

# KNOWLEDGE COMPLEMENTARITY AND TRANSFER THRESHOLDS IN THE DIFFERENTIATED MNC

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## **Keywords**

The differentiated MNC; knowledge flows; value creation.

## **KNOWLEDGE COMPLEMENTARITY AND TRANSFER THRESHOLDS IN THE DIFFERENTIATED MNC**

### **Abstract (160 words)**

The literature on the “differentiated multinational corporation” proposes that such firms can be seen as networks of units that each control heterogeneous knowledge assets, and that they may derive advantages relative to national firms to the extent that they can build complementarities between such knowledge assets. We develop a simple formal model of these ideas, and test hypotheses derived from the model against a unique dataset on subsidiary knowledge development which includes sources of subsidiary knowledge and the extent of knowledge transfer to other MNC units. We find that externally acquired knowledge has a negative effect on subsidiary knowledge transfer if the subsidiary possesses low levels of internally generated knowledge, but a positive effect if it possesses high levels of internally generated knowledge. Similarly, a certain level of external knowledge is required before internal knowledge has a positive effect on knowledge transfer. We estimate the thresholds that determine whether these different types of knowledge become assets or liabilities to the MNC.

## INTRODUCTION

Much recent strategy research has focused on knowledge stocks and their accumulation processes as determinants of sustained competitive advantage (e.g., Dierickx & Cool, 1989; Makadok, 2001). A parallel development in the literature on the “differentiated multinational corporation” points out that MNC knowledge stocks are often distributed across the network of subsidiaries, each controlling heterogeneous knowledge resources (e.g., Hedlund 1986; Bartlett & Ghoshal 1989; Birkinshaw 1996; Ghoshal & Bartlett, 1990; Gupta & Govindarajan 1991, 1995, 2000; Holm and Pedersen 2000). A key message in this literature is that MNCs may derive advantages relative to purely domestic firms from their 1) superior access to such heterogeneous distributed knowledge resources (e.g., Bartlett & Ghoshal, 1986; Hedlund, 1986), and 2) ability to transfer and combine knowledge resources in a low cost manner (e.g., Teece, 1986; Kogut & Zander, 1993). Substantial attention has been paid to how MNCs can manage this process (e.g., Birkinshaw, 1995; Gupta & Govindarajan 1991, 1995, 2000; Foss & Pedersen, 2004).

However, the differentiated MNC literature still needs to address a number of fundamental issues. Specifically, there is a need to more fully address the antecedents of knowledge resources in subsidiaries and how knowledge flows between subsidiaries are related to these antecedents. The specific antecedents we highlight are the sources of subsidiary knowledge stocks. Such stocks are heterogeneous partly because they are built on the basis of different knowledge sources; for example, some subsidiaries may rely more on knowledge sourced from their local environments in the process of building valuable subsidiary-level knowledge bases (i.e., “external knowledge”), while other subsidiaries mainly build knowledge assets based on knowledge inputs from other subsidiaries or corporate headquarters (i.e., “internal knowledge”). The sources of knowledge in an MNC subsidiary influence the cost and benefits of transferring knowledge out of that subsidiary (sometimes referred to as “reverse knowledge transfer,”

e.g. Yang, Mudambi, & Meyer, 2008), because knowledge built from different knowledge sources are likely to have different characteristics (cf. Frost, 2001; Foss & Pedersen, 2004). We build a formal model that frames these ideas and derive empirical implications of these arguments. In particular, we propose and develop the notion of a *complementary knowledge threshold*, which is a level of one type of knowledge that the subsidiary has to exceed before it can benefit from acquisition of other types of knowledge. Although ideas of knowledge complementarities are not new to the MNC literature *per se* (e.g., Doz, Santos & Williamson, 2001), our take on the issue is a distinct one that advances the literature by formalizing these ideas, developing the notion of complementary knowledge threshold, and exploring its implications. We test the idea of a complementary knowledge threshold against a unique data set that includes information on the sources of subsidiary knowledge and the extent of knowledge transfer to other MNC units.

## VALUE CREATION IN THE DIFFERENTIATED MNC

### The Differentiated MNC Literature

The notion that knowledge is a fundamental driver of value creation has become a key tenet in the strategy (e.g., Barney, 1991; McEvily & Chakravarta, 2002) and MNC literatures (Hedlund, 1986; Kogut and Zander, 1993; Gupta & Govindarajan, 1991, 1995, 2000). In the context of MNCs, a knowledge resource (for example, production know-how) may have value to the MNC, particularly if it can be deployed to multiple markets by transferring it to overseas subsidiaries which do not yet hold this knowledge<sup>1</sup>. Furthermore, its value may be enhanced by combining it with other types of knowledge in recipient subsidiaries, such as local market know-how. The broader notion underlying this example is one of the MNC as a network of geographically separated but mutually linked nodes (or units), each

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<sup>1</sup> This assumes that the licensing option is prohibitively costly. Indeed, the characteristics of valuable knowledge often make it an asset that is difficult to trade in the market, and thereby give MNCs an incentive to deploy it internally to their subsidiaries instead (Teece, 1977).

possessing some unique resources, including knowledge stocks (Nohria & Ghoshal, 1989; Ghoshal & Bartlett, 1990).<sup>2</sup> The perception of possibilities for combining complementary resources, and their transfer, and subsequent combination drives overall value creation. Recent contributions to the MNC literature argues that cross-border knowledge flows are less costly inside than between MNCs (e.g. Almeida, Song & Grant, 2002) and accordingly conceptualizes the MNC as an organizational arrangement for international knowledge transfer (Ghoshal & Bartlett, 1988; Hedlund, 1986).

This argument is a comparative one, comparing knowledge transfer costs in markets with the — supposedly lower — costs in (MNC) hierarchies. However, note that the basic premise of the differentiated MNC literature—namely, that knowledge assets controlled by subsidiaries are heterogenous—also implies that intra-MNC transfer costs may not only be substantial, but also differ across transfer channels. As many contributions to the differentiated MNC literature recognize, transfer costs may differ depending on the characteristics of the transferred knowledge, the absorptive capacity of the recipient unit, etc. (e.g., Kogut and Zander, 1993). Moreover, the emphasis on heterogeneity of knowledge resources also implies that the economic value of knowledge may be highly heterogeneous within MNCs, as this value may also depend upon the sources of knowledge, upon which knowledge resources are combined, etc. Understanding the costs and benefits of MNC knowledge flows therefore requires that we first understand why subsidiary knowledge may differ in the first place.

### **Sources of Subsidiary Knowledge**

The knowledge that is held within a MNC subsidiary unit may originate from different sources (Frost 2001). From the perspective of a focal unit, knowledge may come from sources that are *internal* to the MNC and is transferred from other MNC units (i.e., other subsidiaries or the headquarters), or is developed in the subsidiary itself (e.g., through R&D, processes of routinization, etc.). Alternatively,

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<sup>2</sup> The more general notion that firms can usefully be understood as knowledge structures — that is, relations between knowledge resources with certain characteristics — was explicitly put forward by Lyles and Schwenk (1992).

knowledge sources can be *external*, namely customers, suppliers, competitors, and research institutions.<sup>3</sup> Some subsidiaries may rely relatively more on internal knowledge sources, while others may rely more on external ones. This will impact the knowledge that is built in the subsidiary, and therefore the costs and benefits of transferring knowledge from the subsidiary to other MNC units.

One important determinant of these costs and benefits is the *overlap* between the knowledge residing in the sender and recipient units, referring to the amount of knowledge which is shared, that is, contained in both units. A high degree of overlap implies the presence of common knowledge, which has been linked to knowledge transfer in extant studies (e.g. Lane & Lubatkin, 1998; Reagans & McEvily, 2003). If the subsidiary's knowledge is internally developed, the overlap with knowledge held at the receiving unit is likely to be high, either because both units have previously received their knowledge from the same source (for example, MNC headquarters), or in some cases because the subsidiary has previously received knowledge from the (currently) recipient unit. On the other hand, if the subsidiary's knowledge is externally sourced, the overlap with potential MNC recipients in other countries is likely to be low, because these recipients do not have proximate access to the host country where the subsidiary's knowledge has been acquired. While this may seem a relatively straightforward assertion, it has complex consequences which will be developed formally in the following.

### **Modeling the Costs and Benefits of Knowledge Transfer**

Consider a focal foreign subsidiary. The knowledge resources of this unit may be of either internal or external origin or some combination thereof. These resources can be transferred to other units in the MNC, including corporate headquarters or other foreign subsidiaries. The more of the subsidiary's

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<sup>3</sup> Conceptually, one can distinguish between different external sources of knowledge that may be available to subsidiary firms. For example, firms may acquire "network-based knowledge", that is, the gaining of knowledge from long-lasting interaction with specific external parties, such as customers or suppliers, and the use of that knowledge in the firm's activities (Ford 1990; Dyer and Nobeoka 2000). Moreover, they may gain "cluster-based knowledge," which is based upon knowledge inputs from sources such as a well-educated work force or local knowledge institutions like technical universities, etc. (Porter 1990; Porter and Sölvell 1999). Here, we focus on "network-based knowledge" as the main "external knowledge sources" while controlling for "cluster-based knowledge."

knowledge that is transferred out of the host country to other MNC units, the higher the benefits to the MNC, denoted  $B$ , but also the higher the costs incurred in the process, denoted  $C$ . As we argue both costs and benefits are influenced by an interaction between the level of internal knowledge in the subsidiary ( $I$ ), the level of external knowledge ( $E$ ), and the amount of knowledge transferred out of the subsidiary ( $K$ ). The following sections flesh out the nature of this relationship by specifying how the marginal benefits and costs of knowledge transfer — mathematically<sup>4</sup>,  $B_K$  and  $C_K$  — are affected by the sources of subsidiary knowledge.

### **Marginal Benefits of Knowledge Transfer**

The benefits of transferring knowledge from a subsidiary, defined as the increase in value generated in the recipient unit, depend on the characteristics, and thereby ultimately on the source, of the knowledge to be transferred. A key point of the differentiated MNC literature is that important knowledge may develop in the periphery of the firm's knowledge structure, stimulating organizational learning (Zahra, Ireland & Hitt, 2000). This suggests that external knowledge in foreign subsidiaries may be valuable to MNCs (Ghoshal, 1987; Frost, Birkinshaw & Ensign, 2002). For example, the MNC may take advantage of inter-firm spillovers of technological knowledge (Jaffe, Trajtenberg & Henderson, 1993), or extract market knowledge from sophisticated customers and skilled competitors by having specialized subsidiaries in strategic locations (Porter, 1998; Asmussen, Dhanaraj & Pedersen, 2008). Dunning (1996) provided evidence that MNCs derive a significant share of their competitive advantage through such mechanisms. As knowledge derived from a subsidiary's external environment is likely to have low overlap with pre-existing MNC knowledge in other units, it may be *combinable* with knowledge resources in those units.

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<sup>4</sup> As a convention we use subscripts to denote derivatives in this paper, e.g.  $B_K \equiv \partial B / \partial K$ . The only exceptions are (1) subscripted numbers, which denote vector members such as  $a_1$ ,  $a_2$ , etc., and (2) the subscripts  $j$ ,  $S$ , and  $R$  which denotes a variable belonging to a given subsidiary, such as  $K^*_j$  or  $V_S$ .

**Knowledge combinability.** Knowledge transfer benefits exist if it is valuable to combine some of the knowledge resources of the focal subsidiary (we denote these resources  $S$ ) with the pre-existing knowledge resources of the MNC recipient unit (we call these  $R$ ). It is not sufficient that the knowledge stocks in the focal subsidiary have some positive value ( $V_S > 0$ ): combining  $R$  and  $S$  is, of course, only meaningful if the economic value of the resulting composite value stock in the recipient unit ( $V_{SR}$ ) is larger than the value of its original knowledge stock ( $V_R$ ). There are different types and strengths of relationships between knowledge resources (e.g., Thompson, 1967: 15-18; Milgrom & Roberts, 1990; Buckley and Carter 1999), which may lead  $V_{SR}$  to exceed  $V_R$  and hence provide a potential knowledge transfer benefit given by  $B = V_{SR} - V_R$ .

One type of dependency between knowledge resources is when they can be considered *substitutes*, for example, when the knowledge pertains to the best technique to perform a certain task and a choice has to be made between alternative techniques. The economic value of the combined substitute knowledge resource is then  $V_{SR} = \max(V_S, V_R)$ . For example, having knowledge of both techniques enables a unit to choose the best one (the one that maximizes  $V$ ). Transferring substitute knowledge may thus enhance the performance of the recipient units *iff* there is some heterogeneity in the knowledge and performance of the different units of the MNC. To be precise, the sending subsidiary must be better at performing the task than is the recipient unit ( $V_S > V_R$ ), in which case  $V_{SR} = V_S$  and therefore knowledge transfer benefits (the economic value gained by the MNC) is given by  $B = V_S - V_R$ .<sup>5</sup>

Another type of relationship is when relevant knowledge resources are *additive* (Buckley and Carter, 1999), such as when knowledge resources pertain to production of a product which the recipient subsidiary did not initially know how to make. In this case the economic value of the combined value stock is  $V_{SR} = V_S + V_R$ . An even stronger dependency between knowledge resources is when they are

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<sup>5</sup> Such benefits plays a key role in the literature on “best practice transfer” (Szulanski, 1996), “transfer of innovation” (Doz, Santos & Williamson, 2001), and “organizational learning” (Epple, Argote, & Devadas, 1991).

*complementary* (Milgrom and Roberts, 1990) in the sense that the returns from knowledge resource  $S$  increase with higher levels of knowledge resource  $R$  (and *vice versa*). This implies that  $V_{SR} > V_S + V_R$ . An extreme form of complementarity is when knowledge resources are *perfectly co-specialized*, that is, if one resources has no economic value without the other, so that  $V_S = V_R = 0$  but  $V_{SR} > 0$ . For example, if the focal subsidiary has technological knowhow that allows it to manufacture a certain product, and the recipient unit knows the necessary specifications for the product to be sold in the markets that the subsidiaries supply, one of them needs to acquire the residual knowledge from the other subsidiary in order to generate value.<sup>6</sup>

***Knowledge relevance.*** As the preceding analysis demonstrates, the combinability of knowledge resources, and hence the benefits of knowledge transfer, hinges on the knowledge of the focal subsidiary being somehow different from (having low overlap with) the knowledge at the recipient unit. As we have argued previously, this is most likely to be the case if the subsidiary knowledge is externally generated, suggesting that external knowledge is a key driver of knowledge transfer benefits. However, too little overlap may be as detrimental to these benefits as too much overlap, because the value of transferred knowledge also depends on the *relevance* of the knowledge to the recipient, defined as the extent to which the knowledge is related to and connects with the pre-existing knowledge in the recipient unit (Schulz, 2003). If the context of the sender and recipient subsidiaries differ, external knowledge may be so far removed from the realities of the recipient unit that the personnel in this unit does not realize its value, or does not have the necessary tacit complementary knowledge to exploit it. In other words, the recipient unit does not possess the relative absorptive capacity to utilize the external

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<sup>6</sup> Most examples mentioned in this section are simultaneous, but dependencies may also be sequential (Thompson, 1967; Milgrom and Roberts, 1995; Buckley and Carter 1999). For example, a sequential complementary dependency occurs if subsidiary knowledge is an input prior to the building of knowledge in another part of the MNC, such as when knowledge of local tastes are transferred to centralized R&D functions.

knowledge (Lane & Lubatkin, 1998), and, hence, even if the knowledge is successfully transferred, it may reside at the recipient without being exploited to its full commercial potential.

**Knowledge fungibility.** Another drawback of external knowledge is that the value of such knowledge may be specialized to certain locations. For example, while we may argue that production blueprints from the focal subsidiary are valuable to overseas MNC units which can use them to manufacture products for their local customers, this would depend crucially upon whether the customers in those countries actually value the product described by the blueprint. This suggests that, in addition to combinability and relevance, the degree of knowledge *fungibility* is an important determinant of the benefits of knowledge transfer. Teece (1982) defined fungible resources as generalized firm-specific capabilities, such as technical or managerial knowledge, that can potentially be used to diversify into a wide variety of product markets.<sup>7</sup> In the multinational context Rugman and Verbeke (1992) have stressed the importance of geographic fungibility by distinguishing between location-bound and non-location bound firm-specific advantages. Geographic fungibility means that the value of the focal subsidiary's knowledge stock is reduced as soon as it arrives in another country. In the terminology introduced earlier, the value of the transferred knowledge stock may be  $V_S$  in the originating subsidiary but only  $f_j V_S$  in the recipient unit, where  $f_j < 1$  captures the imperfect fungibility of the knowledge stock to subsidiary  $j$ .<sup>8</sup> Several factors may contribute to making a knowledge resource location-bound: the recipient units may be badly positioned to exploit the knowledge, because they are distant from the customers, suppliers, partners, or competitors with regard to whom the knowledge is most relevant. This suggests that external knowledge, unique as it may be, is also likely to be more difficult to apply in

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<sup>7</sup> The idea of fungibility as the opposite of specialization was further developed by Montgomery and Wernerfelt (1988), who argued the marginal rents from applying a given resource in a given market declines with the distance to the market and the specialization of the resource.

<sup>8</sup> In the example of substitute knowledge, the benefits of knowledge transfer are thus reduced to  $B = f_j V_S - V_R$  and so best practice transfer should therefore be constrained to knowledge with high fungibility. This seems consistent with the best practice literature which often focuses on technical knowledge such as production know-how (e.g. Darr, Argote & Epples, 1995).

other MNC units, precisely because it is of a more peripheral origin. It is less fungible than internal knowledge because it relates specifically to host country conditions and is therefore more location-bound.

***Interaction of internal and external knowledge.*** As a result of these diverging effects, external knowledge does not have an unambiguous effect on the marginal benefits of knowledge transfer. If the combinability effect dominates it would have a positive effect, so that more external knowledge leads to higher knowledge transfer benefits. On the other hand, if knowledge relevance and fungibility are low, there is a negative relationship between external knowledge and knowledge transfer benefits. We propose that the *interaction* of external with internal knowledge determines which of these effects dominates, for several reasons. First, in order for external knowledge to be combinable with complementary knowledge assets in other MNC units, it has to be interpreted and formulated in such a way that it will be accessible to other units. One way to accomplish this is to relate knowledge based on external knowledge sources to knowledge based on internal knowledge sources. This may increase the relevance of the subsidiary's composite knowledge stock. For example, external knowledge may be reformulated so that it is more complementary to knowledge held in other MNC units. In absence of this interaction with internal knowledge, external knowledge may generate lower benefits in other parts of the MNC because it is too distant from the recipients' pre-existing knowledge; hence, they may lack the absorptive capacity and the complementary knowledge to exploit it. Combining internal and external knowledge can lead to the desired intermediate degree of overlap with the knowledge in other MNC units, so that the knowledge of the subsidiary is neither too close to identity with, nor too different from the knowledge in potential recipient units.

Second, it is possible that internal and external knowledge resources are complementary or even perfectly co-specialized (e.g., internally generated technological knowledge and externally sourced

market knowledge), so that they can be combined into a more valuable composite knowledge resource and subsequently transferred to other MNC units. Finally, if the subsidiary possesses internal knowledge it may be able to acquire external knowledge which is more fungible and relevant in the first place. Internal knowledge can thus empower the subsidiary as a “listening post” for the MNC—a role in which “receiver competence (assessing, filtering, and choosing information) and absorptive capacity (adapting inflows to fit firm-specific requirements) become crucial” (Mudambi & Navarra, 2004: 389). Taken together, all of this leads to the assumption that internal knowledge positively moderates the impact of external knowledge on the marginal benefits of knowledge transfer, formally expressed as  $B_{KEI} > 0$ .

In practice, this implies that a combination of external and internal knowledge sources in the subsidiary is optimal with regard to knowledge transfer benefits. To see this, consider some of the MNC archetypes described in the literature. One is the cluster-based “global” MNC described by Porter (1990), where the knowledge resources of different subsidiaries are internal because they are all essentially transferred from corporate headquarters. In this case the subsidiaries would gain little from combining knowledge because they all have it from the same source in the first place. There may be nearly complete overlap with the knowledge of potential recipient units — that is,  $S$  is identical to  $R$  and hence the combined knowledge stocks  $S$  and  $R$  are no different from either  $S$  or  $R$  in isolation; it follows that  $V_{SR} = V_R$  and hence there can be no benefits to transfer.

The obverse of this case is the “knowledge-seeking MNC” (Cantwell & Mudambi, 2005) where subsidiaries possess external knowledge stocks acquired from their local environments. In the extreme, if all of a subsidiary’s knowledge is external, there is likely to be no overlap with the knowledge of potential recipient units. Hence, while each unit contributes unique knowledge to the network, this knowledge has low fungibility and low relevance to the other units, who would therefore find it difficult to assimilate and utilize in their own unique contexts. That would presumably reduce  $V_{SR}$  compared to

the case where just a small degree of overlap exists. This suggests that  $V_{SR}$  is maximized with a combination of internal and external knowledge, where enough overlap exists to make the transferred knowledge useful to the recipient, but not enough to make it redundant. In other words, from a knowledge-based perspective the ideal type of an MNC combines the features of the extreme types, by having its subsidiaries draw on knowledge both from their local external networks from the MNC internal network.

### **Marginal Costs of Knowledge Transfer**

Irrespective of the benefits of potential knowledge transfer, knowledge resources vary in the degree to which, and at what cost, they can be transferred from one unit to another within a firm. If the knowledge resource can be codified or taught (Zander & Kogut, 1996), it can be considered non-diminishable (Frank, 2007); hence, it can be transferred to another unit without disappearing from the original unit.<sup>9</sup> On the other hand, tacit knowledge may be very difficult to transfer except by transferring the personnel in which the tacit knowledge resides (which effectively makes the relevant knowledge diminishable). In general, the costs of knowledge transfer differ. Knowledge transfer costs are usually ascribed to the efforts undertaken by the sender and receiver of the knowledge (Martin & Salomon, 2003; Reagans & McEvily, 2003; Szulanski, 1996; Teece, 1977), such as “efforts to codify and teaching complex knowledge to the recipient” (Kogut & Zander, 1993: 630). As argued previously, these costs may be substantial even within an MNC. The MNC bears the opportunity costs of the time of the sender and receiver and of the organizational resources that they consume, as well as the direct costs they incur in this process. For example, physical transportation costs may result from knowledge transfer if face-to-

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<sup>9</sup> Knowledge is often argued to possess public good properties, which would imply both non-diminishability (or, “non-rivalrous consumption”) and non-excludability (Frank, 2007). While non-diminishability is clearly an important advantage of knowledge as a resource, knowledge cannot be non-excludable if it is to provide sustained competitive advantage (Barney, 1991).

face contact between personnel from different geographic units is deemed necessary to effectuate the transfer.

The costs of knowledge transfer are determined by a range of factors such as the attributes of the knowledge itself, of the sender, and of the receiver (Teece, 1977; Zander and Kogut, 1992; Cohen and Levinthal, 1990; Galbraith, 1990). In an MNC, the marginal costs of transferring knowledge out of a given subsidiary may differ depending on whether the subsidiary's knowledge stock originates from internal or external sources. If the subsidiary's knowledge is mainly internal, the overlap between the knowledge of the sender and recipient units is likely to be high, as argued above. This leads to low knowledge transfer costs (Reagans & McEvily, 2003): As the two units hold a certain amount of knowledge in common, it is likely that less codification will be necessary because the transferred knowledge is easily recognized and understood; fewer costly misunderstandings occur.

External knowledge in the subsidiary, on the other hand, is likely to have fewer overlapping resources with other knowledge assets in the MNC. Therefore, even though other MNC units could potentially benefit from this knowledge, their relative absorptive capacity to assimilate it is small (Lane and Lubatkin, 1998; Cohen and Levinthal, 1989). In turn, this means that the encoding and decoding of this knowledge may require more effort and the need for face-to-face contact may be higher. All of this suggests that the marginal costs of knowledge transfer will be higher the more of the subsidiary's knowledge is external and lower the more of it is internal. We express this formally as  $C_{KI} < 0$  and  $C_{KE} > 0$ .

### **Net Benefits and the Incentives for Knowledge Transfer**

The difference between marginal benefits and costs—that is, the marginal *net* benefits of knowledge transfer—are what makes knowledge transfer profitable to an MNC. Nevertheless, these net benefits are likely to decrease as a function of the overall level of knowledge transfer, because sooner or

later either the benefits from further knowledge transfer are exhausted or the costs become prohibitive (Cohen and Levinthal, 1989). For example, it is likely that MNC managers will extract the most valuable knowledge from a subsidiary first, leaving increasingly less valuable knowledge — with accordingly lower marginal benefit — unexploited in the subsidiary. Also, MNCs may have a finite capacity for the level of knowledge transfer they can achieve, and as this capacity is approached the marginal costs rise due to “clogged” transmission channels and limited cognitive capacity both in the sender (subsidiary) and receiver (MNC) units. The assumption of diminishing marginal net benefits to knowledge transfer is formally expressed as  $B_{KK} - C_{KK} < 0$ .

### **Predictions from the Model**

The model sketched out above does not say anything about the way in which the  $K$ ,  $E$ , or  $I$  are determined; only about how they interact to influence the performance of the MNC. Nevertheless, the model can generate predictions concerning how an MNC’s incentives to transfer knowledge change with the levels of internal and external knowledge. To see this, note that the best knowledge transfer strategy maximizes the net benefits from knowledge transfer, denoted  $NB$ :

$$\max_K NB(K) = B(E, I, K) - C(E, I, K) \quad [1]$$

The first-order condition for this optimization problem is:

$$NB_K = B_K(E, I, K^*) - C_K(E, I, K^*) \equiv 0 \quad [2]$$

This equation implicitly defines the optimal level of knowledge transfer, here denoted  $K^*$ , as a function of  $E$  and  $I$ . We use this feature to derive the comparative statics of these two parameters, that is, how changes in knowledge levels affect the optimal level of knowledge transfer.<sup>10</sup> By implicit differentiation we get:

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<sup>10</sup> The second order condition for an optimum,  $B_{KK} - C_{KK} < 0$  is fulfilled by the assumption of diminishing marginal net benefits.

$$K^*_I = \frac{B_{KI} - C_{KI}}{-(B_{KK} - C_{KK})} \quad [3]$$

$$K^*_E = \frac{B_{KE} - C_{KE}}{-(B_{KK} - C_{KK})} \quad [4]$$

The signs of the second derivatives in these equations reveal, somewhat surprisingly, that we cannot *a priori* predict the direction of the effect of internal or external knowledge on knowledge transfer. In the case of internal knowledge, if  $B_{KI}$  is negative, it may dominate the benign effect of internal knowledge on the transfer costs ( $C_{KI} < 0$ ), resulting in a negative relationship between internal knowledge and knowledge transfer. This would be consistent with our combinability argument: The more the subsidiary's knowledge is internal, the lower the benefits from combining it with knowledge in other parts of the MNC, and therefore the lower the ideal level of knowledge transfer. In the case of external knowledge, the explanation is similar, except that here  $B_{KE}$  does not even have to be negative. As long as  $B_{KE} < C_{KE}$ , external knowledge will tend to lower the MNC's incentives for knowledge transfer: The more external knowledge the subsidiary possesses, the less applicable will be its innovations and best practices in other parts of the MNC, and the more costly they will be to transfer there. Only if  $B_{KE}$  is positive and higher than  $C_{KE}$ , will knowledge transfer incentives be positively affected by external knowledge.

However, since  $B_{KEI} > 0$  we can be sure that the probability of a positive  $K^*_E$  increases with  $I$ , and the probability of a positive  $K^*_I$  increases with  $E$ . In other words, if the subsidiary has sufficiently strong knowledge of one type, then the marginal benefits of the other type of knowledge will be higher and hence more likely to outweigh its marginal costs.

This implies that there may exist internal and external *knowledge thresholds* that a subsidiary must exceed before the MNC can benefit from its knowledge. Thus, there may be a threshold level of internal knowledge which is required for the MNC to benefit from knowledge that originates in a

subsidiary's external environment. Above this threshold, the acquisition of external knowledge is beneficial to the MNC ( $K^*_E > 0$ ). Below the threshold, external knowledge becomes a liability ( $K^*_E < 0$ ). Similarly, there may be a threshold of external knowledge that the subsidiary has to exceed in order for the MNC to benefit from its internal knowledge. This results in the two main hypotheses of this paper:

*Hypothesis 1: If the internal knowledge of the subsidiary lies above a certain threshold level, the relationship between external knowledge and knowledge transfer is positive, otherwise this relationship is negative.*

*Hypothesis 2: If the external knowledge of the subsidiary lies above a certain threshold level, the relationship between internal knowledge and knowledge transfer is positive, otherwise this relationship is negative.*

Since  $C_{KE} > 0$  and  $C_{KI} < 0$ , we would expect that the threshold defined by Hypothesis 1 is higher than the threshold in Hypothesis 2. This is, however, ultimately an empirical question which we address in the following.

## EMPIRICAL ANALYSIS

### Operationalizing the Model

To make the model described above amenable to empirical testing, we suggest a parameterized version of the model. Suppose the net benefit of knowledge transfer for subsidiary  $j$  can be written as:

$$NB_j(K) = g_1 E_j K + g_2 I_j K + g_3 E_j I_j K - g_4 K^2 + \mathbf{b}' \mathbf{t}_j K + \mu_j K \quad [5]$$

Where  $\mathbf{g}$  and  $\mathbf{b}$  are parameter vectors,  $\mathbf{t}_j$  is a vector of observed subsidiary-specific variables which affect the costs and benefits of knowledge transfer, and  $\mu_j$  captures the net effect of all unobserved subsidiary-specific variables which affect these costs and benefits. This is a very general and simple form which can be easily shown to fulfill all of the assumptions outlined above<sup>11</sup>. It can be solved for a prediction of  $K_j^*$ , resulting in:

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<sup>11</sup> Note that in this equation,  $g_1$  captures the *net* effect of  $B_{KE} - C_{KE}$  when  $I=0$ , and  $g_2$  captures the net effect of  $B_{KI} - C_{KI}$  when  $E=0$ .  $NB_{KEI} = g_3$ , which is expected to be positive due to the complementarity between  $I$  and  $E$ . We add the  $K^2$  term based on the assumption of diminishing marginal net benefits of knowledge transfer.

$$\begin{aligned}
K_j^* &= \frac{g_1}{2g_4} E_j + \frac{g_2}{2g_4} I_j + \frac{g_3}{2g_4} E_j I_j + \frac{1}{2g_4} \mathbf{b}' \mathbf{t}_j + \frac{1}{2g_4} \mu_j \\
&\equiv \gamma_1 E_j + \gamma_2 I_j + \gamma_3 E_j I_j + \mathbf{\beta}' \mathbf{t}_j + \frac{1}{2g_4} \mu_j
\end{aligned} \tag{6}$$

In this model,  $\mathbf{t}_j$  are control variables and  $\frac{1}{2g_4} \mu_j$  is a subsidiary-specific intercept. If we call the mean value of this intercept for  $\phi$ , and the difference between the individual subsidiary's intercept and this mean for  $\varepsilon_{1j}$ , the expected value of  $\varepsilon_{1j}$  is 0 and  $\frac{1}{2g_4} \mu_j = \phi + \varepsilon_{1j}$ . Substituting this into [6] yields an equation which has the advantage that it lends itself directly to empirical testing by regression analysis:

$$K_j^* = \phi + \gamma_1 E_j + \gamma_2 I_j + \gamma_3 E_j I_j + \mathbf{\beta}' \mathbf{t}_j + \varepsilon_{1j} \tag{7}$$

The estimated parameters in this model have relevance to questions of managerial interest. As discussed above, one such question is what level of internal knowledge is required to make external knowledge beneficial. This level can be estimated directly from the above parameters, by asking what level of  $I$  would ensure that  $K^*_E > 0$ :

$$K^*_E = \gamma_1 + \gamma_3 I > 0 \Leftrightarrow I > \frac{-\gamma_1}{\gamma_3} = \frac{-g_1}{g_3} \tag{8}$$

A negative  $g_1$  implies that  $B_{KE} - C_{KE} < 0$  when  $I = 0$  (see footnote 11), in which case the level of internal knowledge in the subsidiary has to be above  $-\gamma_1 / \gamma_3 > 0$  before external knowledge has a positive effect on the knowledge transfer out of the subsidiary. For any subsidiary which has more internal knowledge than this threshold, it is attractive to transfer external knowledge. Subsidiaries with internal knowledge below this threshold, on the other hand, will find external knowledge to be more a liability than an asset. Based on Equation [8], we can identify exactly how many subsidiaries in our sample are able to translate the strength of their local business environment into intra-MNC knowledge transfer.

A similar threshold can be estimated for internal knowledge:

$$K^*_I = \gamma_2 + \gamma_3 E > 0 \Leftrightarrow E > \frac{-\gamma_2}{\gamma_3} = \frac{-g_2}{g_3} \tag{9}$$

If  $g_2$  is negative,  $B_{KI} - C_{KI} < 0$  when  $E = 0$  and in that case  $-\gamma_2 / \gamma_3 > 0$  corresponds to a positive external knowledge requirement.

### **An Instrumental Variables Approach**

While we have treated internal and external knowledge as exogenous variables in our framework, it is possible that these are in fact endogenous. If we estimated Equation [7] using OLS, we would therefore run the risk of obtaining biased results and, consequently, biased thresholds. In principle, if we could identify and observe all variables affecting  $K$ , we would be able to control for these variables and thereby solve the endogeneity problem (controlling on observables). However, in practice we cannot *a priori* rule out the presence of unobserved variables which may affect both  $I$  and  $E$  in addition to  $K$ . For example, suppose that the disturbances  $\varepsilon_{1j}$  were created by unobserved subsidiary-specific variables — such as tacit knowledge management capabilities — affecting both knowledge levels and knowledge transfer. In that case  $I$ ,  $E$ , and  $\varepsilon_{1j}$  would be positively correlated (because they were affected by the same unobserved capabilities), which would lead to inflated estimates of the  $\gamma$  in Equation [7] and thereby to biased estimates of the thresholds in Equations [8] and [9].

To correct this problem we can replace the actual values of the endogenous regressors with instrumental variables or, preferably, by predicted values based on multiple instruments (Kennedy, 2000). Therefore, we add the following two equations to our model:

$$I_j = \eta_0 + \boldsymbol{\eta}' \mathbf{n}_j + \varepsilon_{2j} \quad [10]$$

$$E_j = \alpha_0 + \boldsymbol{\alpha}' \mathbf{a}_j + \varepsilon_{3j} \quad [11]$$

where the  $\varepsilon_j$  are disturbances, and the  $\mathbf{n}_j$  and  $\mathbf{a}_j$  are exogenous variables that are expected to influence internal and external knowledge acquisition, respectively (to be described below). In combination, Equations [7], [10], and [11] constitute a recursive system of simultaneous equations. If the disturbance

terms  $\varepsilon_j$  are correlated, which they will be if there are unobserved variables affecting all three endogenous variables, then OLS coefficients would be biased (Greene, 2000). A better estimation method in that case is 2SLS where the endogenous regressors  $I$  and  $E$  are regressed on all the exogenous variables in the first stage and their predicted values (which, unlike the actual values, are uncorrelated with the  $\varepsilon_{1j}$ ) are used in Equation [7] in the second stage. We employ a Hausman test to determine whether OLS or 2SLS is preferable.

### **Data Collection**

The data for this paper was collected as part of the Centres of Excellence (CoE) project that engaged researchers in the Nordic countries, the United Kingdom, Germany, Austria, Italy, Portugal and Canada (see Holm & Pedersen, 2000). The CoE-project was launched with the purpose of investigating headquarter-subsidary relationships and the internal flow of knowledge in MNCs. In order to collect comparable quantitative data on acquisition of subsidiary knowledge, it was decided to construct a questionnaire that could be applied in all the involved countries. This was accomplished after several project meetings and extensive reliability tests of the questionnaire on both academics and business managers.

For practical reasons, each project member was responsible for gathering data on foreign-owned subsidiaries within their own country. Thus, all subsidiaries in the database belong to MNCs. In the data gathering, subsidiary managers, rather than headquarters, were respondents. One advantage of choosing subsidiary respondents is that they are directly engaged in the operations on the market and are therefore more acquainted with its characteristics. Although we may expect any subsidiary to have a reliable awareness and understanding of its own knowledge resources, it would be an advantage to gather information on intra-MNC knowledge flows from other corporate units as well. However, it would be an

unmanageable task first to identify the appropriate subsidiaries in each country and then to identify and approach the relevant management units in the foreign subsidiaries.

Our analysis is based on data from seven countries, namely Austria, Denmark, Finland, Germany, Norway, Sweden and the UK. All countries are located in the northern part of Europe. The four Nordic countries are relatively small, while Germany and the UK are among the largest in Europe. Approximately 80 percent of the questionnaires were answered by subsidiary executive officers, while financial managers, marketing managers or controllers in the subsidiary answered the remaining 20 per cent. The overall response rate was 30%, and the quality of the data was quite high; a general level of missing values was not greater than 5%. Table 1 shows these sample properties segmented by country. Country variations emerge in the response rates, which range from 20% (in the UK) to 55% (in Sweden), and in the sizes of the subsidiaries, which tend to correlate with the sizes of the host countries and with subsidiary age. In general, the Nordic subsidiaries were younger and smaller than those in other countries.

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***Insert Table 1 Here***  
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The total sample covers information on 2,107 subsidiaries, comprising all types of subsidiaries in all fields of business. The average number of employees in the subsidiaries was 742, with a median of 102. Average annual subsidiary sales were USD 142 million. The average subsidiary age at the time of the survey was 17 years, and 42% of all the subsidiaries were established as greenfield investments (while the remaining 58% were acquisitions). The sample size ranges from 202 (UK) to 530 (Sweden), with the size of the sample being rather similar, with the exception of Sweden. Within the five smaller countries, the average size of the subsidiaries is very similar, while Germany and the UK, due to the larger size of their markets, comprise substantially larger subsidiaries. As it seems natural to expect

larger subsidiaries to comprise more knowledge resources and therefore more potential for knowledge transfer, *ceteris paribus*, we will control for subsidiary size in the data material when conducting tests of our theory.

For all subsidiaries sampled, information exists on the subsidiary knowledge resources, notably subsidiary level competencies, the sources of the competencies, organizational context variables, and the extent to which knowledge has been transferred to other MNC-units. The subsidiaries were asked to indicate the level of competence for six different activities performed by the subsidiary on a seven-point Likert scale, from 1 (= very weak competence) to 7 (= very strong competence). The relevant six activities are: research (basic and applied), development (of products and processes), production (of goods and services), marketing and sales, logistics and distribution, and purchasing. The average score on the seven-point scale of the level of competence is shown in Table 2.

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*Insert Table 2 Here*  
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In general, the subsidiaries indicate that they comprise a relatively high level of competence for all activities with average values ranging from 4 to 6 on the seven-point scale. The pattern is very similar for all six countries, with the highest competence levels for production and marketing/sales, and somewhat lower levels for the four other activities. As expected, the larger German and UK subsidiaries have higher competence levels than the other subsidiaries in the sample, with slightly higher values than the total sample for all six activities.

## **Measures**

All data were collected through the questionnaire and most variables are multi-item measures that were measured using seven-point Likert scales. However, items such as the number of employees were

measured using actual values. The following sections provide the exact wording used for questionnaire items, starting with the three endogenous variables (*K*, *I*, and *E*).

***Knowledge transfer.*** Our definition of (successful) knowledge transfer captures the application of the subsidiary knowledge in other MNC units. Accordingly, the subsidiaries were asked to what extent the knowledge they controlled had been of use to other MNC units. Respondents indicated this on a seven-point Likert scale, where 1 was defined as “to no use at all for other units” and 7 was defined as “very useful for other units” for all the six above-mentioned activities. *Knowledge transfer* is a multi-item construct calculated as the average score reported by respondents across these six items (Alpha = 0.74).

***Internal knowledge.*** The construct of “internal knowledge” captures the knowledge developed through interaction with other MNC units. In order to measure the knowledge inputs from other MNC-units, the respondents were asked to assess the impact of various internal organizations on the development of the subsidiary's competencies, where 1 equaled “no impact at all” and 7 equaled “very decisive impact”. Four organizations were identified: the MNC headquarters, internal MNC customers, internal MNC suppliers, and internal MNC R&D units. In the models used to test our hypotheses, we use a composite measure, *Internal knowledge*, based on the average across the four items (Alpha = 0.71).

***External knowledge.*** The construct of “external knowledge” (i.e., subsidiary-level knowledge built mainly from external knowledge inputs) captures the importance of external parties such as customers and suppliers. The inputs from external partners were measured by asking respondents to assess the impact of various external organizations on the development of the subsidiary's competencies, where 1 equaled “no impact at all” and 7 equaled “very decisive impact”. Four organizations were identified: external market customers, external market suppliers, specific distributor and specific

external R&D units. *External knowledge* is calculated as the average score reported by respondents across these eleven items (Alpha = 0.68).

***Predictors of internal knowledge.*** As predictors of internal knowledge in Equation [10], we included a number of variables suggested by theory. First, we have argued that internal knowledge is closely related to knowledge held in other parts of the MNC, which suggests that such knowledge may more easily emerge when the subsidiary has well developed channels, routines, and organizational structures for exchanging information with other units. The development of internal knowledge is also likely to be stimulated by the transfer of goods and/or services between MNC units. The reason is that such transfer (i.e., intra-MNC trade) is in itself a force pulling in the direction of a widening of communication channels, prompting the discovery of new opportunities for realizing connections between knowledge assets (Foss, Klein, Kor & Mahoney, 2008). Taken together, this suggest that the more tightly integrated the subsidiary is with the rest of the MNC, the more likely it is to develop internal knowledge.

We measured two dimensions of the subsidiary's integration with the rest of the MNC: *subsidiary dependency* and *intra-MNC trade*. Subsidiary dependency captures the extent to which the focal subsidiary is dependent on knowledge from other MNC-units and it was measured by asking respondents "What would be the consequences for the subsidiary if it no longer had access to the competencies of other MNC units?" (1 equaled "no consequences" and 7 equaled "very significant consequences"). The level of intra-MNC trade is an indicator of the breadth of the internal trade links. It is measured as a single item—the share of subsidiary sale going to other MNC units in 1996. The subsidiary sale to other MNC units includes both semi-products and final goods and services. We also included the subsidiary's mode of formation (greenfield (=0) or acquisition (=1)), and the (logarithm of)

number of employees in the subsidiary, as larger subsidiaries are expected to be better positioned in the MNC network and therefore have better access to internal MNC knowledge.

*Predictors of external knowledge.* Extant research has suggested several factors that may influence subsidiary acquisition of external knowledge. First, the *autonomy* of the subsidiary has been linked to the emergence of centers-of-excellence in foreign subsidiaries (Birkinshaw, 1997), and to the location of subsidiaries in industrial clusters (Birkinshaw & Hood, 2000). This supports the idea that local autonomy in decision-making enables subsidiaries to produce innovations in response to local conditions (Ghoshal & Bartlett, 1988) by acquiring external knowledge. In order to efficiently utilize the local resources of knowledge, delegation of rights to make decisions that involve such local knowledge to those that best know how to turn the relevant knowledge to productive uses, namely local subsidiary management, will be necessary (Jensen & Meckling, 1992). To the extent that geographic proximity is a prerequisite for knowledge spillovers *between* firms (Jaffe, Trajtenberg & Henderson, 1993), external knowledge generation would require close interaction between on-site MNC personnel and external organizations in the local external environment. It would be difficult for MNC headquarters to direct this process in any detailed manner because of the knowledge asymmetry. It can therefore be argued that granting more decision rights to an MNC subsidiary, thereby giving it more autonomy, improves the discretion for the subsidiary to engage in the sourcing of local knowledge. Moreover, autonomy may have strong motivation effects, increasing the incentive to engage in such knowledge accumulation (cf. Aghion & Tirole, 1997). In sum, stimulating the development of external knowledge in a subsidiary — for example, in the hope of increasing local marketing and product development— may involve granting a high degree of autonomy to the subsidiary.

Two dimensions reflecting the discretion and autonomy of the subsidiary were measured: *own decision rights* and *strategic influence*. Based on the scale developed by Roth and Morrison (1992),

respondents were asked to identify the level at which certain decisions were made, where 1 equaled foreign corporate (HQ), 2 equaled sub-corporate (e.g. division), and 3 equaled subsidiary level. The decisions were as follows: Hiring top subsidiary management; entering new markets within the country; entering foreign markets; changes to subsidiary organization; introduction of new products/services; approval of quarterly plan/schedules. Our measure, *own decision rights*, is based on the average of these six items (Alpha = 0.61). The influence of the subsidiary on strategic decisions in the MNC is measured by asking “To what extent has the Subsidiary influenced the Corporation when it concerns (1=no influence at all, 7=very high influence): 1) Establishment of new units in host country, 2) Establishment of new units outside host country, 3) Acquisitions in host country and 4) Acquisitions outside host country. The four items were added together in order to form the construct of *strategic influence* (Alpha = 0.72).

When predicting external knowledge we also included the quality of the external business environment. Building on the resources of Porter's (1990) diamond model, respondents were therefore asked to assess this environment along the following dimensions: Availability of business professionals; availability of supply material; quality of suppliers; level of competition; government support; favorable legal environment; and existence of research institutions (1 equaled “very low” and 7 equaled “very high”). Porter's (1990) emphasis on the holistic nature of the model and the high inter-correlation between many of the items motivated us to construct a composite index (Alpha = 0.67). We also controlled for the (logarithm of) total sales of the subsidiary. We expect that subsidiaries with larger turnover will be more likely to acquire external knowledge because they have a more extensive “interface” with the environment and hence more opportunities to interact with external partners.

***Knowledge transfer control variables.*** Finally, we included a number of variables in the control vector in Equation [7] when predicting knowledge transfer. We controlled for the MNC's formal

recognition of and dependency upon the knowledge residing in the subsidiary, as well as the subsidiary's own investments in and assessment of its competences. We expect subsidiaries which are recognized to be highly knowledgeable — by themselves as well as by other units in the MNC — to have more knowledge transfer regardless of their actual knowledge levels. Formal recognition was measured by asking whether the indicated competencies of the subsidiary was formally recognized by the MNC headquarter. They could ask yes or no for each of the above mentioned six activities. The measure of formal recognition was then calculated as a count variable going from 0 to 6. The MNC dependency on the knowledge of the focal subsidiary was measured by the following question: “What would be the consequences for other units in the Foreign Company if they no longer had access to the competencies of the subsidiary?” (1 equaled “no consequences” and 7 equaled “very significant consequences”). The subsidiaries' own investments was measured by asking respondents to assess the level of investments in the subsidiary in the past three years, where 1 equaled “very limited” and 7 equaled “substantial”. The level of investments was assessed for all the six above-mentioned activities (Alpha = 0.74). The subsidiaries own assessment of their knowledge was captured by asking respondents to indicate the level of subsidiary competencies for the six above mentioned activities (also mentioned in Table 2). The Alpha for this multi-item construct is 0.74.

## RESULTS

The correlation coefficients and descriptive data (mean values and standard deviation, minimum and maximum values) on all exogenous variables are provided in Table 3.

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*Insert Table 3 Here*  
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There is a high correlation between the two interaction terms and the main effects of internal, external and subsidiary knowledge (above 0.56) as expected. We did not mean-center our independent

variables around 0, however, since this approach would complicate the interpretation of the threshold that is our focal interest, without improving the stability of the estimated coefficients (Echambadi and Hess, 2007). Also, none of the other correlation coefficients indicated the possibility of multicollinearity (i.e.,  $r > 0.5$ ). Based on a Hausman test we can conclude that the 2SLS estimates are better (test statistics= 50.03,  $p < 0.01$ ) than the OLS estimates while the Hausman test also provided evidence indicating that the 3SLS-model was not superior to the 2SLS-model. We therefore refer to the 2SLS estimates in the following (which however is also very similar to the 3SLS estimates). Our results are reported in Table 4.

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*Insert Table 4 Here*  
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Overall, the system of the three equations works well with many significant variables and a high adjusted R-square value (0.22) for the ultimate dependent variable of Knowledge Transfer. Consider first the prediction of internal knowledge. Both dimensions of subsidiary integration (i.e., subsidiary dependency and intra-MNC trade) have a significant and positive effect on the development of internal knowledge (both at the one percent level). Proceeding to the prediction of external knowledge, there is also support for the idea that subsidiary autonomy impacts the building of knowledge that is mainly based on external knowledge sources, with significant positive relationships at the one percent level for both the measure of own decision rights and strategic influence. Among the other mechanisms, subsidiary employees and sales turn out to be significant, indicating that large subsidiaries do have higher knowledge levels. Also, the formation and assessment of the external environment are significant predictors of knowledge. As expected, the assessment of the cluster factors in the local environment has a strong and positive impact on the external sources of subsidiary knowledge.

The two main hypotheses in our model—roughly, that the development of internal and external subsidiary knowledge facilitates knowledge transfer, given that internal and external knowledge are about certain threshold levels—are tested in the third column corresponding to Equation [7]. Both hypotheses are confirmed. The negative main effects of both internal and external knowledge, combined with their positive interaction, indicates that the direction of the impact of each type of knowledge is not universal, but contingent upon the level of the other type of knowledge in the subsidiary, as our theoretical model predicted.

Specifically, from the estimated coefficients in Table 4, we can conclude that the level of internal knowledge only has to be above 1 (on a 7-point Likert scale) before more external knowledge motivates more knowledge transfer. The underlying mechanism is that subsidiary knowledge built from external knowledge sources must therefore somehow be integrated with internal knowledge before knowledge transfer takes place. It may also be concluded that such integration is widely used: 92% of the subsidiaries in our sample have a level of internal knowledge that is above the estimated threshold. Before internal knowledge has a positive effect on knowledge transfer, however, the subsidiary needs at least external knowledge of 2.56. This is apparently slightly more difficult to accomplish, since only 60% of the subsidiaries in our sample has  $E > 2.56$ . The fact that the former threshold is larger than the latter is surprising, and that subsidiaries thereby give, giving that we assumed that  $C_{KI} < 0$ . It suggests that the benefits from external knowledge are much larger than the benefits from internal knowledge, and this difference outweighs the higher costs of transferring external knowledge. Nevertheless, the positive interaction between the two types of knowledge is consistent with our theory.

Only 58% of the sample subsidiaries can be considered truly knowledge-intensive in the sense that they exceed *both* thresholds. The thresholds are illustrated in Figure 1. This figure also shows, more

generally, the “production function” transforming internal and external knowledge to knowledge transfer.

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*Insert Figure 1 Here*  
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In the third column in Table 4, the subsidiaries’ own investments have a significant positive effect on the level of knowledge transfer. The same is true for subsidiaries where other MNC units are more dependent on their knowledge, while the assessment of own competencies are insignificant in predicting the level of knowledge transfer.

## CONCLUDING DISCUSSION

### Contribution to the MNC Literature

The contribution of this work is to advance the differentiated MNC literature as it pertains to intra-MNC knowledge transfer. Specifically, we have highlighted the sources of knowledge as important determinants of the costs and benefits of knowledge transfer. The key to our argument is that there is a meaningful distinction between knowledge in MNCs that mainly stem from internal sources and knowledge that mainly stem from external sources, and that the two kinds of knowledge may be complementary. This insight is not new in itself to the MNC literature *per se* (e.g., Frost, 2001). However, our simple formalization, based on innocuous assumptions, a specific dimensionalization of subsidiary knowledge resources (i.e., combinability, relevance, and fungibility), and an assumption that there are systematic relations between these dimensions and the (marginal) costs and benefits of knowledge transfer yields new, non-trivial predictions. Thus, we find knowledge transfer is not monotonically increasing in the internal and external subsidiary knowledge, and that there are knowledge thresholds in subsidiaries which determine the sign of the net benefits of knowledge transfer. In our empirical analysis we test these ideas, and identified the thresholds of each type of knowledge which the

subsidiary must possess before the marginal gains from the other type of knowledge become positive. Our findings suggest that many subsidiaries (40% of the subsidiaries in the sample) may not have reached these thresholds so that knowledge transfer from them does not add overall value to the MNC.

### **Managing Internal and External Subsidiary Knowledge**

Much interest in the MNC literature has centered on how MNCs can deploy organizational instruments to ease intra-MNC knowledge transfer (e.g., Gupta and Govindarajan, 2000). Thus, depending on the characteristics of knowledge as well as of senders and receivers, MNCs can deploy channels of communication, influence values, install reward systems, etc. that foster knowledge sharing. However, our analysis suggests that MNCs can enter at an *earlier* stage in the causal chain, and try to influence the sources of knowledge that is built and transferred inside the MNC. Specifically, while our two-stage model was in the first instance motivated by concerns of endogeneity, it also contributes with managerial implications by showing that such arrangements as the level of subsidiary autonomy and integration—which may be interpreted as organizational instruments—have a bearing on the development of different sources of subsidiary knowledge.

Consistent with our theoretical model, we found that sourcing knowledge exclusively on an internal basis or exclusively on an external basis has a negative effect on subsidiary knowledge transfer, but that a combination of both types of knowledge has a positive effect. This indicates that, to the extent that managers choose a specific way of sourcing knowledge, they also implicitly choose the characteristics of the sourced knowledge and the ease with which it can be transferred inside the MNC.

### **Managerial Implications**

Our findings have profound managerial implications: They indicate that knowledge development and acquisition is a difficult and perhaps underestimated task facing internationalizing firms. So, when MNCs establish subsidiaries in foreign countries with a knowledge-seeking motive (Ghoshal, 1987;

Vermeulen & Barkema, 1998; Asmussen, Dhanaraj & Pedersen, 2008), they should never assume that these subsidiaries can readily retransmit cluster-based innovation from the foreign environment in which they are placed; subsidiaries first need to be upgraded with proprietary MNC knowledge before large amounts of such “reverse” knowledge transfer can profitably occur. External knowledge cannot substitute for internal knowledge, or *vice versa*. In fact, we found that the complementarity between the two types knowledge dominates so that a strong external environment, if anything, should motivate the MNC to create an equally strong internal environment in the subsidiary. Our findings suggest that MNCs can motivate a combination of internal and external knowledge acquisition in their subsidiaries by combining such organizational mechanisms as subsidiary autonomy and integration. The tension between these seemingly disparate arrangements is a challenge but not an insurmountable one, as suggested by the fact that they are positively correlated in our sample.

### **Future Work**

Our study has some limitations that we hope can be addressed in future research. First, we have relied on perceptual data to measure knowledge stocks and flows. While this is to some extent necessitated by the concept of knowledge itself—it is something which exists mainly in the minds of its holders, at least in its tacit forms—alternative knowledge measures can be deployed that uses “objective” data. For example, to the extent that firms buy other firms in order to acquire the knowledge of their employees, the acquisition price of foreign subsidiaries could contain information about the MNC’s evaluation of the knowledge stocks in those subsidiaries. Patent data provides yet another possibility.

Second, we have no direct measures of the costs and benefits of knowledge transfer but infer them from the knowledge stocks and flows chosen by MNC managers. We do this with an argument that costs and benefits create incentives for managerial action. Hence, if managers at least attempt to respond

sensibly to these incentives, a cost-benefit approach may be both useful and powerful. Nevertheless, this should not be seen as a rejection of the importance of developing more realistic theories about *how* managers actually make decisions about MNC knowledge transfer. These theories, which could draw on agency theory, cognitive psychology, organizational sociology, or other fields, would be a welcome contribution of knowledge (additive as well as complementary) to our cost-benefit analysis.

Finally, while we believe the knowledge thresholds we have estimated to be of considerable managerial interest, they may be specific to our sample. In fact, it may be questioned to what extent such thresholds are generalizable and to what extent they vary, for example, by the industry, home country, or other characteristics of the MNC, or by host country characteristics. This raises both theoretical and empirical questions of interest for scholars of the MNC and international strategy. For example, do the thresholds capture a liability of foreignness in local knowledge acquisition, and how does this liability vary with the diversity and distance between home and host country? Building on the approach we present in this paper, such questions could be tackled by future research.

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**Table 1** Sample overview

<i>Host country</i>	<i>Response rate</i>	<i>N</i>	<i>Average subsidiary age</i>	<i>Share of greenfield investments</i>	<i>Average no. of employees</i>	<i>Average sales (million US \$)</i>
Austria	28%	313	18	61%	318	61
Denmark	41%	308	17	29%	284	57
Finland	24%	238	13	44%	200	50
Germany	21%	254	20	30%	1,574	465
Norway	22%	262	15	52%	130	63
Sweden	55%	530	16	39%	244	74
UK	20%	202	18	42%	3,787	377
<b>Total sample</b>	<b>30%</b>	<b>2,107</b>	<b>17</b>	<b>42%</b>	<b>742</b>	<b>142</b>

**Table 2** Average competence level score on a seven-point scale

<i>Country</i>	<i>Research</i>	<i>Development</i>	<i>Production</i>	<i>Marketing/ sales</i>	<i>Logistics/ distribution</i>	<i>Purchasing</i>
Austria	3.1	4.4	5.8	6.1	5.7	5.2
Denmark	4.8	5.2	6.0	5.9	5.7	5.3
Finland	4.3	4.9	5.9	5.9	5.5	5.3
Germany	4.6	5.3	6.3	6.2	5.9	5.7
Norway	4.2	4.9	5.6	5.7	5.3	5.2
Sweden	4.7	5.3	5.9	5.9	5.5	5.2
UK	4.9	5.3	6.1	6.1	5.9	5.5
<b>Total</b>	<b>4.4</b>	<b>5.1</b>	<b>6.0</b>	<b>6.0</b>	<b>5.6</b>	<b>5.3</b>

**Table 3** Correlation Matrix (n=2,107)

<i>Variable</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>	<i>15</i>
1) Knowledge transfer	1.00														
2) Internal knowledge	0.29	1.00													
3) External knowledge	0.31	0.48	1.00												
4) Subs. Investments	0.53	0.21	0.25	1.00											
5) Subs. Dependency	0.02	0.34	0.05	-0.05	1.00										
6) Intra-MNC-trade	0.31	0.23	0.09	0.15	0.09	1.00									
7) Formation	0.14	-0.08	0.07	0.15	-0.25	0.08	1.00								
8) No. of employees	0.40	0.09	0.14	0.35	-0.13	0.24	0.26	1.00							
9) Decision rights	-0.08	-0.12	0.03	0.15	0.24	0.06	-0.12	-0.09	1.00						
10) Strategic decisions	0.27	-0.17	0.14	0.26	0.02	0.03	0.01	0.20	-0.07	1.00					
11) Cluster factors	0.23	0.15	0.20	0.19	0.07	0.11	0.03	0.21	0.03	0.09	1.00				
12) Total sales	0.20	0.09	0.11	0.18	-0.05	0.08	0.09	0.52	-0.06	0.13	0.11	1.00			
13) Formal recognition	0.51	0.14	0.18	0.40	-0.05	0.22	0.18	0.32	-0.08	0.15	0.19	0.12	1.00		
14) Own competencies	0.21	0.01	0.07	0.18	-0.07	-0.01	0.08	0.16	-0.11	0.09	0.11	0.08	0.20	1.00	
15) MNC dependency	0.45	0.27	0.23	0.25	0.18	0.38	0.04	0.23	0.03	0.21	0.15	0.11	0.27	0.06	1.00
<b>Mean</b>	<b>2.55</b>	<b>3.21</b>	<b>3.01</b>	<b>3.01</b>	<b>4.51</b>	<b>2.50</b>	<b>0.58</b>	<b>4.71</b>	<b>1.97</b>	<b>2.50</b>	<b>4.31</b>	<b>3.21</b>	<b>2.18</b>	<b>5.40</b>	<b>3.26</b>
<b>Std. dev.</b>	<b>1.42</b>	<b>1.34</b>	<b>1.25</b>	<b>1.23</b>	<b>1.89</b>	<b>1.74</b>	<b>0.49</b>	<b>1.69</b>	<b>0.42</b>	<b>1.41</b>	<b>0.82</b>	<b>2.23</b>	<b>1.51</b>	<b>0.51</b>	<b>1.76</b>

All values = or > |0.04| is significant at a 5% level

**Table 4** Two-stage least squares estimation of a simultaneous equation model (n=2,107)

<i>Dependent Variable:</i>	<i>Internal Knowledge</i>	<i>External Knowledge</i>	<i>Knowledge Transfer</i>
Subsidiary dependency	0.34** (0.01)		
Intra-MNC trade	0.15** (0.02)		
Formation	0.30** (0.05)		
Logarithm of number of employees	0.16** (0.02)		
Own decision rights		0.28** (0.05)	
Strategic influence		0.13** (0.02)	
Assessment of cluster factors		0.45** (0.02)	
Logarithm of total sales		0.05** (0.01)	
<b>Internal knowledge</b>			<b>-0.64** (0.14)</b>
<b>External knowledge</b>			<b>-0.25* (0.17)</b>
<b>Internal knowledge*</b>			<b>0.25** (0.04)</b>
<b>External knowledge</b>			<b>0.12** (0.02)</b>
MNC Dependency			0.21** (0.03)
Formal recognition of knowledge in subsidiary			0.13* (0.06)
Assessment of own competencies			0.41** (0.07)
Subsidiary investments			
<b>Adjusted R-square</b>	<b>11.5</b>	<b>2.9</b>	<b>22.1</b>

\* Significant at p>0.05; \*\* Significant at p>0.01

**Figure 1** *Knowledge Transfer\* and Thresholds*

\* The numbers and shaded areas within the chart reflect the net contribution of internal and external knowledge on knowledge transfer (darker areas are lower).