a lower level of such mechanisms.

The Moderating Effect of Knowledge Transfer Mechanisms on Subsidiary Autonomy

So far we have argued that higher degrees of subsidiary autonomy will reduce the extent of reverse knowledge transfer due to the increasing context specificity and complexity of subsidiary knowledge, the

potential existence of forces pushing versus excludable control of knowledge, the decreasing connection with and dependency to the parent company. These arguments raise the issue of whether the extensive use of specific knowledge transfer mechanisms under conditions of high levels of subsidiary autonomy might moderate its effect on reverse knowledge transfer. Since the literature has highlighted two major groups of communication mechanisms—person-based and electronic-based—in the following we will look at each of the two groups in turn.

Person-based communication. There are three mechanisms that can explain how the use of person-based communication can positively moderate the impact of subsidiary autonomy on reverse knowledge transfer, namely a cognitive, motivational and a social mechanism.

The first and most straightforward mechanism is the cognitive one. When subsidiary knowledge becomes more complex and tacit, the use of richer information transmission channels, i.e. person-based mechanisms, will be preferred due to their better capacity of transferring complex and tacit knowledge (Daft & Lengel, 1986, Gupta & Govindarajan, 1991). Using patent citation data, Singh (2005) finds a greater probability of knowledge flows within a firm when inventors have close interpersonal ties. Moreover, recent research on search for innovation emphasizes that the mobility of individuals is not only an opportunity to transfer own expertise, but also to facilitate the interpretation of this knowledge in a new context (Rosenkopf & Almeida, 2003).

As far as the motivational mechanism is concerned, it can be noted that person-based mechanisms may overcome the negative impact of autonomy on reverse knowledge transfer because they stimulate intrinsic motivation. It has been observed that a higher level of subsidiary autonomy will increase the motivation and the initiatives that a unit can take in intra-group knowledge exchange (Tsai, 2002). Recent studies argue that employees' intrinsic motivation has a positive effect on knowledge transfer (Bock, et al., 2005, Cabrera, et al., 2006, Mudambi, et al., 2007, Osterloh & Frey, 2000), while the extrinsic motivational disposition of a source unit to transfer its knowledge does not affect intra-MNE knowledge transfer (Gupta & Govindarajan, 2000). Furthermore, intrinsic motivation fosters participation and personal relationships among employees because their perceived self-determination is raised and

psychological contracts are established: the so-called "team spirit" is enabled (Osterloh & Frey, 2000). Therefore, in organizations that adopt person-based mechanisms more strongly, it is more likely that employees exploit their analytic and creative skills by working on unique business problems (Amabile, 1997), and they are more likely to share complex and tacit knowledge (Hansen, et al., 1999, Osterloh & Frey, 2000). Accordingly, a high subsidiary autonomy that favors individuals' intrinsic motivation (Mudambi, et al., 2007) will match the transfer of complex knowledge from subsidiaries to parent companies through person-based mechanisms.

Finally, there is the social control mechanism (O'Donnell, 2000, Ouchi, 1980). Socialization models of organizational control discuss the use of training, teamwork and other person-based mechanisms to disseminate the mission, goals, values and cultures of organizations to workers to transcend their varied interests and align their goals with the values of the organization (Johnson & Medcof, 2007, O'Donnell, 2000). The direct impact of socialization on knowledge transfer appears quite univocal: shared values and identity facilitate meaningful communication that is essential in knowledge transfers (Nahapiet & Ghoshal, 1998).[1] Nevertheless, we also expect socialization mechanisms to positively moderate the negative effect of subsidiary autonomy on reverse knowledge transfer in presence of internal competition or autonomy-control tension. On the one hand, more person-based mechanisms that create socialization interactions will positively affect knowledge transfer among competing organizational units because of their strong incentive to understand what the other competitor units are doing (Tsai, 2002). On the other hand, higher levels of socialization will stimulate the formation of convergent interests, the sharing of beliefs, common values and norms between managers of different units (Tsai & Ghoshal, 1998), and, therefore, the parent-subsidiary tension will be reduced (Jaeger & Baliga, 1985). Accordingly, the extensive use of a person-based communication in the parent company-

[1] It should be observed that the literature seems to disagree on the ultimate effect of socialization on foreign subsidiary ability of augmenting its capabilities. For instance, Ambos and Reitsperger (2004) find a negative relationship between high socialization and the technical success of centers of excellence abroad. However, when other control modes are taken into account, the results show that higher levels of socialization combined with lower levels of formalization and centralization positively affect subsidiary initiatives to develop and create new knowledge (Nobel & Birkinshaw, 1998).

subsidiary relationship will enhance trust and a shared vision within the MNE, also under conditions of internal competition or high autonomy-control tension. Thus, also from a socialization perspective, the combination of subsidiary autonomy and a higher use of person-based mechanisms will be positively related to the extent of reverse knowledge transfer. Based on the above considerations, the following hypothesis is formulated:

> Hypotesis 2: A parent company will transfer more knowledge from a foreign subsidiary that has a higher level of autonomy and which uses a higher level of person-based mechanisms than from one that has higher level of autonomy but uses a lower level of such mechanisms.

Electronic-based communication. As mentioned above, empirical consensus exists on the role played by electronic-based mechanisms in intra-MNE knowledge transfer. In particular, electronic tools are effective for transferring standard data and well understood messages and information, while their limitations are revealed when less codified knowledge has to be transferred (Daft & Lengel, 1986, Pedersen, et al., 2003). Indeed, the adoption of electronic-based mechanisms requires firms to develop 'knowledge objects' (Hansen, et al., 1999, Zack, 1999), that is, knowledge that can be viewed as a thing to be stored and manipulated. Such knowledge is collected mostly in databases, reports, or handbooks through a "people-to-documents" process, and it can be accessed and used relatively easily by anyone in the company (among others see, Hansen, et al., 1999, Zollo & Winter, 2002). Accordingly, the effective transfer of tacit knowledge through electronic-based mechanisms will also be possible in many cases, but only after the application of a specific codification strategy that involves the transformation of tacit knowledge into explicit knowledge (Schulz & Jobe, 2001).

Recent literature has shown that electronic-based mechanisms reduce knowledge heterogeneity and promote exploitation learning (Kane & Alavi, 2007), such as incremental learning focused on refinement, and reuse of existing knowledge (March, 1991). It has also been observed that organizations that experience minor environmental turbulence will benefit from electronic-based mechanisms (Kane & Alavi, 2007), while organizations might abstain from codifying their knowledge if the costs of the process

exceed the benefits. These considerations lead to the following implications when electronic-based mechanisms are used in combination with different degree of subsidiary autonomy.

First, the literature suggests that low levels of subsidiary autonomy reflect specific characteristics of the subsidiaries such as a low level of R&D activities and a greater involvement in adaptation of manufacturing technology and marketing decisions for the local environment (Taggart, 1997). Accordingly, subsidiary knowledge is likely to partially overlap with extant knowledge of the parent company. In other words, low levels of subsidiary autonomy are more likely where subsidiaries are expected to face environments of relatively low complexity (Ghoshal & Nohria, 1989) and where their knowledge is mainly explicit or codifiable in a cost-efficient manner (Schulz & Jobe, 2001). Under these conditions, the transfer of knowledge from subsidiaries to parent companies through electronic-based mechanisms is expected to be efficient. Therefore, we might expect to observe a positive impact on reverse knowledge transfer when a low degree of subsidiary autonomy is combined with a greater use of electronic-based mechanisms within the parent-subsidiary relationship.

Conversely, high degrees of subsidiary autonomy are more likely in subsidiaries which generally face complex knowledge and more a turbulent environment (Cantwell & Mudambi, 2005, Gupta & Govindarajan, 1991). Greater autonomy will motivate subsidiary managers in taking initiatives and innovate (Ghoshal & Bartlett, 1988, Venaik, et al., 2005), often taking advantage from tight links with local suppliers, customers and research institutions (Andersson & Forsgren, 2000, Andersson, et al., 2002). However, as we already explained, under these circumstances the resulting knowledge might be more contexts specific and complex. In this context, in order to use electronic-based mechanisms, knowledge will require to be processed and codified before the transfer (Schulz & Jobe, 2001) or knowledge flows will be subjected to transmission losses (Daft & Lengel, 1986, Shannon & Weaver, 1998, Szulanski, 1996). Nevertheless, codification strategies involve considerable costs of creating and maintaining repositories of organizational knowledge (Hansen, et al., 1999, Schulz & Jobe, 2001). To make sure that the codification process works efficiently, organizations have to invest a lot to create an integrate electronic repository, have comparable formats, and design a customized and common taxonomy

(Weiss, et al., 2004). Only if standardization, communalities, and compatible ICT systems are well spread and maintained over some time horizon among the units, will MNEs be able to achieve efficient knowledge transfer when using electronic-based communication. The management information systems literature has suggested that a decentralized MNE will be more likely to pursue independent ICT operations in each subsidiary (Jarvenpaa & Ives, 1993). A high level of corporate standards may, moreover, be perceived as intrusive from local managers with a high degree of autonomy in decision making (Karimi & Konsynski, 1991). Based on the above considerations when subsidiaries have high degrees of autonomy a greater use of electronic-based mechanisms within the parent-subsidiary relationship is likely to be inefficient. Accordingly, we suggest the following hypothesis:

> Hypothesis 3: A parent company will transfer more knowledge from a foreign subsidiary that has a lower level of autonomy and which uses a higher level of electronic-based mechanisms than from one that has a lower autonomy but uses a lower level of such mechanisms.

METHOD

Sample and Data Collection

As our study concerns the impact of the organizational structure on the extent of knowledge transfer from a focal foreign subsidiary to its parent company, we consider the dyad of a focal foreign subsidiary and its parent company as the unit of analysis. Using this dyadic approach, we created a dataset of 299 observations.

Our sample selection was guided by the following criteria. First, we generated the sample frame from the Reprint database (Mariotti & Mutinelli, 2005), which contains census data on the foreign activities of the Italian firms as of the beginning of 2004. Second, we limited the sample frame to the population of all Italian MNEs with more than 50 employees, operating in manufacturing industries, and with at least one majority-owned subsidiary located in advanced countries and involved in "primary upstream activities" such as R&D and manufacturing. The final sample frame consists of a total of 358 Italian MNEs, out of which 84 were studied through on-site face-to-face structured interviews with the

parent company's top managers (response rate of about 24 percent). Five of these MNEs also served as sites for the pre-testing and refinement of the questionnaire.

Data collection took place from December 2004 to July 2005 and involved six researchers. All parent companies' top managers were contacted by phone and asked for a face-to-face interview. At the same time a personalized letter with a description of the project and assurances regarding the confidentiality of collected data was sent to them. The interviews ranged from one to three hours in length; however, for most of the parent companies with more then five subsidiaries (20% of the sample), we were able to obtain longer interviews, sometimes based on two-day meetings. For each of the 84 MNEs we collected data regarding the dyadic relationships of the parent company with each of its majority-owned foreign subsidiaries involved at least in some kind of upstream activities.

Measures

Reverse Knowledge Transfer. It is the dependent variable of this study and is operationalized by the degree of use of the foreign subsidiary's knowledge as perceived by the parent company (Minbaeva, et al., 2003). Following Gupta and Govindarajan (1991), we define knowledge flows as the transfer of either skills and capabilities (i.e. expertise) or external market information of strategic value, such as globally relevant information about key customers, competitors, or suppliers, from the foreign subsidiary to its parent company. Using open questions, informants were first asked to provide descriptions on the subsidiary's expertise regarding products, technologies, and primary activities (Schulz, 2001). Next, structured questions were posed, focusing on whether the identified subsidiary's knowledge pertaining to the above three domains was transferred to, and used by, the parent company. Examples of these questions are: has the subsidiary's technology that you described been transferred to and used by the parent company? Have the specific subsidiary's competences that you described been transferred to and used by the parent company? Finally, the respondents were asked to aggregate the subsidiary's knowledge across the identified domains and indicate the intensity of the knowledge transfer from the subsidiary to the parent company ('null', 0; "low," 1; "medium," 2; "high," 3). Based on this last answer, we define the

dependent variable *reverse knowledge transfer*, ranging from 0 (no transfer at all), to 3 (high transfer). Therefore, transfers were assessed from the receiving unit's perspective, i.e. the parent company. In line with Lord and Ranft (2000, p. 582), "this was done primarily because to try to measure knowledge transfer from the sender's perspective is inherently problematic – e.g., knowledge that is 'sent' is not always 'received' (Szulanski, 1996)."

Subsidiary Autonomy. The measure of subsidiary autonomy is essentially based on questions originally developed by Ghoshal and Nohria (1989). Specifically, we know at which MNE level each of the following four firm's strategic decisions are taken: (i) definition of R&D projects, planning, resources, etc.; (ii) introduction of new technologies; (iii) changes in products/services; and (iv) hiring and firing of the subsidiary workforce. The following scale was used: (1) 'the parent company decides alone'; (2) 'the parent company decides but considers subsidiary inputs'; (3) 'both parent company and subsidiary have roughly equal influence on decisions'; (4) 'the subsidiary decides, but considers parent company suggestions'; and (5) 'the subsidiary decides alone' (Ghoshal, et al., 1994, Ghoshal & Nohria, 1989). The final measure of *subsidiary autonomy* is the average of responses to the four items (Cronbach's alpha = 0.74).

Person- and electronic-based mechanisms. Inter-unit trips and visits, international committees, teams, task forces, and training involving participants from multiple units have been found to facilitate MNE integration and favor knowledge transfer (Björkman, et al., 2004, Bresman, et al., 1999, Chini, 2004, Ghoshal, et al., 1994, Gupta & Govindarajan, 2000, Håkanson & Nobel, 2001, Hansen, 1999, Nobel & Birkinshaw, 1998, Schulz, 2001, Tsai, 2001, 2002). Accordingly, to capture parent-subsidiary communication based on personal ties we focus on teamwork involving people from both the foreign subsidiary and the parent company, and the temporary (short-term) transfer of managers and/or scientific and technical staff (researchers, engineers, etc.) within the parent-subsidiary dyad. As regards short-term transfer, the respondents were asked to consider the movement of people other than people visiting for only one or a few days or expatriates. Respondents were asked to assess the intensity of the use of the

three person-based mechanisms on a 7-point Likert scale, from 'used rarely' to 'used very often'. The final measure of *person-based* is the average of responses to the three items (Cronbach alpha = 0.72).

We capture electronic based communication by the intensity of the use of internet instruments, such as forums, newsletters, e-mails, instant messages, etc., and the sharing of documents like handbooks, blueprints, databases, in the parent-subsidiary relationship (Pedersen, et al., 2003, Persaud, 2005). Based on a 7-point Likert scale, from 'used rarely' to 'used very often', the final measure of *electronic-based* is the average of responses to the two items (Cronbach's alpha = 0.60).[2]

Interaction Effects. To capture the combined effect of using a specific type of vertical linkages under different degrees of subsidiary autonomy, we follow previous works (Birkinshaw, et al., 2002, Schoonhoven, 1981) in constructing interaction terms between both the two communication mechanisms and the subsidiary autonomy variable. Specifically, we add to the model the following variables: *person-based×subsidiary autonomy* and *electronic-based×subsidiary autonomy*. In order to support our hypotheses, we expect a positive and a negative effect on the extent of reverse knowledge transfer, respectively.

Control Variables. To avoid picking up spurious effects we control for other likely predictors of reverse knowledge transfer. In particular, we operationalize the following variables.

- Degree of sophistication of subsidiary knowledge. We follow Nobel and Birkinshaw (1998) and Ambos and Schlegelmilch (2007) and apply a rather simple heuristic based on the nature of the subsidiary activities. The respondents were asked to indicate whether the focal foreign subsidiary was devoted to 'capability-augmenting' or 'capability-exploiting' activities. The former group's activities are undertaken to create new products and/or new technologies whereas the latter group focuses on activities directed towards significant and/or marginal product/process improvements. Those subsidiaries that are neither

[2] Although the value of 0.7 is often used as a guide for Cronbach's Alpha, Nunnally (1967) recommends a value equal to or greater than 0.60 as the minimum for research purposes. While our results concerning electronic-based communication have to be taken with the necessary caution, we contend that this does not undermine them since key variables with similar values of Cronbach's Alpha have been used successfully in previous knowledge-transfer-related research (among others, see Schulz, 2001, Szulanski, 1996).

capability-augmenting nor capability-exploiting belong to those subsidiaries with *simple knowledge*; those that are capability-exploiting but not capability-augmenting are subsidiaries with *unsophisticated knowledge*, while those that are also capability-augmenting are subsidiaries with *sophisticated knowledge*.

- Entry mode. Although acquisitions and joint ventures have traditionally been seen as a common way for the MNE to access local competencies and skills (Bresman, et al., 1999, Kogut & Zander, 1993, Lane, et al., 2001, Simonin, 1999), empirical studies also found that the incidence of technology transfer from subsidiaries to parent companies is higher for greenfield subsidiaries than for acquisitions (Frost, 1998, Zhou, 2002). Therefore, in order to capture the effects of the entry mode on reverse knowledge transfer, we add to the model the dummy variable *greenfield*.

- Parent-subsidiary distance. The literature has argued that the cost of knowledge transfer increases with the distance between home and host country (Ambos & Ambos, 2009, Yamin & Forsgren, 2006). Accordingly, we control for both the cultural and the geographical distances in the parent-subsidiary dyad. Specifically, we define the variable *cultural distance* measured utilizing Kogut and Singh's (1988) cultural distance index (among the others that have previously adopted this measure, see for instance Ambos, et al., 2006, Håkanson & Nobel, 2001). The variable *geographical distance* is captured by kilometers (thousand of) between Rome – capital city of Italy – and the capital city of the foreign subsidiary's country.

- Foreign investment age. This variable is the difference between 2005 (year when the interviews were conducted) and the year when the subsidiary became a part of the Italian MNE.

- Subsidiary size. We measure the subsidiary size with two variables (Taggart, 1997). The first, *subsidiary sales*, it measures the sales (in million of Euros) of the subsidiary, as in 2004. The second, *relative size*, it is the difference between the natural logarithm of the subsidiary's number of employees and the natural logarithm of the parent company's number of employees, as in 2004.

Testing for Response Bias

To assess non-response bias, we tested whether responding MNEs differ from non-responding MNEs with respect to size (class of number of employees) and sector. The tests indicate that low-tech sectors are underrepresented ($p<0.001$) in our sample (see Table 1). Accordingly, the generalization of our results concerning low-tech industries must be taken with the necessary caution. However, it should be noted that previous findings suggest that firms in low-tech sectors have a much lower tendency to engage in reverse knowledge transfer from their subsidiaries, since foreign technology is generally obtained from outside the firm's boundaries (Brusoni, et al., 2001). This is in line with the information put together during the data collection process: most of the MNEs investing abroad in low-tech sectors declared that they do not consider the possibility to transfer back knowledge from their subsidiaries an important issue. That has curbed their interest in participating in the project.

– INSERT TABLE 1 ABOUT HERE –

The use of perceptual measures introduces the risk of common method bias. To assess common method bias in our sample, we performed the Harman's single-factor test (Harman, 1967, Podsakoff & Organ, 1986) on items included in our econometric model. The factor analysis reveals six factors with eigenvalues greater than one, the first of which (eigenvalue = 3.17) explains 19.82% of the variance. This result indicates that common method bias is not a serious problem.

To rule out possible one-respondent bias, we performed validity response tests on our dependent and independent variables based on perceptual data. In fact, for 62 dyads we were able to collect relevant information not only from the parent company's manager but also from the subsidiaries' top manager. Therefore, we present the Kruskal-Wallis equality of populations rank test that tests the hypothesis that two (or more) samples are from the same population (Brett, et al., 1995, Downey, et al., 1975). In general, the validity tests confirm that the responses from managers at the parent company and at the subsidiary regarding our dependent and independent variables are not significantly different (see Table 2). The only exception concerns the items "temporary transfer of managers" and "temporary transfer of professionals". Specifically, the parent companies perceive a greater number of personnel transfers with their subsidiaries than the foreign subsidiaries perceive. However, this difference is to be expected. Although personnel

transfers may be one-way or two-way (from the parent company to the subsidiary and vice-versa), we know from the interviews that it is mostly a uni-directional movement (from the parent to the subsidiary). Also taking into account that the diffusion of this work practice in the MNE is usually encouraged and formalized by the parent company, it is not surprising that the foreign subsidiaries report using smaller numbers of personnel transfers than their parent companies.

– INSERT TABLE 2 ABOUT HERE –

RESULTS AND DISCUSSION

The summary of the descriptive statistics and correlations for all variables in this study are reported in Table 3. No variables exhibit distribution or correlation problems. Given the ordinal nature of our dependent variable, we estimate ordered probit models. Results from the econometric estimations are reported in Table 4, while the relevant marginal effects are reported in Table 5. We standardized the independent variables by subtracting the mean and dividing by the standard deviation, in order to avoid high correlation between these variables and their interaction terms (Neter, et al., 1990). The dyadic approach raises an issue of possible non-independence among the observations (Greene, 2000). Therefore, using the Stata's cluster option we obtain a robust variance estimate that adjusts for within-cluster correlation (Froot, 1989, Williams, 2000)). In this way we are able to control for the fact that observations (i.e., dyads) belonging to the same MNE are possibly not independent. Three models are presented in Table 4. In Model 1, we enter only the control variables, in Model 2 we add the independent variables, and in Model 3 we insert the interaction terms for testing our moderating hypotheses.

– INSERT TABLE 3 ABOUT HERE –

With respect to the control variables, it is worth observing that in line with the theory, our estimations reveal that the extent of reverse knowledge transfer increases with the increase of the sophistication of subsidiary knowledge. Moreover, as suggested by the positive and significant coefficient of the variable *relative size*, subsidiaries bigger than their parent companies to be involved in greater levels of reverse knowledge transfer.

Turning to the independent variables, we do not find support for hypothesis 1a: in Model 2, the coefficient of *subsidiary autonomy* is not significant. ADD DISCUSSION

Our results support hypotheses 1b and 1c. Both the variables person-based and electronic-based mechanisms are positively related to reverse knowledge transfer. In Model 2, the variable person-based shows a positive and significant coefficient ($p<0.01$) indicating that the circulation of staff internationally generates a greater degree of reverse knowledge transfer. An extensive use of face-to-face mechanisms maximizes the level of interaction with employees of the parent and the subsidiary, offering the greatest opportunity to transfer knowledge through the grafting of individuals with special expertise. An extensive use of electronic-based mechanisms also enhances reverse knowledge transfer, since the coefficient of electronic-based mechanisms is positive and significant at $p<0.1$. When we add the interaction terms to the model (Model 3), it can be observed that the coefficients of person-based and electronic-based continue to be positive and significant ($p<0.01$ and $p<0.05$, respectively). These results are in line with the previous literature on reverse knowledge transfer that suggests both types of communication mechanisms as effective channels for transferring knowledge. They also extend results found in the context of the intra-MNE knowledge transfer to the case of reverse knowledge transfer.

However, based on the idea that communication mechanisms might play a prominent role in understanding the balance between subsidiary autonomy and effective reverse knowledge transfer, we expected that a greater emphasis on one of the two possible transfer mechanisms will be associated with a higher degree of reverse knowledge transfer under different subsidiary autonomy conditions. This interdependence between subsidiary autonomy and knowledge transfer mechanisms is also apparent when the coefficient for subsidiary autonomy is examined; it is not significant in Model 2 but significant in Model 3, where we control for different communication systems that we expect to interact with the degree of subsidiary autonomy.

– INSERT TABLES 4 AND 5 ABOUT HERE –

The coefficients of the interaction terms *person-based×subsidiary autonomy* and *electronic-based×subsidiary autonomy* are significant and have the right sign, positive and negative, respectively.

These findings are well in line with our theoretical predictions, thus supporting Hypotheses 2 and 3. Our results confirm that the interdependence among organizational structure dimensions, specifically subsidiary autonomy and knowledge transfer mechanisms, should be considered an important contingency affecting the extent of reverse knowledge transfer. Based on the results of the recent research in strategic management, we expect – and our estimations confirm – that increasing levels of subsidiary autonomy with an increased use of person-based communication will lead to higher levels of reverse knowledge transfer, while increased use of electronic-based media should be coupled with decreasing levels of subsidiary autonomy and should hence lead to higher levels of reverse knowledge transfer.

The negative effect of the interaction of electronic mechanisms with subsidiary autonomy can be said to give support to the information processing theory advanced by Egelhoff (1988), since the theory suggests that "information processing" works better when centralization dominates, and given that electronic media may be considered carriers of "information" in the Egelhoff sense of the word. Centralization helps to reduce costs that include redundancies, incompatibility, lack of common understanding and standards, whose existence is expected to decrease the effectiveness of the use of the electronic-based mechanisms (i.e. communication technologies such as e-mail, forum, listservs, etc., knowledge repositories, and portals). In addition, when subsidiary autonomy increases differences among parent and subsidiary 'knowledge structures', which may include knowledge domain, terminology, interpretation of phenomena and social context, are expected to increase, giving rise to misunderstandings between senders and receivers, limiting codification strategies and the electronic media impact on reverse knowledge transfer.

Considering person-based mechanisms, we know – as the literature suggests – that they are costly to maintain (Daft & Lengel, 1986, Pedersen, et al., 2003) due to travel costs, availability of time, and differences in cultures and language; therefore, their extensive use should be justified. Accordingly, a contingency perspective is warranted. That is to say, effective management of knowledge transfer from high autonomous subsidiaries – expected to be more innovative and to own complex and context specific knowledge (Cantwell & Mudambi, 2005, Gupta & Govindarajan, 1991) – requires the use of richer

communication mechanisms (Daft & Lengel, 1986), and parent companies will be willing "to pay" because of the expected positive influence on the costs and benefit trade-off in such transfer processes. Whereas managers will face several difficulties in transferring context and tacit knowledge across countries through electronic-based mechanisms (Persaud, 2005): significant investments in ICTs for supporting such a type of communication may be not justified if the people-to-documents process cannot be pursued in an economic way or too much knowledge is lost during the transfer.

Additional Analysis

It is crucial to clarify that in non-linear models, such as ordered probit models, the impact of the interaction term on the dependent variable is "a function of not only the coefficient for the interaction, but also the coefficients for each interacted variables and the values of all the variables." (Hoetker, 2007, p. 336). More unexpectedly, the sign of the effect of the interaction may be different for different observations, and the statistical significance cannot be determined from the *z*-statistic reported in the regression output (Norton, et al., 2004). To date, unfortunately, no procedure dealing with interaction terms for ordered probit models has been developed. However, Ai and Norton (2003) have proposed a procedure that computes correct magnitudes and standard errors of interaction effects in logit and probit models (this procedure has been implemented in STATA through the *inteff* module). Accordingly, in order to deal with this complication – unreliability of interaction terms in non-linear models – we opted for a conservative choice, running a probit estimation of Model 3, applying the Ai and Norton's (2003) procedure (see also, Norton, et al., 2004). We transformed our dependent variable into a binary variable by collapsing all the observations with reverse knowledge transfer equal to 1, 2, or 3 to the value of 1. We are aware that this operation removes a great deal of the variance in our model, but we also think that this conservative choice is crucial in order to provide an appropriate and complete interpretation of our findings.

Based on results from Model 6 (Table 6), the graphs in Figure 1 compare the interaction effect calculated by the conventional linear method with the interaction effect calculated by the method

suggested by Norton et al. (2004) against predicted probabilities of *reverse knowledge transfer* equal to one. The graphs in Figure 2 plot the statistical significance of the interaction effect against predicted probabilities of *reverse knowledge transfer* equal to one.

– INSERT TABLE 6 ABOUT HERE –

Considering person-based communication, Figure 1(a) illustrates that the strongest interaction effect occurs at medium predicted levels of probability of reverse knowledge transfer (approximately between 0.2 and 0.6), whereas the effect is less pronounced for low and high levels of predicted probability of reverse knowledge transfer. In Figure 1(b), a similar path is observable for electronic-based mechanisms where the strongest interaction effect occurs approximately between 0.2 and 0.8 of the predicted levels of probability of reverse knowledge transfer. Figure 2(a) illustrates that the interaction effect of subsidiary autonomy and person-based mechanisms is positive and significant in the majority of cases within the 0.2-0.6 interval of the predicted probability (80.7% of the observations are significant at the two-tailed ten percent level), while Figure 2(b) shows that the interaction term of subsidiary autonomy and electronic-based communication is negative, but also significant in the majority of cases within the 0.2-0.8 interval of the predicted probability (83.8% of the observations are significant at the two-tailed ten percent level). These results are in line with the findings from the ordered probit estimation and they offer evidence of the positive role on reverse knowledge transfer played by the use of person-based communication under conditions of high subsidiary autonomy. Likewise, they provide support for the result that under conditions of low subsidiary autonomy, the emphasis should be on electronic-based communication.

– INSERT FIGURES 1 AND 2 ABOUT HERE –

CONCLUSION

This work has sought to make a contribution to the understanding of the unclear direct impact of subsidiary autonomy on reverse knowledge transfer. The key contribution to the strategic management literature was to identify and examine the implications of the interaction effects between the subsidiary

autonomy and the use of different communication mechanisms, i.e. person-based and electronic-based, as an important feature of reverse knowledge transfer. While the relevance of both subsidiary autonomy and communication mechanisms in knowledge transfer processes within MNEs has been acknowledged before, they have typically been treated as independent dimensions. This has led to conflicting results of the impact of subsidiary autonomy on reverse knowledge transfer. In this study we have argued and empirically substantiated that to resolve the ambiguity in the literature regarding the effect of the subsidiary autonomy on reverse knowledge transfer it is crucial to consider which communication mechanism to emphasize. Specifically, we considered two distinctive configurations of interdependence: the combination of a high degree of subsidiary autonomy and the use of person-based mechanisms, and the combination of a low degree of subsidiary autonomy and the use of electronic-based mechanisms.

This study also offers potentially important implications for parent companies' managers. In fact, not all firms are equally capable of transferring knowledge inside the MNE, in particular, the managerial choice of how to set the organizational structure variables is one that most directly reflects how to facilitate or inhibit reverse knowledge transfer. Thus, although all the potential obstacles that parent companies' managers may face in pursuing reverse knowledge transfer within the multinational network cannot be addressed, our results suggest actions and provide guidance for managers. By identifying the combination of the subsidiary autonomy and communication mechanisms that enhances the extent of reverse knowledge transfer, the primary practical implication is that parent companies can employ organizational structure dimensions as a strategic choice for affecting effective reverse knowledge transfer. In line with previous findings found in the intra-MNE context, the empirical analyses showed that both person-based and electronic-based are mechanisms able to affect positively the extent of reverse knowledge transfer. However, the study suggests that different communication mechanisms should be emphasized according to the degree of autonomy granted to the foreign subsidiary. Specifically, parent companies' managers can increase the probability of observing reverse knowledge transfer, giving more autonomy to the subsidiaries. However, they should consider that this decentralization is expected to reduce the effectiveness of electronic-based media within the MNE.

The limitations of this study should also be noted. Of course, the context of the study—reverse knowledge transfer within Italian MNEs—was specific; therefore, it imposes limits on the generalizability of our results to other national samples. Nevertheless, the findings suggest that it is worth examining the interdependence among organizational structure dimensions that could be chosen to influence the transfer of knowledge from foreign subsidiaries to their parent companies. As we used perceptual data from a single respondent at the parent company level, albeit with some validity checks at the subsidiary level, we may still have some common-method bias. In this case, the availability of secondary and/or objective data about concepts like subsidiary autonomy, vertical linkages, knowledge transfer, would be a valuable source for additional insights. Moreover, we were able to define valid measures for three specific organization structure dimensions: subsidiary autonomy, person-based and electronic-based communication mechanisms. Further studies might gain additional understanding by searching for additional organizational controls. Research in information systems, for example, considers electronic communities of practice an important mechanism for transferring and sharing knowledge. Finally, this study analyzed reverse knowledge transfer at the dyadic level. However, a more comprehensive understanding of the hypothesized relationships could be gained by analyzing all the possible knowledge transfer processes between the different entities of an MNE.

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Figures and Tables

Figure 1 – The size effect of the interactions between subsidiary autonomy and person- and electronic-based communication systems

(a) Subsidiary autonomy × person-based mech. (b) Subsidiary autonomy × electronic-based mech.

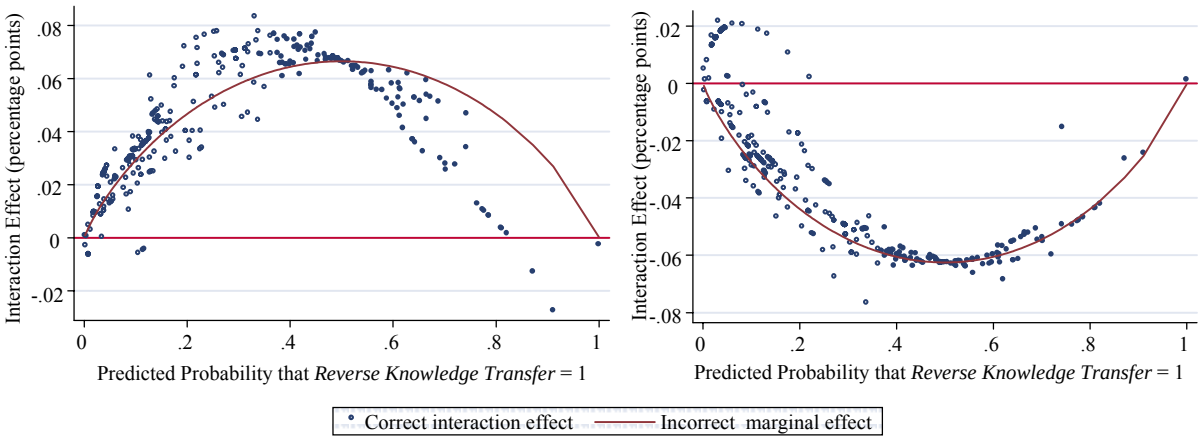
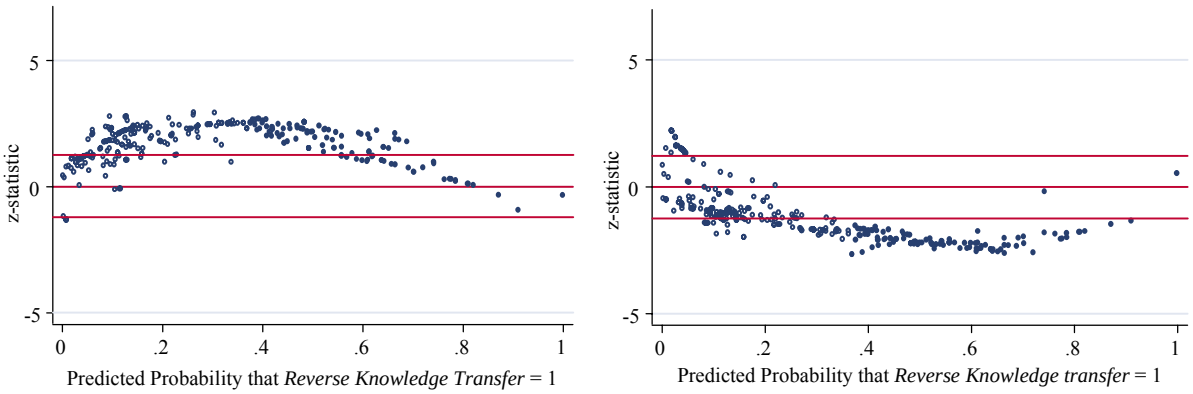


Figure 2 – The significance of the interactions between subsidiary autonomy and person- and electronic-based communication

(a) Subsidiary autonomy × person-based mech. (b) Subsidiary autonomy × electronic-based mech.



The two horizontal lines represent the z-statistic at ±1.64. All the observations above +1.64 and below –1.64 are significant at least at p<0.1.

Table 1 – Sample's representativeness

	Sample frame	Non Respondent	Respondent	χ^2 test
Industry				
High-tech sectors [a]	109	71	38	0.0008***
Size				
50 – 249	98	80	18	0.1624
250 – 499	81	66	15	0.2325
500 – 5000	145	102	43	0.0225**
> 5000	34	26	8	0.9924

[a] 249 MNEs belong to the low-tech sector of which 203 were non respondent.
* p< .10; ** p< .05; *** p< .01

Table 2 – Validity response tests

	Observations[a]	Kruskal-Wallis test	P_value[b]
Dependent variable			
Degree of reverse knowledge transfer	62	1.250	0.264
Independent variables			
Teamwork	59	1.988	0.159
Temporary transfer of managers	55	26.988	0.000***
Temporary transfer of professionals	55	23.554	0.000***
Exchange of blueprints, db, etc.	57	0.015	0.904
Internet tools	56	1.621	0.203

[a] Number of parent company-foreign subsidiary dyads available.
[b] Rejecting the null hypothesis means that the two distributions – the answers from the parent companies and the answers from the subsidiaries – are different.
* p< .10; ** p< .05; *** p< .01

Table 3 – Descriptive statistics

Variable [a]	Means	S.d.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Reverse knowledge transfer	0.602	0.999											
(2) Unsophisticated knowledge	0.161	0.368	0.238										
(3) Sophisticated knowledge	0.314	0.465	0.176	-0.296									
(4) Greenfield	0.308	0.462	0.048	0.084	-0.124								
(5) Cultural distance	1.185	0.936	-0.083	-0.030	-0.182	0.083							
(6) Geographical distance	3.383	3.423	-0.047	0.070	-0.082	0.140	-0.062						
(7) FDI age	9.498	6.723	0.007	0.038	-0.055	0.233	-0.235	0.130					
(8) Relative size	-1.739	1.219	0.155	0.069	0.152	-0.174	-0.101	-0.057	-0.005				
(9) Subsidiary sales	0.050	0.149	0.099	0.117	-0.027	-0.164	-0.176	-0.106	0.031	0.297			
(10) Subsidiary autonomy [a]	2.497	0.773	0.069	-0.087	0.273	0.047	-0.136	0.016	0.118	-0.070	-0.072		
(11) Person-based [a]	3.181	1.801	0.297	0.090	-0.167	0.026	0.128	0.004	-0.077	0.132	0.105	-0.281	
(12) Electronic-based [a]	4.543	2.095	0.193	0.024	-0.012	0.187	0.039	-0.042	0.078	-0.103	-0.012	0.011	0.206

[a] The variable is standardized. The table lists the means, standard deviations, and correlations of these variables prior to the standardization.

Table 4 – Results of the ordered probit regressions for reverse knowledge transfer

	Model 1		Model 2		Model 3	
Unsophisticated knowledge	0.986	(0.437)**	1.166	(0.412)***	1.185	(0.404)***
Sophisticated knowledge	0.755	(0.242)***	0.954	(0.227)***	0.890	(0.242)***
Greenfield	0.373	(0.295)	0.227	(0.216)	0.229	(0.224)
Cultural distance	-0.003	(0.101)	-0.111	(0.098)	-0.113	(0.098)
Geographical distance	-0.030	(0.037)	-0.041	(0.035)	-0.042	(0.036)
FDI age	-0.004	(0.013)	0.002	(0.014)	-0.003	(0.014)
Relative size	0.141	(0.070)**	0.160	(0.073)**	0.159	(0.078)**
Subsidiary sales	0.280	(0.338)	-0.107	(0.367)	-0.080	(0.373)
Subsidiary autonomy			0.181	(0.139)	0.278	(0.152)*
Person-based			0.266	(0.078)***	0.265	(0.075)***
Electronic-based			0.115	(0.062)*	0.119	(0.060)**
Person-based ×Subsidiary autonomy					0.172	(0.083)**
Electronic-based ×Subsidiary autonomy					-0.186	(0.067)***
Log-pseudolikelihood	-265.71		-240.10		-233.54	
Wald χ^2	37.47***		80.85***		94.41***	
McFadden's Adjusted Pseudo-R^2	0.077		0.163		0.186	

In brackets, robust standard errors corrected for heteroscedasticity and cluster-correlated data. 299 observations.
* p< .10; ** p< .05; *** p< .01 (two-tailed tests applied).

Table 5 – Marginal effects of independent variables on reverse knowledge transfer (RKT)

Variable [a]	RKT=0	RKT=1	RKT=2	RKT=3
Unsophisticated knowledge	-0.431	0.078	0.181	0.171
Sophisticated knowledge	-0.303	0.081	0.134	0.088
Greenfield	-0.074	0.024	0.033	0.017
Cultural distance	0.036	-0.012	-0.016	-0.008
Geographical distance	0.013	-0.004	-0.006	-0.003
FDI age	0.001	0.000	0.000	0.000
Relative size	-0.050	0.017	0.022	0.011
Subsidiary sales	0.025	-0.008	-0.011	-0.006
Subsidiary autonomy	-0.088	0.029	0.039	0.019
Person-based	-0.084	0.028	0.037	0.018
Electronic-based	-0.037	0.012	0.017	0.008
Person-based ×Subsidiary autonomy	-0.054	0.018	0.024	0.012
Electronic-based ×Subsidiary autonomy	0.059	-0.020	-0.026	-0.013

[a] Marginal effect for dummy variable is calculated by comparing the probabilities that result when the variable takes its two different values with those that occur with the other variables held at their sample means (see, for details, Greene, 2000).

Table 6 – Results of the probit regressions for reverse knowledge transfer

	Model 4		Model 5		Model 6	
Constant	-0.621	(0.329)*	-0.576	0.343*	-0.492	0.353
Unsophisticated knowledge	0.762	(0.456)*	0.858	0.436**	0.875	0.423**
Sophisticated knowledge	0.658	(0.291)**	0.834	0.272***	0.758	0.283***
Greenfield	0.525	(0.353)	0.429	0.288	0.435	0.291
Cultural distance	0.012	(0.125)	-0.080	0.107	-0.085	0.105
Geographical distance	-0.045	(0.041)	-0.059	0.040	-0.062	0.041
FDI age	0.001	(0.013)	0.005	0.014	0.002	0.014
Relative size	0.191	(0.081)**	0.211	0.089**	0.211	0.094**
Subsidiary sales	0.572	(0.494)	0.257	0.587	0.358	0.625
Subsidiary autonomy			0.108	0.145	0.209	0.160
Person-based			0.247	0.092***	0.249	0.090***
Electronic-based			0.122	0.065*	0.115	0.064*
Person-based ×Subsidiary autonomy					0.130	0.089
Electronic-based ×Subsidiary autonomy					-0.174	0.072**
Log-pseudolikelihood	-166.66		-146.18		-142.15	
Wald χ^2	30.74***		55.42***		62.85***	
McFadden's Adjusted Pseudo-R^2	0.106		0.211		0.233	

In brackets, robust standard errors corrected for heteroscedasticity and cluster-correlated data. 299 observations.
* p< .10; ** p< .05; *** p< .01 (two-tailed tests applied).