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Knowledge-sharing and social interaction within MNEs

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Abstract
Social interaction between managers from different units of a multinational enterprise (MNE) has been shown to be an important factor stimulating intra-MNE knowledge-sharing. Face-to-face social interactions form a communication channel particularly conducive to the transfer of tacit, non-codified knowledge. But intensive social interaction also provides opportunities for social construction of knowledge in a learning dialogue. The first explanation (sender–receiver) makes us expect social interaction to moderate positively the effects of the factors giving rise to knowledge flows in the first place, such as differences in capabilities between MNE subsidiaries. The second perspective (social learning) also grants an independent effect to social interaction as a main factor stimulating intra-MNE knowledge flows. We formulate hypotheses based on both perspectives, and test these on data from 169 MNE subsidiaries. Our findings show a considerable main effect of social interaction on all intra-MNE knowledge flows, confirming the expectations based on the social learning model. Interaction effects, based on the predictions of the sender–receiver model, are only partly confirmed. These findings suggest that future research should devote more attention to the social constitution of MNE knowledge.
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INTRODUCTION

Recent studies of multinational enterprises (MNEs) commonly conceptualize this type of firm as a network (Ghoshal & Bartlett, 1990; Nohria & Ghoshal, 1997; Rugman & Verbeke, 2001). An important implication of the network view is that the hierarchical relationship between the center (headquarters or parent firm) and the periphery (subsidiaries or business units at various locations) is de-emphasized. Instead, the network MNE is seen as a "social community" (Kogut & Zander, 1993) or a "heterarchy" (Hedlund, 1986). Ghoshal and Bartlett (1990: 603) describe the MNE as "a group of geographically dispersed and goal disparate organizations that include its headquarters and the different national subsidiaries".

As the emphasis on authority relations within the MNE declines, attention to knowledge flows increases. Knowledge is an important, if not the most important, strategic resource of firms (Grant, 1996; McEvily & Chakravarthy, 2002; Szulanski, 1996), and the ability to share knowledge between units of the organization is an important basis of competitive advantage of firms (Argote &

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Ingram, 2000; Nonaka & Takeuchi, 1995). The ability to share knowledge across national borders is the prime reason behind the formation of MNEs (Gupta & Govindarajan, 1994). Within the MNE network, knowledge may be created in one location, and put to productive use in many other locations (McCann & Mudambi, 2005; Mudambi & Navarra, 2004). The MNE as an organizational form arises, according to this view, because of its "superior efficiency as an organizational vehicle by which to transfer … knowledge across borders" (Kogut & Zander, 1993: 625; see also Almeida, Song, & Grant, 2002; Reagans & McEvily, 2003). It is the "synthesis" of knowledge originating in diverse locations that is seen to be the prime source of MNE innovation (Buckley & Carter, 1996; see also Håkanson & Nobel, 2001).

Detailed practical examples of knowledge transfer within an MNE can be found in Bélanger, Berggren, Björkman, and Köhler's (1999) book on ABB's power transformer business. This study illustrates how in some cases peripheral units try to catch up by learning from the MNE center, while in other cases lateral learning relationships form, "not imposed and not even organized by corporate headquarters" (p 253). These authors also note that in several cases the initial roles are reversed, as "former teachers have to become pupils" (p 11).

Acknowledgement of the importance of knowledge-sharing within the MNE has led to a number of studies of the factors promoting or impeding intra-MNE knowledge flows. One factor that has repeatedly come out as conducive to intra-MNE knowledge-sharing is what we in this paper call "social interaction". Björkman, Barner-Rasmussen, and Li (2004), for instance, found that inter-unit trips and visits, international committees, teams and task forces, and training involving teams from multiple units, positively influence knowledge outflows from a focal subsidiary. Persson (2006) found positive influences of liaison mechanisms and temporary teams with members from different subsidiaries on knowledge flows between subsidiaries. Schultz (2003) looked at knowledge inflows (both vertical and lateral) at a focal subsidiary, and found that informal relations between the units have a positive effect. Subramaniam and Venkatraman (2001) discovered that cross-national teams positively influence cross-border knowledge flows. In all cases the informal, face-to-face nature of the social interactions promoted by the focal mechanisms stands out.

Although the conclusion that social interaction endorses intra-MNE knowledge flows appears to be inescapable, from a theoretical perspective an independent positive effect of social interaction on intra-MNE knowledge flows is far from self-evident. Many studies in this field employ a "sender–receiver" model rooted in general information and communication theories (Carlile, 2004). In this view social interaction serves as an efficient conduit for knowledge transfer, a "channel" with the requisite "bandwidth" to transmit complex, context-dependent knowledge. However, the existence of a channel or pipeline can in itself never explain the flows it accommodates. In the logic of the model other factors need to exist that lead to knowledge flows, and a communication channel can only positively moderate the effects of these underlying factors.

In this paper we look at the influence of social interaction on knowledge-sharing within the MNE from both the perspective of the sender–receiver model and the perspective of social learning. We argue that in the logic of the sender–receiver approach there is only limited ground for assuming that social interaction has an independent effect on intra-MNE knowledge flows. We would rather expect social interaction to strengthen the effects of other variables that may be assumed to motivate knowledge flows in the first place, such as the relative superiority of the capabilities of the sending subsidiary, or the relative needs of the receiving subsidiary. Assuming the perspective of social learning theory, in contrast, gives more scope for discussing an independent role of social interaction. Social learning theory does not deny the role of senders, receivers and channels in knowledge flows, but it emphasizes that the knowledge shared between partners is likely to have a tacit dimension to it (Brown & Duguid, 2001). Tacit knowledge "cannot be 'captured', 'converted' or 'transferred', but only displayed and manifested, in what we do" (Tsoukas, 2003: 410). The metaphor of knowledge "flows" should consequently not be taken too literally: knowledge, at least the tacit dimension of it, does not so much flow from one individual or unit to another, as it is shared in a social process of mutual engagement (Elkjaer, 2003). Tacit knowledge needs to be disembedded, translated, interpreted and integrated in order for learning to occur (Becker-Ritterspach, 2006). This is possible only in a dialogue in which both parties assume the roles of sender as well as receiver. Hence social interaction assumes a much more important role: instead of being a "pipeline" for the transfer of knowledge produced at one location and consumed at another,

it forms an important condition for the possibility of knowledge-sharing and integration.

In developing our ideas about social interaction and intra-MNE knowledge streams, we assume a subsidiary perspective – looking at knowledge flows into and out of a focal subsidiary (for this perspective see, e.g., the various contributions in Birkinshaw & Hood, 1998). The subsidiary perspective is important, as subsidiaries in network-type MNEs may play very different roles (Birkinshaw & Hood, 1998; Ghoshal & Nohria, 1989, 1993; Harzing & Noorderhaven, 2006; Nohria & Ghoshal, 1994), and may consequently also have very different kinds of knowledge inflow and outflow. We decompose knowledge flows into four categories, depending on the direction (*to* vs *from* the focal subsidiary) and on the sender/recipient (the MNE parent firm or another MNE subsidiary). It is important not to treat knowledge streams as a single composite variable, but to acknowledge role differentiation between subsidiaries (Gupta & Govindarajan, 1991) that may be associated with differences in inflows, outflows, or both.

We develop hypotheses regarding the influence of social interaction on knowledge flows within MNEs from the perspectives of both the sender–receiver model and social learning theory. We focus on the role of factors such as social interaction, workflow integration, subsidiary capabilities and subsidiary autonomy in knowledge-sharing within MNEs. We test our hypotheses on survey data from 169 MNE subsidiaries. Instead of looking only at one particular component of intra-MNE knowledge flows, such as knowledge flows from subsidiaries to the parent firm (e.g., Ambos, Ambos, & Schlegelmilch, 2006) or knowledge outflows from one subsidiary to another (e.g., Persson, 2006), we investigate knowledge inflows and outflows to/from the parent firm and to/from other subsidiaries simultaneously.

The next section of the paper discusses the sender–receiver model and social learning theory, and develops hypotheses regarding knowledge inflows and outflows to/from a focal MNE subsidiary, both in relations with the MNE parent firm and in the relations with other subsidiaries. The third section describes our dataset and methods of analysis. Subsequently we present our findings in the fourth section, and close with a discussion and conclusions in the fifth section.

THEORY AND HYPOTHESES

As indicated above, we distinguish two perspectives on intra-MNE knowledge flows. The first perspective, the sender–receiver model, was introduced to the study of intra-MNE knowledge flows by Gupta and Govindarajan (1991, 2000). The social learning perspective in the study of intra-MNE knowledge flows is exemplified by Kogut and Zander (1996). Below we first define the way in which we use the concept of "knowledge" in this paper. After that we briefly discuss the two perspectives, and subsequently develop hypotheses regarding intra-MNE knowledge flows on the basis of a combination and confrontation of the two views.

The Concept of Knowledge

Regarding the concept of "knowledge", we adopt the definition of Davenport and Prusak (1998: 5):

> Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms.

This definition draws our attention to the coexistence of more explicit and codified, and more tacit and uncodified, forms of knowledge. Any study of intrafirm knowledge flows must take the distinction between these different types of knowledge into account. Non-codifiable and tacit knowledge is not easy to transmit within a firm, let alone across national boundaries within an MNE. Codified and explicit knowledge can be transferred more easily, within as well as across organizational and national boundaries (Kogut & Zander, 1993). The distinction between the different types of knowledge is important not only because the internal transmission of know-how is one of the *raisons d'être* of MNEs (Kogut & Zander, 1993). It also should be taken into account because information flows within the MNE also comprise routine orders (e.g., from headquarters to subsidiaries) and reports (e.g., from subsidiaries to headquarters). These flows of "declarative knowledge" (Harvey & Anderson, 1996) are closely tied to the formal organization. Know-how, in contrast, is a form of "procedural knowledge" (Anderson, 1983): the knowledge about how to do something, which may plausibly be assumed to be associated with internal mechanisms other than declarative knowledge. Our discussion of intra-MNE knowledge streams focuses on procedural knowledge, which always has a tacit dimension to it (Brown & Duguid, 2001), while the explicit elements represent no

more than the "tip of the iceberg" (Nonaka & Takeuchi, 1995).

The Sender–Receiver Model

The sender–receiver model is adopted by many studies of intra-MNE knowledge flows, albeit often implicitly (e.g., Adler & Hashai, 2007). Szulanski (2000: 11) observes that "the signaling metaphor … informs most of the actual research in knowledge transfer. This metaphor specifies the basic elements of a transfer: source, channel, message, recipient, and context". The roots of this perspective lie in the information-processing approach in organization theory (Egelhoff, 1993; Galbraith, 1973; Lawrence & Lorsch, 1967), which in turn has its basis in more general communication and information theories (Carlile, 2004). Publications in this stream of research typically focus on one or more of the following factors: characteristics of the sender unit, characteristics of the receiving unit, characteristics of the relationship between sender and receiver, and characteristics of the knowledge transferred.

Regarding characteristics of the sender unit, the most important assumption is that the sender needs to be relatively well endowed with knowledge. Foss and Pedersen (2002), for instance, consider three sources of transferable knowledge at the subsidiary level: investments in internal knowledge production, knowledge based in direct linkages to local players, and knowledge based in more diffuse linkages to sources of knowledge in their environment. The authors find that the presence of each of the three types of knowledge does indeed positively influence knowledge transfer from the focal subsidiary to other MNE units. With regard to characteristics of the receiving unit, the receiver must be able to absorb the knowledge transmitted by the sender. Tsai (2001) uses R&D intensity of business units as a proxy for absorptive capacity, and finds that absorptive capacity has positive independent as well as moderating effects on the units' rate of innovation and profitability. Minbaeva, Pedersen, Bjorkman, Fey, and Park (2003) distinguish between an ability-based and a motivation-based dimension of subsidiary absorptive capacity, and find positive effects of both factors. Gupta and Govindarajan (2000) focus, among other things, on the richness of transmission channels between sender and receiver. They find significant positive effects of both formal and informal integrative mechanisms. Regarding the characteristics of the knowledge transferred, Dhanaraj, Lyles, Steensma, and Tihanyi (2004) compare the flow of tacit and explicit knowledge between a parent firm and an international joint venture. These authors find that trust between parent firms and international joint ventures is significantly more important for the transfer of tacit knowledge than for that of explicit knowledge. This finding, pertaining to both characteristics of the knowledge transferred and characteristics of the relationship between the focal units, echoes the findings of an earlier study by Hansen (2002), who found that direct relationships (distinguished from indirect relationships) between units were conducive for the transfer of non-codified knowledge, but not for the transfer of codified knowledge.

The examples given above indicate that the sender–receiver model, taken broadly, has generated a stream of research leading to interesting findings. Nevertheless, Becker-Ritterspach (2006: 360) criticizes this approach, precisely because of the focus on flows of knowledge, "where knowledge assumes almost liquid-like properties, and different viscosities or different characteristics of pipelines and storage facilities determine flows". This author stresses that more attention needs to be paid to "what happens to the knowledge as well as receiving contexts when knowledge is transferred and integrated into a new social (societal – organizational) environment" (Becker-Ritterspach, 2006: 360).

In the context of this paper the role of social interaction, as emphasized by, e.g., Gupta and Govindarajan (2000), is important. As indicated in the Introduction, we believe that the logic of the sender–receiver model points in the direction of a moderating, but not a main effect of communication channels such as social interaction. Although the importance of social interaction for knowledge-sharing appears to be generally accepted, we think it is important analytically to separate main effects from moderating effects.

The Social Learning Approach

In the "hydraulic" perspective of the sender–receiver approach, knowledge will flow (under certain conditions) from units that are relatively knowledge-rich to units that are relatively knowledge-poor. Although intuitively appealing, this idea may also be misleading. We can speak of knowledge "flows" only metaphorically. The image of knowledge flowing from one individual or unit to another does insufficient justice to the inherently social nature of the process. For a better understanding of this, we must turn to social learning theory.

The aim of this section is not to provide an overview of the vast and rapidly expanding literature on social learning, but rather to discuss briefly some aspects of social learning theory that may be assumed to have implications for our view on intra-MNE knowledge flows. A first and obvious observation is that, in social learning theory, learning occurs and knowledge is created through conversations and interactions between people (Easterby-Smith, Crossan, & Nicolini, 2000). Unlike the sender–receiver approach, social learning theory explicitly emphasizes that knowledge is not an object that is "passed physically from one to another" (Dewey, quoted in Plaskoff, 2003: 163). Rather, knowledge "is socially constructed through collaborative efforts with common objectives or by dialectically opposing different perspectives in dialogic interaction" (Plaskoff, 2003: 163). With regard to intra-MNE knowledge flows, this means that in the view of social learning theory such "flows" will be possible only where individuals working in different units of the MNE engage in social interaction.

This implication for intra-MNE knowledge flows is strengthened by the focus in social learning theory on the tacit component of knowledge. Van Baalen, Bloemhof-Ruwaard, and Van Heck (2005: 301) identify two different views on the relationship between explicit and tacit knowledge. On the one hand, authors such as Nonaka and Takeuchi (1995) endorse a "near tangible view", according to which explicit and tacit knowledge can – under certain conditions – be converted to each other. In contrast, the more radical "distributed view", as formulated for instance by Tsoukas (2003), states that tacitness is an aspect of all knowledge, and that this can never be made completely explicit. Adoption of this view implies that the "procedural knowledge" (Anderson, 1983) on which we focus in this paper will be assumed to be largely tacit, and transfer (learning) takes place through "observation and emulation of skilled practitioners and socialization" (Easterby-Smith & Araujo, 1999: 5). Hence knowledge transfer necessitates quite intensive (face-to-face) interaction and cooperation.

Third, social learning theory accentuates the situated and contextual nature of knowledge and learning (Fox, 2000; Plaskoff, 2003). Knowledge is strongly tied to activities or practices, outside of which it has little relevance. Learning occurs where individuals are engaged jointly in a shared activity. This is the essence of a "community of practice" (Fox, 2000). Communities of practice encompass individuals working closely together to accomplish certain tasks (Wenger, 1998). The shared practice in which the members of such a community engage may be seen as a sort of rail along which tacit knowledge travels (Fineman, 2003; Fox, 2000). With regard to intra-MNE knowledge flows, these flows are thus to be expected predominantly where individuals from different MNE units are engaged in shared practices (i.e., where there is strong operational integration between units).

While the social learning perspective is not diametrically opposed to the sender–receiver approach, there are important differences. We see these two approaches as partly complementary, partly competitive. The social learning approach enriches the sender–receiver model, which has been used in many of the previous studies of intra-MNE knowledge flows. But social learning theory also leads to expectations that are at odds with what we might expect from a sender–receiver perspective. In developing hypotheses with regard to intra-MNE knowledge flows, we focus specifically on social interaction between a focal subsidiary and other parts of the MNE, the integration within the MNE of the focal subsidiary in terms of workflows, and the level of capabilities and the extent of autonomy of the focal subsidiary. The sender–receiver model leads us to expect that factors such as the relative capabilities of a subsidiary, its level of autonomy and its integration in intra-MNE workflows are the main factors promoting or impeding knowledge flows, moderated by the existence of the requisite communication channels (social interactions). Social learning theory, on the other hand, provides us with arguments to expect social interaction to be a knowledge-generating factor, and hence an independent factor causing knowledge flows.

Development of Hypotheses

In this section we will discuss the influence of a number of factors on intra-MNE knowledge flows, focusing in particular on social interaction. We have mentioned earlier, and substantiate below, that findings from previous studies posit social interaction between parts of MNEs as an important variable explaining intra-MNE knowledge flows. In addition to social interaction we focus on three other factors that we hypothesize to influence intra-MNE knowledge flows, directly as well as in conjunction with social interaction: workflow

integration, subsidiary capabilities, and subsidiary autonomy. Although we do not pretend that our explanation on the basis of these factors is complete, we do believe that these variables play a crucial role. We see workflow integration as an important factor because it makes it more likely that knowledge shared between two units is relevant to the operational processes of these units (Schultz, 2003). Subsidiary capabilities are important because they relate to the stratification of knowledge stocks that needs to be taken into account in explaining knowledge flows (Foss & Pedersen, 2004). Finally, we consider subsidiary autonomy to be important because, if subsidiaries are managed less hierarchically (as in the networked MNE), this may positively influence a subsidiary's competitiveness and local knowledge base (Birkinshaw, Hood, & Jonsson, 1998; Foss & Pedersen, 2002), but at the same time make effective knowledge-sharing with other parts of the MNE less likely.

Social interaction intensity. It has often been argued that social interaction and communication facilitate knowledge flows within MNEs. Ghoshal and Bartlett (1988) stated that inter-unit communication density facilitates the movement of knowledge. Gupta and Govindarajan (1994) also found that the use of lateral integration mechanisms (liaison personnel, temporary taskforces, and permanent teams that coordinate with sister subsidiaries) and the intensity of both corporate – subsidiary and inter-subsidiary communication are important predictors of knowledge outflows and inflows at the subsidiary level. In their study published in 2000, the same authors find that corporate socialization mechanisms influence the knowledge inflows and outflows, both to/from headquarters and with other subsidiaries (Gupta & Govindarajan, 2000). Hansen, Mors, and Løvas (2005) argue that frequent and intense interactions increase the exposure to the views and skills of other subsidiaries, thereby reducing negative perceptions. Apparently, rich communication media allowing for face-to-face communication, informal interaction, and teamwork help to overcome the "transmission losses" that occur during the transfer of complex procedural knowledge (Mudambi, 2002, see also Björkman et al., 2004; Tsai, 2001; and Tsai & Ghoshal, 1998). Direct, face-to-face interaction has two desirable characteristics: "bandwidth" and "synchrony". *Bandwidth* refers to the ability to convey non-verbal and visual cues (Daft & Lengel, 1986; Short, Williams, & Christie, 1976); *synchrony* refers to the ability to provide and receive immediate feedback (Kraut, Fussel, Brennan, & Siegel, 2002). For reasons of bandwidth and synchrony, face-to-face communication remains the "gold standard" (Rice, 1993) when tacit, non-codified knowledge needs to be transferred, in spite of the development of new communication technologies (Barner-Rasmussen & Björkman, 2005; Nadler, Thompson, & Van Boven, 2003; Urry, 2003).

Direct face-to-face contacts between members of different MNE units can be stimulated in various ways. Barner-Rasmussen and Björkman (2005) found the intensity of inter-unit communication within MNEs to be related to participation in corporate training programs. Ghoshal, Korine, and Szulanski (1994) found subsidiary employees to engage in inter-unit communication more frequently the more time they spent in inter-unit committees, teams, taskforces, meetings, conferences, and at world headquarters. Ghoshal et al. (1994) also found that interpersonal relationships that are developed through lateral networking mechanisms such as joint work in teams, taskforces, and meetings have positive effects on the frequency of both subsidiary – headquarter- and inter-subsidiary communications. Bresman, Birkinshaw, and Nobel (1999) point to the importance of "protracted modes of interaction" (technical meetings, extended visits and joint training programs) for the transfer of knowledge between units. Ghoshal and Bartlett's (1988) concept of "normative integration" is associated with practices such as "extensive travel and transfer of managers between the headquarters and the subsidiary" and "joint work in teams, taskforces, and committees" (Ghoshal & Bartlett, 1988: 371).

We refer to the various forms of communication within the MNE described above as "social interaction". Importantly, however, the argument that this factor has an independent (main) effect on intra-MNE knowledge flows cannot credibly be based on the logic of the sender–receiver model. In the sender–receiver approach social interaction is a factor influencing the "bandwidth" of the channel for knowledge flows between units, but nothing will flow through the channel unless, for instance, one of the units has superior capabilities, or unless the units need to share knowledge because of, for instance, operational interdependency.

In contrast to the sender–receiver approach, the perspective of social learning theory does allow us to argue that social interaction should indeed be seen as more than a moderating factor for intra-MNE knowledge flows. In the Introduction we quoted Plaskoff's (2003: 163) assertion that knowledge "is socially constructed through collaborative efforts with common objectives or by dialectically opposing different perspectives in dialogic interaction". To the extent that knowledge is indeed socially constructed, social interaction should be seen not primarily as a means for transferring existing knowledge, but rather as a necessary condition for the social production of knowledge. This is the essence of the communities-of-practice view (Lave & Wenger, 1993). The knowledge developed in social communities is "collective knowledge, shared sense-making and distributed understanding that doesn't reduce to the content of individual heads" (Brown & Duguid, 1998: 96). Social learning theory posits that social cohesion around a relationship affects the willingness and motivation of individuals to invest time, energy and effort in sharing knowledge with others (Reagans & McEvily, 2003). Brown and Duguid (2000) refer to the role of "face-to-face communities" in learning processes. The existence of such communities is predicated on direct contact between members. In order to be useful to others, knowledge has to be disembedded from the local situation, translated so that it is understandable to the receiver, interpreted by the receiver, and adapted to local practices (Becker-Ritterspach, 2006; Zander, 1991). The result is the occurrence of a learning dialogue and reciprocal knowledge transfer (Adenfelt & Lagerström, 2006; Bresman et al., 1999). Taken to the extreme, this view implies that there will be no knowledge to transfer if there is no social interaction.

This discussion illuminates a fault line between the sender–receiver approach and social learning theory. The sender–receiver model cannot predict the central role given to social interaction in social learning theory. Hence our first hypothesis is based in social learning theory, but not in the sender–receiver approach:

> **Hypothesis 1**: Social interaction between a subsidiary and other parts of the MNE will be positively related to knowledge exchange (inflows as well as outflows).

Hypothesis 1 is our baseline hypothesis: that is, we strongly expect this hypothesis to be confirmed, and such a confirmation will not in itself form a contribution to the knowledge of the factors influencing intra-MNE knowledge flows. But we need to posit and test this hypothesis for two reasons: to distinguish explicitly between the expectations based in sender–receiver logic and those based in social learning theory, and to provide us with a backdrop against which we can formulate and test predictions with regard to the contingent effects of social interaction.

Workflow integration. Our next hypothesis pertains to the relation between knowledge exchange between MNE units and their operational integration. Foss and Pedersen (2002) argued that inter-subsidiary trade stimulates attempts to solve problems interactively and hence transfer knowledge, and they do indeed find a positive effect of interdependence between the focal subsidiary and the MNE and intra-MNE trade on knowledge flows. Likewise, in a study of subsidiaries of Swedish MNEs, Persson (2006) finds that product flows are positively related to knowledge flows. From the point of view of the sender–receiver perspective, the effect of workflow integration would be mainly a motivational effect: both sender and receiver are likely to be more motivated to share knowledge to the extent that this knowledge is more strongly tied to their operational processes, and thus more relevant (see Schultz, 2003).

As mentioned earlier, the social learning literature states that learning is not an isolated process, but is tied to ongoing activities and practices (Fox, 2000). Learning and working go hand in hand (Brown & Duguid, 1991). This suggests that knowledge-sharing is most likely between MNE units that are connected through operational practices: "knowledge leaks in the direction of shared practice, it sticks where practice is not shared" (Brown & Duguid, 2001: 207). Previous studies of MNEs and other multi-unit firms have argued that similarity in knowledge content among business units is a prerequisite for effective knowledge-sharing (see, e.g., Farjoun, 1998). While interdependency between units can take various forms, the intensity of physical flows between parts of the MNE has been argued to be the most important indicator of multinational integration (Bartlett & Ghoshal, 1987). This would presumably be linked to inter-unit relationships in other dimensions, including knowledge flows (Egelhoff, Gorman, & McGormick, 2003). We define workflow integration as the extent to which material inflows and

outflows from a focal subsidiary originate from or are destined for other parts of the MNE. These material flows consist of parts, semi-manufactured articles, and/or finished products.

To be sure, it is entirely possible that two MNE subsidiaries are linked by high material flow dependencies while not exchanging knowledge (other than declarative knowledge).[1] One subsidiary could for instance be a sales subsidiary that receives 100% of its material inputs from a production subsidiary. In this case low (or absent) flows of procedural knowledge could coexist with very high levels of operational workflow dependency. In our empirical analysis we will control for this possibility to some extent by including an indicator of the breadth of activities (sales, marketing, assembly, production, etc.) the focal subsidiary engages in.

Hypothesis 2a: MNE subsidiaries will engage in more knowledge exchange (inflows as well as outflows) with those parts of the MNE with which they have more strongly integrated work processes.

Regarding the combined influence of social interaction and workflow integration, both the sender–receiver perspective and social learning theory make us expect a positive interaction effect. If stronger workflow integration motivates MNE units to share knowledge, social interaction will enable them to do so more effectively. In the logic of the social learning approach, operational interdependence and social interaction are strongly linked. To the extent that two units are engaged in shared or interrelated practices, social interaction between them can be expected to have a more positive effect on knowledge-sharing. Hence:

Hypothesis 2b: The positive effect of social interaction on intra-MNE knowledge flows will be stronger for subsidiaries connected by strong workflow integration.

Subsidiary capabilities. Social learning theory frequently refers to the master – apprentice relationship (Fox, 2000). Apprentices participate in the practice under the guidance of the more experienced masters. In the constantly emerging structure of the community of practice formed by masters and apprentices, both types of participant learn from each other in a process of negotiation of meaning and identity formation (Wenger, 1998). But the position of masters in such communities of practice is quite different than that of apprentices. Although a master may be influenced by an apprentice (e.g., challenged to think through more carefully the truth of received wisdom), the influence in the opposite direction will logically be stronger.

Hence knowledge outflows from a given subsidiary are to be expected specifically if the subsidiary has a stock of knowledge that is valuable for other parts of the MNE (i.e., has superior capabilities). Bartlett and Ghoshal (1990) identify tangible assets such as plants and equipment, but also intangible assets such as expertise, skills, capabilities or creativity, as the basis of knowledge flows. These are most likely to lead to knowledge outflows if the subsidiary has certain capabilities that are stronger than what is present at other parts of the MNE. We therefore assert that the apposite measure of subsidiary capabilities pertains to the capabilities at the level of the focal subsidiary, *relative to the rest of the MNE*. Accordingly, we define subsidiary capabilities as the strength of a focal subsidiary in technological, operational, organizational and marketing activities, relative to the rest of the MNE (Holm & Pedersen, 2000). In accordance with the sender–receiver model, we expect units that have stronger capabilities to be more likely to act as senders of knowledge than units that are relatively deprived of capabilities, and vice versa (see, e.g., Foss & Pedersen, 2002).

Hypothesis 3a: Strong capabilities (relative to other subsidiaries of the same MNE) make a subsidiary more likely to act as a knowledge sender; relatively weak capabilities make a subsidiary more likely to act as a knowledge receiver.

As with Hypothesis 1, this hypothesis is not surprising, and its confirmation will not increase our knowledge substantially. However, we need to establish the importance of subsidiary capabilities to make the step to the contingent effect of social interaction. Based on the sender–receiver model, we hypothesize that having communication channels with the requisite bandwidth is particularly important when a difference in relative subsidiary capabilities motivates knowledge flows. Outflows of knowledge from relatively strong subsidiaries (and inflows to relatively weak subsidiaries) will be greater to the extent that intensive social interaction with receiver units (sender units) occurs. Hence our next hypothesis:

Hypothesis 3b: The positive effect of social interaction on knowledge outflows will be stronger

for subsidiaries with relatively strong capabilities; the positive effect on knowledge inflows will be stronger for subsidiaries with relatively weak capabilities.

Subsidiary autonomy. Above we have discussed several factors promoting intra-MNE knowledge flows. In contrast, we expect the level of autonomy of a focal subsidiary to have a negative impact on intra-MNE knowledge-sharing. Hierarchical coordination has been found to correlate positively with the information flow within the MNE (Gates & Egelhoff, 1986), and more autonomy means less hierarchical coordination. We define subsidiary autonomy as the influence that a focal subsidiary has on decisions regarding the development or customization of products, selection of and price negotiations with suppliers, and advertising and pricing policy in the local market. The effect of subsidiary autonomy on knowledge transfer is uncertain, however. Ghoshal and Bartlett (1988) found no effect, while Gupta and Govindarajan (2000) found a positive relation between centralization (the opposite of subsidiary autonomy) and the knowledge flow from headquarters to subsidiary. The study of Foss and Pedersen (2002), however, found that autonomy positively influences knowledge flows to other subsidiaries, and this was particularly true of knowledge originating from local clusters.

However, the logic of both the sender–receiver perspective and social learning leads us to expect a negative main effect of subsidiary autonomy. A very autonomous subsidiary will likely be less motivated to either send or receive knowledge. Autonomy, to the extent that it indicates standalone activities, also makes social learning in the context of shared practices less likely.

Hypothesis 4a: Subsidiary autonomy will be negatively related to intra-MNE knowledge flows to and from that subsidiary.

As with workflow integration and subsidiary capabilities, we hypothesize for subsidiary autonomy not only a main effect, but also an interaction effect with social interaction. In contrast to the negative main effect, we expect a positive interaction effect of subsidiary autonomy and social interaction on intra-MNE knowledge flows. A subsidiary functioning at arm's length from the MNE can nevertheless have knowledge of considerable value to other units, for instance because it is embedded in a local knowledge infrastructure, as demonstrated by Foss and Pedersen (2002). In this situation the existence of social interactions will be particularly important to realize knowledge flows that are not dictated by the needs of day-to-day business.

Hypothesis 4b: The positive effect of social interaction on intra-MNE knowledge flows will be stronger for subsidiaries characterized by a high level of autonomy.

Other Factors

It is important to distinguish the variables that we hypothesize to influence knowledge flows within MNEs, independently and in interaction with social interaction, from other factors that may influence these flows. Social interaction should be distinguished from more formal coordination procedures, which according to the argument developed above are more appropriate for the transfer of declarative knowledge than for the transfer of procedural knowledge. While we reason that formal coordination mechanisms are more important for the transfer of declarative rather than procedural knowledge (and we therefore refrain from formulating a hypothesis regarding its effect), we must nevertheless control for this factor.

Other factors that have been associated with intra-MNE knowledge flows in previous studies are the type of the focal subsidiary and the functions it performs. With type of subsidiary we refer to the distinction between acquired and newly established subsidiaries. Gupta and Govindarajan (2000) reason that acquired subsidiaries have a stock of knowledge that is less duplicative *vis-à-vis* the knowledge stock of the rest of the MNE. Hence greater knowledge outflows are to be expected. Conversely, because of a lower relative absorptive capacity, these authors expect acquired subsidiaries to have a lower inflow of knowledge than the rest of the subsidiaries. Furthermore, the business functions performed by a given subsidiary may vary. Traditionally, many MNE subsidiaries performed mainly downstream activities (such as marketing, sales and distribution), but now, more and more subsidiaries also perform upstream activities (including production, design and R&D) (Mudambi & Navarra, 2004). We also control for this factor, as differences in the kinds of activities performed are likely to be related to differences in knowledge flows.

Other factors that may be expected to influence intra-MNE knowledge flows are the age of the

subsidiary (older subsidiaries have had more time to develop a knowledge stock), the size of the subsidiary (larger subsidiaries being more likely to have strong capabilities), and the size of the MNE. We therefore also control for these effects, as well as for industry (because industries differ in knowledge intensity; see Gupta & Govindarajan, 2000) and home country of the MNE (because country of origin is a factor influencing the global strategy of the MNE; see Harzing & Sorge, 2003; Noorderhaven & Harzing, 2003).

DATA AND METHODS

Data Collection

Data for this study were collected through a questionnaire survey that was developed after an extensive review of the relevant literature on headquarters – subsidiary relationships. It was subsequently pilot-tested in a focus group consisting of five postgraduate students from five different countries. These students had between 4 and 10 years of work experience in MNEs. Pilot testing focused on both content and questionnaire design. After modification, the questionnaire was pilot-tested again with a different (but equally diverse) student group. Further modifications were made, and the questionnaire then was pilot-tested by four subsidiary managing directors, which resulted in some minor changes to enhance comprehensibility. The final questionnaire had a total of 149 questions measuring a range of aspects of the headquarters – subsidiary relationship.

Final questionnaires were mailed to the subsidiary managing directors of 2754 subsidiaries of MNEs headquartered in the USA, Japan, Germany, the UK, France and the Netherlands. Subsidiaries were located in more than 50 different countries. Data were collected in 2002. The sample was drawn from the Dun & Bradstreet *Who Owns Whom* database. Four very different manufacturing industries (motor vehicles and parts, chemicals, food and beverages, and electronics) were selected, including MNEs from most of the six home countries. Three to five MNEs were selected for each home country,[2] resulting in a total of 82 MNEs. For each MNE, 30–50 subsidiaries were selected, taking care to not select more than five subsidiaries in each subsidiary country. Subsidiaries with fewer than 25 employees were excluded, as were pure service subsidiaries.

Of the 2754 questionnaires, 553 were returned as undeliverable. After an initial mailing and one follow-up mailing, a total of 174 questionnaires were returned. Five of these contained more than 15% missing values and were thus discarded, leading to a usable response of 169, or 8%. Although very low, this response is not unusual for multi-country studies. Harzing (1997) reported that response rates for international mail surveys typically varied between 6 and 16%, and key studies in the field (Ghoshal & Nohria, 1989) have been based on response rates of 15%. Ghoshal and Nohria's data were collected nearly 20 years ago. Intensification of the pace of business as well as the increasing use of mail surveys are likely to have led to a substantial decline in willingness to respond to mail surveys.

The resulting sample of 169 subsidiaries represented nearly 50 different MNEs, with the number of responses per MNE varying from one to five. Since only six MNEs were represented by five subsidiaries, our findings are unlikely to be influenced by factors specific to any of the MNEs in our sample. Non-response bias was evaluated in a number of ways. First, we tested whether responses on the key variables in this study differed systematically between respondents in the original mailing and respondents in the reminder. In this procedure, late respondents were treated as a proxy for non-respondents. No significant differences were found for any of the key variables in our study. We then compared responding and non-responding firms with regard to size (number of employees), age, industry and country of headquarters. No significant differences were found on any of the variables. We can therefore be reasonably confident that non-response bias is not a problem in our study.

Given our relatively small sample size and the fact that many questionnaires had incidental missing values, we decided to use the EM (expectation – maximization) method to estimate missing values. The advantage of the EM method is that, unlike mean substitution, it does not reduce variability in the sample, but preserves the underlying relationships in the data (Hair, Anderson, Tatham, & Black, 1998). The EM method is generally considered superior to listwise or pairwise deletion, mean substitution or imputation by multiple regression (Fichman & Cummings, 2003; Roth, 1994), especially with more than 10% missing values. Although we used 15% missing values as the cut-off point, 85% of our sample had less than 5% missing values (for a questionnaire with around 150 questions). This would seem to indicate that our questionnaire was generally well understood

and felt to be applicable to the subsidiary's circumstances.

Measures

Subjective constructs in our study were all measured with multi-item scales. Our measures of *knowledge flows* were taken from Gupta and Govindarajan (2000). However, given the large number of constructs in our questionnaire, we decided to reduce their seven items to four:

(1) marketing know-how;
(2) distribution know-how;
(3) product design; and
(4) management systems and practices.

Following Gupta and Govindarajan (2000), the respondent was asked to indicate on a scale from 1 to 7 the extent to which the subsidiary engaged in the transfer of knowledge and skills in the areas above, in each of the following four directions:

(1) provides knowledge and skills to HQ (α=0.90);
(2) provides knowledge and skills to other subsidiaries (α=0.85);
(3) receives knowledge and skills from HQ (α=0.75);
(4) receives knowledge and skills from other subsidiaries (α=0.84).

Turning to our independent variables, we developed four measures of workflow integration. Inward workflow integration was measured as the proportion of all of the material inputs of the subsidiary originating from the parent company or from other subsidiaries, and outward workflow integration as the proportion of all of the subsidiary's outputs that flow to the parent company, or to sister subsidiaries. All four measures vary between zero and 100%. These workflow integration measures are formative scales: hence Cronbach's alpha is not a relevant measure (Cortina, 1993; Diamantopoulos & Siguaw, 2006).

The measure for *subsidiary capabilities* was adapted from Holm and Pedersen (2000). Respondents were asked to evaluate their subsidiary's capabilities relative to other subsidiaries on functions ranging from R&D to logistics and human resource management to the management of international activities. Alpha reliability of this nine-item scale was 0.80.

Subsidiary autonomy, adapted from Otterbeck (1981), asked the respondent to assess (on a five-point scale) the influence that headquarters would normally have on a range of issues – from selection of suppliers to design of advertising for the local market. Alpha reliability of this six-item scale was 0.82.

Social interaction intensity was measured by three items based on Harzing (1999), referring to the use (in the contacts between the focal subsidiary and the MNE) of international taskforces, international training programs, and informal communication (all measured on seven-point scales). These coordination mechanisms create face-to-face communication between employees/managers of different MNE units. Cronbach's alpha for this composite scale was 0.65.[3]

In order to test Hypotheses 2b, 3b and 4b we calculated interaction terms of social interaction intensity with the four types of workflow integration, with subsidiary capabilities, and with subsidiary autonomy. Because in testing our hypotheses we are interested in comparing the main effects of these variables with the interaction effects, we followed the procedure recommended by Aiken and West (1991: 37–39) and used mean-centered variables and their interaction terms in all regressions.

We used confirmatory factor analysis to evaluate convergent and discriminant validity of our four dependent variables and of three of the independent variables (excluding the formatively scaled workflow integration indicators). The confirmatory factor analysis was carried out with the maximum likelihood estimation in LISREL 8.20. Each item was restricted to load on its specified construct, with the seven constructs being allowed to correlate freely. All of the items loaded significantly on their latent variable (*t*-statistics ranging from 2.67 to 7.25), demonstrating convergent validity. We assessed discriminant validity by comparing the model in which the latent variables were allowed to correlate freely with a model in which all latent variables were restricted to correlate perfectly. The difference in chi-square between the two models (489.16, df=21) was highly significant ($p<0.0000$), demonstrating discriminant validity (Byrne, 1998). As both dependent and independent variables were perception-based and measured with the same instrument, a pairwise test of the main perceptual reflective scales (subsidiary capabilities, subsidiary autonomy, social interaction and the four types of knowledge flow) was performed. For each of the 21 pairs of constructs a model in which the two latent variables were allowed to correlate freely was compared with a model in which the latent variables were restricted to correlate perfectly. In all cases the chi-square statistic of the second model

was significantly higher than that of the first model, demonstrating discriminant validity.

Turning to our control variables, *type of subsidiary* was operationalized in our study in the form of a dummy variable with the value of 1 for an acquisition, and zero for a greenfield subsidiary. The *upstream function* of the subsidiary was coded as a dummy variable – subsidiaries with an upstream function (R&D, assembly, production) were coded as 1, and those without this function were coded as zero. *Formal coordination* was based on three items (Cronbach's alpha 0.70), referring to the use of planning systems, formal procedures, and reporting, and enterprise resource planning systems.

Finally, we used controls for subsidiary age and size, MNE size, industry, and the home country of the MNE. Subsidiary age was measured by subtracting the year of establishment from the year of data collection. The number of employees served as a measure of subsidiary size. As this variable was badly skewed, we used the natural logarithm of the number of employees as the final measure of size. The same procedure was followed for MNE size. In the questionnaire, HQ country and industry were verified with tick boxes, and an additional variable, "other", was created. We created dummy variables for the following industries: motor, food and beverages, chemicals and electronics (the reference group being "other industries"); dummy variables were also created for the MNE home countries most frequently observed in our dataset: the UK, Germany, Japan and the USA (the reference group being "other home countries").

Methods

We used OLS regression analyses to test our hypotheses. We first regressed each of our dependent variables (knowledge outflows to the parent company, knowledge outflows to other subsidiaries, knowledge inflows from the parent company, and knowledge inflows from other subsidiaries) on 14 control variables: subsidiary age and size, MNE size, type of subsidiary, upstream functions, and formal coordination, plus controls for industry and MNE home country. After that, we entered the independent variables: social interaction intensity, the relevant types of workflow integration (depending on whether we look at subsidiary – headquarters relations or at subsidiary – subsidiary relations), subsidiary capabilities, and subsidiary autonomy, and in the next steps the interaction terms of social interaction intensity with workflow integration, subsidiary capabilities and subsidiary autonomy.

Multicollinearity. As several of our independent variables are correlated (see Table 1), we also checked for possible collinearity problems by inspecting variance inflation factors. The highest of these in any equation was 2.521 (control variable for MNE home country USA), suggesting that multicollinearity is not an issue.

Common-method bias. As all of our variables were measured using the same instrument, we checked for common-method bias by performing a factor analysis on all of the variables used in the regressions (Podsakoff & Organ, 1986). This factor analysis did not indicate that there is a single background factor that could be seen as an indication of a common method influencing our results. It resulted in 11 factors with eigenvalues above 1, with the first factor explaining only 10% of the variance. Furthermore, following Lindell and Whitney (2001), we checked for common-method variance by introducing a marker variable. A marker variable should be measured by the same instrument as the scales used in the analysis, but should be theoretically unrelated to the variables of interest. We selected "performance-based coordination" as our marker variable, as we did not use this variable in our analyses, there seemed to be no theoretical reason to assume a relationship with any of our variables of interest, and the marker variable was measured in the same way as most of our other variables. We checked the partial correlations between all of our perceptual variables, controlling for performance-based coordination, and found that all of the significant correlations in Table 1 remained significant. Based on these checks, we conclude that common-method variance does not play an important role in our findings.

Missing data. As described above, we estimated missing data using the EM method. To check for the robustness of our findings, we repeated all of our regression analyses using only cases that missed, at most, values of two single items, and listwise deleted all other cases. This left us with 116 cases. Virtually all of our substantive findings were replicated with this reduced dataset – with a few exceptions in which the smaller sample size rendered some of the weaker effects insignificant, while the direction of the effects remained the same. These findings bolster our confidence that missing data substitution has not produced any artificial effects.

Table 1 Descriptive statistics and correlations of variables in the study

		Mean	*s.d.*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Knowledge outflows to headquarters	3.05	1.51															
2	Knowledge inflows from HQ	3.81	1.13	1.000														
3	Knowledge outflows to subsidiaries	3.26	1.40	0.12	1.00													
4	Knowledge inflows from subsidiaries	2.84	1.17	0.38**	0.33**	1.00												
5	Subsidiary age (years)	39.11	30.22	0.11	0.07	−0.01	1.00											
6	Subsidiary size (log)	5.16	1.42	0.02	0.16*	0.03	0.28**	1.00										
7	MNE size (log)	10.75	1.15	0.15*	0.03	0.02	0.11	0.30**	1.00									
8	Type of subsidiary	0.44	0.50	−0.11	0.01	−0.13	0.10	−0.10	−0.04	1.00								
9	Upstream functions	0.62	0.49	−0.03	0.06	0.03	0.11	0.21**	−0.12	0.06	1.00							
10	Formal coordination	4.84	1.15	0.18*	0.08	0.12	0.20*	0.12	0.19*	0.00	0.03	1.00						
11	Social interaction	3.86	1.26	0.30**	0.44**	0.40**	0.18*	0.16*	0.15	−0.14	−0.12	0.29**	1.00					
12	Workflows to HQ	6.83	19.62	0.22**	−0.07	−0.01	−0.04	0.09	0.01	−0.01	0.15*	−0.04	0.02	1.00				
13	Workflows from HQ	27.07	31.92	0.36**	−0.00	−0.05	−0.00	−0.02	0.12	−0.20**	−0.29**	−0.06	0.10	0.11	1.00			
14	Workflows to other subsidiaries	12.58	21.48	−0.05	0.14	0.09	0.05	0.12	0.01	−0.03	0.19*	0.02	0.00	−0.06	−0.20**	1.00		
15	Workflows from other subsidiaries	23.14	29.52	0.04	0.11	0.22**	−0.05	−0.10	0.14	−0.10	−0.34**	0.16*	0.12	−0.20**	−0.27**	0.12	1.00	
16	Subsidiary capabilities	4.37	0.82	−0.04	0.29**	−0.01	0.08	0.25**	−0.01	−0.01	0.23**	0.10	0.21**	−0.03	−0.12	0.08	−0.03	1.00
17	Subsidiary autonomy	2.29	0.84	−0.35**	−0.04	−0.07	0.10	0.03	−0.09	0.14	0.27**	−0.16*	−0.07	−0.07	−0.45**	−0.04	−0.26	0.21**

N=169; *p<0.05 (two-tailed); **p<0.01 (two-tailed).

RESULTS

Table 1 reports the main descriptives and correlations of the dependent and independent variables used in this study.

As can be seen in Table 1, *knowledge inflows from the parent company* forms the strongest knowledge stream in our sample, and *knowledge inflows from other subsidiaries* the weakest. This finding echoes that of Gupta and Govindarajan (2000), whose data were collected in 1991 (i.e., more than 10 years earlier than our data). The mean inflow from the parent firm is virtually identical in both studies (3.81 vs 3.75). The other flows, however, are all substantially higher in our study (knowledge outflows to the parent firm: 3.05 vs 2.39; knowledge inflows from other subsidiaries: 2.84 vs 2.21; knowledge outflows to other subsidiaries: 3.26 vs 2.36). Thus, even though inflows from HQ are still significantly greater (at $p<0.001$) than the other three types of knowledge flow, it appears that, in the decade between the two studies, MNEs have become more interdependent and less hierarchical. Furthermore, we see that the four knowledge flows are positively correlated – particularly the two types of outflow. Apparently, if a subsidiary has valuable knowledge, this is transmitted to various parts of the MNE. The subsidiaries in our sample receive, on average, more than 50% of their material inputs from other parts of the MNE. In contrast, less than 20% of outputs are transferred to other MNE units, indicating that the subsidiaries deliver mainly to external customers.

Tables 2 and 3 show the results of our regression analyses with knowledge flows to/from the parent firm as dependent variables.

The first model in each series (Models 1 and 4 in Tables 2 and 3) shows the effects of our control variables on the different types of knowledge flow (controls for industry and MNE home country were also included, but since none of these reached the level of significance we do not report these). In the second model in each series (Models 2 and 5 in Tables 2 and 3) the main terms of the independent variables are entered into the regression. Finally, the third model in each series (Models 3 and 6 in Tables 2 and 3) shows the interaction effects of social interaction intensity with workflow integration, subsidiary capabilities and subsidiary autonomy.

Table 2 Factors influencing knowledge flows to/from MNE headquarters

	Dependent variable					
	Knowledge flows to HQ			*Knowledge flows from HQ*		
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Constant	2.703*	−0.769	−0.889	2.232*	2.815**	2.841**
Subsidiary age	0.000	−0.001	−0.000	0.004	0.003	0.003
Subsidiary size	0.076	−0.009	−0.027	−0.062	−0.077	−0.084
MNE size	−0.001	0.022	0.044	0.114	0.104	0.105
Type of subsidiary	−0.007	0.241	0.224	−0.302	−0.031	0.004
Upstream functions	−0.156	0.063	0.067	−0.007	0.331†	0.332†
Formal coordination	−0.031	−0.228*	−0.229*	0.144†	0.027	0.032
Intensity of social interaction		0.323**	0.289**		0.213**	0.194**
Workflows *to* HQ		0.004	0.003		0.010**	0.009*
Workflows *from* HQ		0.006†	0.003		0.009**	0.009**
Subsidiary capabilities		0.507***	0.564***		−0.034	0.005
Subsidiary autonomy		−0.422**	−0.441**		−0.382***	−0.406***
Interactions with social interaction:						
with Workflows *to* HQ			0.005			−0.003
with Workflows *from* HQ			0.002			0.004†
with Subsidiary capabilities			−0.219†			−0.066
with Subsidiary autonomy			0.195†			0.137†
R^2	0.052	0.259	0.298	0.081	0.328	0.348
ΔR^2		0.207	0.039		0.248	0.020
F-statistic	0.602	2.744***	2.676***	0.965	3.834***	3.364***
Hierarchical *F*		8.343***	2.000†		10.992***	1.088

†$p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.001$; controls for industry and MNE home country included but not reported; significance levels reported one-sided where hypothesized, two-sided otherwise.

Table 3 Factors influencing knowledge flows to/from other subsidiaries

	Dependent variable					
	Knowledge flows to other subsidiaries			*Knowledge flows from other subsidiaries*		
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
(Constant)	2.438*	3.933***	3.537**	1.994*	2.943**	2.893**
Subsidiary age	0.000	−0.002	−0.003	−0.002	−0.003	−0.003
Subsidiary size	0.207*	0.113	0.085	0.023	0.007	0.000
MNE size	−0.063	−0.074	−0.029	0.035	−0.018	−0.006
Type of subsidiary	0.065	0.281	0.285	−0.344†	−0.148	−0.173
Upstream functions	−0.142	0.047	0.065	−0.025	0.376†	0.394†
Formal coordination	0.047	−0.145	−0.108	0.113	0.000	−0.002
Intensity of social interaction		0.480***	0.433***		0.389***	0.389***
Workflows *to* other subsidiaries		0.007†	0.008*		0.002	0.004
Workflows *from* other subsidiaries		0.003	0.004		0.008**	0.009**
Subsidiary capabilities		0.354**	0.364**		−0.193*	−0.174†
Subsidiary autonomy		−0.147	−0.108		0.009	0.019
Interactions with social interaction:						
with Workflows *to* other subs			0.001			0.003
with Workflows *from* other subs			0.002			−0.003
with Subsidiary capabilities			−0.268**			−0.108
with Subsidiary autonomy			0.213*			−0.044
R^2	0.078	0.325	0.371	0.110	0.283	0.300
ΔR^2		0.248	0.046		0.173	0.017
F-statistic	0.925	3.778***	3.721***	1.356	3.095***	2.704***
Hierarchical *F*		10.933***	2.653*		7.200***	0.887

†$p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.001$; controls for industry and MNE home country included but not reported; significance levels reported one-sided where hypothesized, two-sided otherwise.

Overall, the control variables explain very little of the variance. Formal coordination is negatively related to knowledge flows to headquarters, but (marginally) positively related to knowledge flows from headquarters. The latter effect disappears when the explanatory variables are entered into the regression. Model 4 in Table 3 shows that acquired subsidiaries are somewhat less likely to receive knowledge from other subsidiaries, but this marginal effect also disappears in the more complete models. Those subsidiaries with upstream functions are marginally more likely to receive knowledge both from the parent firm and from other subsidiaries than those without these activities. This is somewhat surprising, as an effect on knowledge outflows seems more intuitive.

Turning to the main effects of the explanatory variables, intensity of interaction has a consistent positive effect on all four types of knowledge flow. This confirms Hypothesis 1, our baseline hypothesis. Since the scale reliability of our social interaction scale was not very strong, we repeated our analyses using the separate items instead of the composite scale (only for the main effects). The coefficient for *international training* came out significantly in all regressions, and the coefficient for *international taskforces* in three of the four regressions. The coefficient for *informal communication*, in contrast, did not reach the level of significance in any of the regression analyses. While this does not materially alter our conclusions regarding the importance of social interaction for knowledge exchange within the MNE, it does suggest that informal communication is too vague a concept to be of much use. The two other items, however, did tap into aspects of MNE management that are related to knowledge exchange.

We also checked for a possible alternative explanation of the unexpected negative sign of the interaction between social interaction and subsidiary capabilities. If two independent variables are positively correlated, their interaction might act like a quadratic term, indicating a non-linear (inverted U-shaped) relationship between (one of) these variables and the dependent (Blanton & Jaccard, 2006). This alternative explanation can be ruled out in our case, however, since we constructed our interaction term from centered

variables, and as a result it is significantly correlated to neither of the main terms (correlation coefficients with social interaction intensity and subsidiary capabilities are 0.043 and 0.090, respectively). As the main terms of social interaction intensity and subsidiary autonomy are unrelated (correlation is −0.070) we do not need to check for this alternative explanation in this case.

The findings with regard to the main effects of workflow integration are less consistent. In the relationship with headquarters, workflow integration is related only to knowledge inflows, and not to knowledge outflows. In the relationships with other subsidiaries the pattern suggests that knowledge streams follow workflow streams: knowledge flows to other subsidiaries are positively associated with workflows to these subsidiaries; knowledge inflows from other subsidiaries with workflows from these subsidiaries. Thus Hypothesis 2a is partly confirmed. The finding that, between subsidiaries, knowledge flows do indeed seem to follow workflows gives credence to the social learning perspective. However, in the relationship between a focal subsidiary and the parent firm a different mechanism seems to be at work. Subsidiaries that are strongly integrated into workflows to/from the parent firm also receive more knowledge from headquarters (regardless of the direction of the workflow integration). These subsidiaries are also more likely to have upstream functions such as R&D and production. Perhaps knowledge flows to MNE headquarters depend more strongly on the formal status of the subsidiary (e.g., explicit recognition as a "center of excellence"; Frost, Birkinshaw, & Ensign, 2002).

The effect of subsidiary capabilities on knowledge outflows is consistently positive. The expected negative effect on knowledge inflows is found only in the relationship with other subsidiaries. Hence Hypothesis 3a is confirmed as far as knowledge outflows are concerned, but only partly confirmed for knowledge inflows.

Subsidiary autonomy is negatively related to knowledge flows to and from headquarters, but unrelated to knowledge flows to/from other subsidiaries. Hence Hypothesis 4a is confirmed for the relationship with headquarters, but rejected for the relationship with other subsidiaries. In each case adding the main effects to the control variables leads to a significant increase in explanatory power of the models (hierarchical-*F* values are reported in the tables).

In the final model of each series the interaction terms of social interaction intensity with workflow integration, subsidiary capabilities and subsidiary autonomy are entered into the equation. Only in the two models with knowledge outflows as the dependent variable does this lead to a significant increase in explanatory power. The interactions with workflow integration reach a marginal level of significance only for outflows to headquarters. Hence we reject Hypothesis 2b: the effect of social interaction on knowledge-sharing is *not* stronger under conditions of workflow integration. The interaction terms between social interaction and subsidiary capabilities are consistently negative, although only significantly so in the equations with knowledge outflows as the dependent variable. We hypothesized a positive effect. Hence we reject Hypothesis 3b: not only is the effect of social interaction on knowledge-sharing not stronger when subsidiaries have strong capabilities, but the opposite effect seems to be at work. We will return to an interpretation of this finding below. Finally, the interaction of social interaction and subsidiary autonomy has a positive effect on knowledge outflows, both to headquarters (marginally) and to other subsidiaries. We also see a (marginally) positive effect on knowledge inflows from headquarters, but not from other subsidiaries. Hence Hypothesis 4b is partly confirmed.

In Figure 1 we illustrate the effects of the interactions of social interaction intensity with subsidiary capabilities and subsidiary autonomy on knowledge outflows to HQ and to other subsidiaries.

Although intensive social interaction in all cases has a positive effect on knowledge outflows to other subsidiaries, this effect is particularly strong for subsidiaries with relatively weak capabilities. We suggest that the intensive interaction may bring to light what can be learned even from a subsidiary with relatively weak capabilities. Furthermore, the social interaction process could itself lead to the creation of new knowledge, as observed by Adenfelt and Lagerström (2006: 392) in a transnational team: "the close collaboration … among the members of the team also brings about new knowledge, as it creates a means of combining their existing knowledge in diverse areas in new ways".

Turning to the interaction effect of social interaction and subsidiary autonomy, our reason for expecting a positive effect was that we thought that informal interaction would be particularly important if a subsidiary functioned relatively independently from headquarters. Figure 1 also illustrates the effect we found for knowledge flows to other

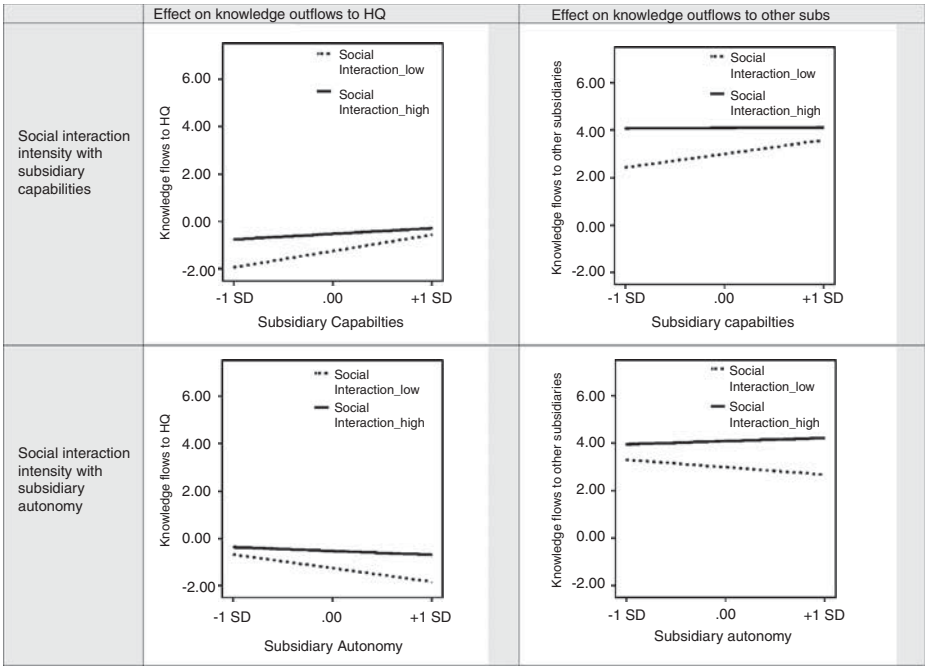

Figure 1 Interaction effects.

subsidiaries. Although subsidiary autonomy has no main effect on these knowledge flows, moderated by social interaction the effect is clear: for highly autonomous subsidiaries social interaction leads to considerably more knowledge outflows; for less autonomous subsidiaries the effect is much weaker. The same pattern (but weaker) is found in the regression with knowledge outflows to headquarters as the dependent variable.

DISCUSSION AND CONCLUSION

Findings Pertaining to Main Effects

Our analyses were guided by the ideas developed in two different perspectives on intra-MNE knowledge flows: the sender–receiver model and social learning theory. Based on both perspectives we expected (as our baseline hypothesis) a positive effect of social interaction intensity on all intra-MNE knowledge flows, and this effect was indeed very clear and consistent. We also hypothesized that knowledge flows would be associated with relevant workflows, both because this would increase the motivation of the subsidiary to send/receive knowledge (sender–receiver model) and because it opens the possibility of linking knowledge-sharing to shared practices (social learning approach). Here we found mixed results: knowledge flows seem to follow workflows in lateral relations within the MNE, but not in vertical relations.

As predicted, subsidiaries with relatively strong capabilities are more likely to act as knowledge senders, both to the parent firm and to other subsidiaries. Relatively weak capabilities are associated only with knowledge inflows in the relationship with other subsidiaries. In the relationship with the parent firm knowledge flows do not seem to be motivated by a relative lack of skills of the focal subsidiary, but rather by the importance of its position in workflows, as suggested above.

Finally, more autonomous subsidiaries do indeed send as well as receive less knowledge from their headquarters, as predicted. However, contrary to our predictions, subsidiary autonomy seems to be unrelated to knowledge-sharing between subsidiaries. This suggests that hierarchical relations still play an important role in vertical knowledge-sharing, but not in horizontal relations. This confirms the network view of the modern MNE.

Findings with Regard to Interaction Effects

Our findings pertaining to the main effects of social interaction, workflow integration, capabilities and autonomy are not very surprising. By and large, these findings confirm those of earlier studies, although these typically tended to look only at one or two of the four types of knowledge flow we

analyzed simultaneously. We believe, however, that our study is particularly interesting in as far as the interaction effects are concerned.

In the logic of the sender–receiver model social interaction is a "pipeline" accommodating knowledge-sharing, but not a factor that would in and by itself lead to knowledge flows. Hence its main effect would be expected to be overshadowed by its interaction effects with independent motivators of knowledge-sharing, such as workflow integration and relative subsidiary capabilities in our study. However, our findings are very different. The main effect of social interaction intensity is strong and consistent; the interaction effects with the other predictor variables are much weaker and in many cases insignificant. The interaction effect with workflow integration is mostly positive, but (marginally) significant only for knowledge flows from headquarters. The interaction effect with subsidiary capabilities is consistently negative, and significantly so for knowledge outflows (both to headquarters and to other subsidiaries). The interaction effects with subsidiary autonomy are mostly positive, as predicted.

Contributions to Theory

Overall, our findings strongly emphasize the importance of social interaction for intra-MNE knowledge streams. This confirms ideas developed originally by Sumantra Ghoshal and Christopher Bartlett 20 years ago (Ghoshal & Bartlett, 1988). Although it is debatable whether the transnational corporation as an organizational form is on the rise to the extent expected by Ghoshal and Bartlett and almost a generation of scholars following in their footsteps (Gooderham & Ulset, 2002), many of the seminal ideas of Ghoshal and Bartlett regarding the internal management of the MNE appear to remain very relevant. In particular, it seems that there are important limitations to what MNEs can achieve with hierarchical coordination, particularly when it comes to knowledge-sharing between subsidiaries. Social interaction seems to be more than just a communication channel with considerable "bandwidth". Bringing employees from different subsidiaries together in informal settings may have serendipitous effects, and lead to ideas and solutions not previously considered (Galunic & Rodan, 1998). Furthermore, with regard to the dissemination of existing knowledge, intensive social interaction may have a strong main effect, just because "utilization of knowledge residing elsewhere in the organization has to be preceded by the notion of its existence and whereabouts" (Persson, 2006: 552).

From a theoretical point of view, our findings suggest that social learning theory has much to offer to the study of intra-MNE knowledge flows. The sender–receiver model has its limitations, in particular because it gives insufficient attention to the importance of social interaction for the (co-) production and integration of knowledge between MNE units. Social learning theory emphasizes that learning, in practice, takes place in communities (Wenger, 1998). Conventional theory based on the sender–receiver model may miss the most crucial point: that knowledge worth transferring and integrating originates in the coming together of disparate MNE units. Less attention should thus be paid to the isolated characteristics of senders, receivers and communication channels, and more attention should be devoted to the social constitution of MNE knowledge (Becker-Ritterspach, 2006).

Rather than treating social interaction as a factor that positively moderates the effects of a number of independent factors causing intra-MNE knowledge flows (such as knowledge characteristics, motivation and capabilities), we need to consider how communication influences or even creates these factors. For instance, Monteiro, Arvidsson, and Birkinshaw (2008) argue that frequent communication between MNE units makes managers more aware of opportunities for leveraging competencies: that is, more communication increases both the perceived capabilities of the other unit and the motivation to learn. In the view of these authors, the subjective self-assessment of a subsidiary's capabilities is therefore not a second-best indicator, but rather a theoretically privileged measure of a factor influencing motivation to share knowledge. Another example of the interweaving of the various factors of the sender–receiver model can be taken from a case study of knowledge-sharing within SCA Packaging, a leading European producer of corrugated paper packaging. Jonsson and Kalling (2007: 167) note that certain pieces of production knowledge used within SCA Packaging are considered to be tacit: "We have a complex process that we can't write down. There are too many parameters to think of". However, at some plants, where management was more strongly motivated to share knowledge, such obstacles were overcome, and much of the production knowledge was made explicit. As one production manager remarks: "Only the lazy claim it is tacit" (Jonsson & Kalling, 2007: 167). Motivation influences (perceived) capabilities as

well as knowledge characteristics, and social interaction influences all these factors.

We see these examples from recent work on intra-MNE knowledge flows as supportive of our conclusion that the sender–receiver metaphor that has dominated much of the work on intra-MNE knowledge flows has reached its limits. To make further progress, we need to focus more squarely on social interaction processes within MNEs, and study how these processes affect the perceived knowledge base, the motivation to share knowledge, and even the very nature of that knowledge (i.e., more or less tacit or explicit). Forsgren (1997) talks about the paradox that MNEs face. On the one hand the ability to integrate knowledge between disparate units is their most important potential advantage; on the other hand the very fact that these units are spread out over the globe makes such knowledge-sharing more difficult. This study suggests that successful MNEs may very well be the ones that support the social interaction processes that both motivate and enable knowledge-sharing.

Managerial Implications

The overriding recommendation that can be based on our findings is the advice to MNE managers to consider the network characteristics of the internal MNE environment when making decisions concerning knowledge development and sharing. In their direct relationships with subsidiaries, MNE headquarters can influence knowledge streams by means of formal coordination mechanisms. For many contemporary MNEs, however, this is only part of the story, and lateral knowledge flows between subsidiaries are increasingly seen as equally important. Our analysis suggests that whereas vertical knowledge flows may be increased by giving a subsidiary less autonomy, this parameter does not influence knowledge-sharing between subsidiaries. Lateral knowledge flows seem to be more strongly linked to the relative strength of subsidiary capabilities, and to follow workflows. This implies that knowledge is shared between subsidiaries when something valuable is offered that is connected to the main tasks of the focal subsidiaries. Having a requisite level of informal social interaction between managers from these units is an important condition for this knowledge-sharing. Hence vertical knowledge-sharing within the MNE can be organized in a top-down fashion, but lateral knowledge-sharing can better be stimulated by headquarters by enabling social interaction between subsidiaries.

We operationalized social interaction intensity in our study as the use of international taskforces, international training programs, and informal communication. MNEs that want to stimulate the sharing of knowledge need to invest in these coordination mechanisms. However, this is costly, in terms of both management time and travel expense. Nowadays, information technology enables MNEs to achieve a certain level of informal integration by working with "virtual teams", avoiding the high costs of face-to-face contacts. However, virtual teams pose their own particular management challenges (e.g., Kirkman, Rosen, Tesluk, & Gibson, 2004), and it remains an open question to what extent virtual teams can substitute for face-to-face interaction (Kiesler & Cummings, 2002). Managers should thus be aware that to the extent that face-to-face interaction is important, intra-MNE knowledge transfer is far from costless. Hence MNE managers need to carefully select the nodes in the MNE network that they want to engage in intensive lateral knowledge-sharing, and concentrate the use of intensive interaction mechanisms on these nodes.

Limitations and Suggestions for Further Research

Our study is characterized by several limitations. First of all, and as noted in the Methods section, all of our measures were perception-based. Although we requested factual information as much as possible (e.g., with regard to the use of inputs from other parts of the MNE, measured in percentages), some degree of bias can be present. While our robustness analyses (reported in the findings section) and our substantive outcomes do not point in the direction of biases, future studies could improve on our work by collecting data from several sources (e.g., from headquarters as well as from subsidiaries). Needless to say, such an approach will pose its own research challenges.

Second, we provide a cross-sectional analysis of a fundamentally dynamic process. Knowledge exchange within MNEs is often bound to projects and goes through different phases (Hansen et al., 2005). The cross-sectional nature of our study gives us a snapshot of knowledge flows from the perspectives of subsidiaries that may be in very different phases of knowledge production and integration processes. More fine-grained and longitudinal research could reveal whether the factors we studied are equally important in different phases.

Third, our model might not be complete. We did not for instance include motivational disposition of the sender and receiver, a factor that was mentioned in previous studies. However, previous studies did not find strong support for this factor, and it is less important for the social learning perspective than for the sender–receiver model.

Fourth, the variable *social interaction intensity*, which proved to be of considerable interest in our study, needs to be better operationalized and measured in future studies. Future researchers may first want to study more closely what MNEs do in order to promote exchange of information between units, and then base an improved measure of social interaction on these observations.

Fifth, although we based our measure of knowledge flows on previous studies, we might not have captured all aspects of inter-unit learning in the MNEs studied. For instance, it might be desirable to include manufacturing know-how as a knowledge domain in future studies.

Sixth, in our study we looked at knowledge-sharing, but this is only part of the job: the knowledge acquired must also be put to productive use to be of value to the MNE (Subramaniam, 2006). Future studies may include a measure of the extent to which the knowledge acquired is also used, and has a positive effect.

Finally, the strong and consistent findings concerning the positive association between social integration and intra-MNE knowledge flows clearly suggest the importance of the use of international taskforces and international training programs. However, we cannot on the basis of our study tell how the mechanisms work. Does social interaction give managers access to fine-grained information that helps to bring about knowledge integration? Or does social interaction mainly help to remove obstacles to knowledge transfer? In-depth, qualitative and longitudinal studies of MNE teams as exemplified by Maznevski and Chudoba (2000), for example, may help to answer these questions.

The study of the management of MNEs has made substantial progress since the seminal work of Ghoshal and Bartlett (1988). The general picture sketched by these authors has inspired many follow-up studies, several of which have focused on the role of subsidiaries, and on knowledge flows within the MNE network. Our study has contributed to this stream of research by systematically analyzing four types of knowledge flow (knowledge outflows and inflows to/from MNE headquarters and other subsidiaries). We focused on the role of social interaction, and theoretically explored and empirically tested the functions that can plausibly be assigned to this factor (in conjunction with other factors) from the perspectives of the sender–receiver model and the social learning approach. Our findings suggest that future work needs to go beyond the study of characteristics of senders, receivers and communication channels, and look more closely at social processes of knowledge production, integration and sharing within the MNE network.

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NOTES

[1]This possibility was pointed out to us by an anonymous reviewer.

[2]We were not able to balance the sample frame completely, as the Netherlands has no MNEs in the motor vehicles and parts industry and few MNEs in the electronics industry, and Germany has few MNEs in either the electronics or food and beverages industry.

[3]As the alpha reliability of this construct is rather low, we also performed the analysis with the three separate items instead of the multi-item scale (see the Robustness Analysis section).

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