Track No: 6

Competitive paper

The Multinational Corporation and the global sourcing of knowledge: Remodeling absorptive capacity

Abstract

We build on extant theory of the MNE, MNE subsidiaries, absorptive capacity and Penrose's concept of 'productive opportunity' to develop a framework on the MNE and absorptive capacity (AC) that allows us to explore the role of subsidiaries in the global sourcing of knowledge. We develop and test hypotheses using primary questionnaire-collected data. Our results support the idea that subsidiaries' AC can be improved by the AC of the MNE group and in turn may improve the performance of the subsidiaries and the group as a whole.

The Multinational Corporation and the global sourcing of knowledge: Remodeling absorptive capacity

1. Introduction

Multinational Corporations (MNCs) are major forces in global Research and Development (R&D) (UNCTAD, 2004). Competitive pressures in the context of globalization include the emergence of new forces in the international technological scene such as China, which account for a substantial share in corporate R&D (Gassmann and Han, 2004). This trend complements growing empirical evidence that shows on the one hand that R&D decentralization is not only rising within the MNC group but also expands beyond the confines of the group and on the other hand that the type of R&D carried out abroad goes beyond product and process adaptation, revealing a multifaceted aspect of knowledge sourcing (Cantwell and Janne, 1999; Chiesa, 2000).

At the same time competition pressures have changed significantly the organizational structure of MNCs in favor of a less hierarchical and more horizontal organization (Hedlund, 1986; Bartlett and Ghoshal, 1989). In this organization critical is the role of subsidiaries since they are not perceived anymore as static elements of the MNC structure (Birkinshaw, 1996; Crookell and Morrison, 1990). (Manolopoulos et al, 2005).

In a global environment that is increasingly characterized by technological and market heterogeneity, creative subsidiaries with specific product mandates may constitute an effective way to monitor knowledge flows on behalf of the MNC group. Therefore, headquarters' technology planning should not only screen the diffusion of technology acquired in the home country, but also the technological inputs derived from overseas subunits stemming either from their in house R&D departments or their established localized knowledge (Ivarsson and Johnsson, 2003; Hakanson and

Nobel, 2001; Andersson and Forsgren, 2000; Dunning, 2000; Kuemmerle, 1999; Patel and Vega, 1999).

Cohen and Levinthal (1989) defined "absorptive capacity" (AC) as the "ability of a firm to identify, assimilate, and exploit knowledge from the environment" (p. 569). Since then the issue of "absorptive capacity" has attracted the attention of researchers but little has been done to put together issues of international business and AC and how the MNC organization reacts, assesses and builds its AC in order to enhance its ability and performance.

The contribution of this paper is then twofold: Firstly, it offers new theoretical insights in the conceptualization of AC and MNC organization by addressing issues of performance at the subsidiary level. Secondly, it provides empirical evaluation of specific measurements of absorptive capacity. Under this perspective, it allows us to further understand the evolution of the MNC organization and the impact of the external environment and internal environments in this dynamic process.

The rest of the paper is organized as follows: the next section describes the underlying theoretical framework of external knowledge and absorptive capacity. Section 3 develops the model and hypotheses to be tested. Section 4 provides a brief description of the data and econometric methodology. Section 5 discusses the obtained results and finally section 6 summarizes and concludes.

2. Theoretical framework

The issue of knowledge creation and diffusion in the MNC has been at the heart of the analysis of MNCs' operations since Hymer's (1960/1976) seminal contribution. For Hymer knowledge was one of various 'monopolistic advantages', the exploitation of which was most efficient intra, rather than inter-firm for various reasons, such as the 'tacit' nature of knowledge, the possibility of assessing differently the value of knowledge by different parties, (or at least pretending to have different perceptions of

the value), and even the ability of firms to transfer knowledge intra-firm, more speedily (see Dunning and Pitelis, 2005, for an extensive account). Subsequent work by Hirsch (1976) discussed the importance of the "*K* factor", which represents "*firm-specific know-how*" and other intangible income-producing proprietary assets (p. 260) such as R&D. Under certain assumptions, *K* acts as an incentive for a firm to invest abroad, as it allows a firm to exploit its technological superiority. For Hirsch "this analysis leads us to envisage a development and manufacturing sequence involving several countries" (p. 264). This observation implies that factor *K* can be produced in different locations and thus is a product of a decentralized and consequently internationalized process.

Buckley and Casson's (1976) contribution places emphasis on the internalization of "markets in knowledge" (p.34) that leads to "the integration of production, marketing and R&D" (p.34-35). The argument suggests that knowledge has the characteristics of a public good within a firm: "This means that the exploitation of proprietary knowledge is logically an international operation" (p. 35). They then firstly, acknowledge different types of R&D (p. 55) and secondly, they pose that different types of R&D reflect different needs in regards to where they will be located resulting, according to the type of R&D, to a more or less dispersed location strategy (p. 54-55). For Buckley and Casson "…the firm thus operates an international intelligence system … the international acquisition and exploitation of knowledge will normally involve international production through a world-wide network of basically similar plants" (p. 35).

In their 1989 seminal paper on "absorptive capacity" (AC) Cohen and Levinthal defined AC as the "ability of a firm to identify, assimilate, and exploit knowledge from the environment" (p. 569). Their work does not, however, address issues of multinationality, how a MNC, through its network of subsidiaries can depict different levels of AC and how these varying levels of AC influence a "subsidiary's technological performance and affect its profitability." Similarly, Hirsch (1976), and Buckley and Casson (1976) did not recognize at that time that R&D itself is a

determining factor of differentiation among the foreign operations of MNCs, i.e. of their subsidiaries. In order to complete the above framework on the evolution of foreign production and multinationals, insights from international management underline that "As the scope and aims of globally competing firms have evolved and widened, the nature and position of individual subsidiaries within such MNC groups have also undergone important changes. These subsidiary-level developments are crucial in influencing the emergence of significant decentralized technological activity in MNCs, and in determining the forms it can take" (Pearce and Papanastassiou 1996:32)[1]. The nearest to providing an explanation for the emergence of AC is arguably Penrose's classic 1959 book *The Theory of the Growth of the Firm* (TGF thereafter). In TGF firms are bundles of human and non-human resources under administrative coordination and authoritative communication, producing for sale in markets for a profit. The cohesive shell of the organization, called firm, helps engender knowledge and innovation through specialization, learning and teamwork. In this context a firm's AC is endogenously generated in the very process of firm's operations.

Intra-firm knowledge generation in particular, allows managers to enhance their 'image' of the firm's 'productive opportunity', which Penrose sees as the dynamic interaction between the internal firm environment (resources) and its external environment (industry, markets, the economy), as perceived by managers. These perception by managers in effect define the firm's AC, and the higher this is, the better will tend to be the firm's 'productive opportunity' and ceteris paribus, the firm's performance.

It follows that the Penrosean perspective can usefully complement the Cohen and Levinthal view. This synthesis and our discussion of the MNE literature leads us to the framework depicted in Figure 1.

[1] See also Birkinshaw et al., 1998; Birkinshaw et al., 2002; Hakanson and Nobel, 2001.

Insert Figure 1 here

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3. Related literature and empirical testing

Despite it being extensively analyzed by researchers both in theoretical and empirical levels, AC remains a complex and fuzzy notion due to multiple definitions and components. In broad terms, AC is implicitly accepted as a set of firm capabilities in acquiring and managing knowledge. Researchers have offered different definitions for AC that capture skills to deal with tacit knowledge (Mowery and Oxley, 1995), the capacity to learn and solve problems (Kim, 1997; 1998), or even receptivity to technological change (Kedia and Bhagat, 1988).

Cohen and Levinthal (1989) have offered the widest and the most influential notion of AC as the ability "to identify, assimilate and exploit knowledge from the environment" (also Van De Bosch, 2003). Zahra and George (2002) expand this concept by adding another element, that of transforming the knowledge, i.e., "capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge (p. 190). In their paper they also introduce two subsets of AC, "potential and realized AC" (p. 185). They define these as follows. "Potential capacity comprises knowledge acquisition and assimilation capabilities and realized capacity centers on knowledge transformation and exploitation" (p. 185). The characteristics of acquisition and assimilation relate to the external environment of the firm whilst transformation and exploitation reflect the internal firm capabilities.

On the empirical side, there are numerous studies that examine AC, using alternative measures depending on the author's focus and interest. Most widely used 'proxies' for AC include R&D expenditures, R&D intensity and the stock of knowledge, as proposed by Cohen and Levinthal (1989). Studies that use such 'proxies' include

those of Stock et al. (2001), Leahy and Neary (2004), Oltra and Flore (2003). The stock of knowledge proxied by human capital availability has also been used quite a lot in the relevant literature (Rothwell and Dodgon, 1991; Vinding, 2000; Frenz et al., 2004). A notable extension is by Vegeulers (1997) who captures AC by the existence of an R&D laboratory. Other studies view AC from an organizational point of view, for example, the ability of an entire organization to stimulate knowledge, thus place emphasis on the organizational structure (Van Den Bosch et al., 1999; Welsch et al., 2001; Daghfous, 2004). Schimdt (2005) in a recent study extends traditional measures by including human resource and knowledge management proxies drawing information from a questionnaire survey.

Lane et al. (2002) recognize that despite two decades of influential work on the AC, there are limited attempts to revise the definition of AC and measure it, outside the conventional R&D measures (also Manhe et al., 2005). Although AC has been studied in different contexts, for example, in different thematic categories varying from simple knowledge characteristics to AC and corporate scope and alliances (Lane et al., 2002), there is paucity in the literature as regards the issue of AC within the boundaries of the MNC organization, let alone the subsidiary of the MNC group. Recent work by Minbaeva et al. (2003) is an exception. Their paper departs from the tradition of Cohen and Levinthal in the sense that their measure of AC reflects Human Resource Management (HRM) influences and concerns. They analyze a sample of 169 foreign–owned subsidiaries located in three host countries namely, Finland, Russia and USA. In their work they offer a conceptualization of AC as the ability and motivation of employees to constitute the crucial aspects of a firm's ability to "facilitate internal technology transfer" (p. 589). They also estimate the determinants of AC in a three stages least squares model. In their results they show that employees' ability and motivation independently do not constitute a significant indicator of a firm's AC in the sense that none of the two facilitate knowledge flows in the group. However, their interaction appears to enhance knowledge transmission. Whilst their contribution is enlighting and the construct they use meets the arguments developed by Zahra and George (2002), they do not address the R&D issue explicitly.

On the other hand, Veugelers (1997) as noted above measures AC in the "form of a full-time staffed R&D department" (p. 303). The purpose of her paper was to examine the relation between the technological performance of a firm (measured by "the internally financed intra-muros expenditures (p. 306) of the firm") and the potential of external collaborations in R&D. Results were in line with Cohen and Levinthal's notion of complementarity between external collaboration in R&D and own internal R&D facilities. Although her sample referred to Flemish innovative companies she included a variable that aimed to capture multinationality and in particular subsidiary differentiation. The results on this variable indicated a more centralized strategy in R&D resulting in subsidiaries that do not own R&D facilities. However, when AC is positive then cooperative strategies of foreign affiliates "have a larger positive effect on internal R&D" (p. 313).

In this paper, we study the AC of foreign subsidiaries. Following the distinction of Zahra and George of *potential and realized* AC and building on their influential work. By incorporating individual subsidiary roles and internal and external to the MNC group sources of technology, including various types of in-house R&D laboratories, and by measuring ***realized and potential AC***, we aim to overcome some limitations of extant quantitative measures of R&D (Zahra and George, 2002).

The central idea evolves around the notion that the total AC (and thus the performance) of an MNC exhibits some form of feedback between (a) domestic R&D, (b) the R&D performed and realized AC of its subsidiaries. In the event of such a feedback relationship, one can think that the expected profits of a subsidiary (and by implication the expected profits of the MNC) depend on the decision to establish or not a (foreign) R&D lab; the assumption being that by assigning a role to a new R&D lab, the subsidiary will be enhancing its performance and increasing its existing absorptive capacity. One can envisage that such a binary decision (to establish a new R&D lab or not) should be influenced by a number of factors but, at the same time and due to feedback, these factors will be affected by the expectation of the possible role of a new R&D lab. The expected-potential AC of a subsidiary finally becomes a function of its existing-realized AC (expressed as a function of

possibly other characteristics) and of its decision to assign a role to a new R&D lab – this clearly points to the dynamic nature of the evolution of absorptive capacity.

In all, the above point to the following Research Questions (RQ):

RQ 1:

A subsidiary's AC depends on the degree of independence of the subsidiary, the realized AC of the MNC group as well as on the potential AC of the subsidiary.

RQ 2:

The intensity of a subsidiary's own AC depends on the dynamic interaction between its external and its internal environment (Penrose's 'productive opportunity').

RQ 3:

A subsidiary's performance will be determined by the existence or not of AC and in particular by the realized AC.

All questions are testable, and in what follows we try to model and test them.

4. Data description and econometric methodology

In order to empirically test the aforementioned questions, data derived from a questionnaire survey will be applied. This survey is an updated version of a questionnaire survey designed and tested by Pearce and Singh in 1988-1990 (Pearce and Singh, 1992). Both surveys aimed at investigating the positioning of overseas R&D in foreign MNC subsidiaries and contain questions that: (1) Define subsidiary roles, (2) Define internal and external to the MNC group sources of technology, which can be accessible by overseas subsidiaries and (3) Define overseas R&D roles[2].

The survey was carried out in 1994/95. Experienced academics were consulted with regards to particular phrasing and sequence of questions asked. The final version of

[2] A brief description of the survey may be found in Appendix.

the questionnaire was posted to 812 subsidiaries operating in the UK[3] (see for full description Papanastassiou and Pearce, 1999) extracted from the International Directory of Corporate Affiliations (1992).

The questionnaire was sent twice within a month's time. We collected 190 replies, for a response rate of 23.3%. This response rate compares favourably with the ones obtained in similar surveys (Harzing, 1997). We excluded one reply due to inadequate information, thus we finally ended up with 189 valid responses.

Based on our modeling directions posed we employ the following econometric methodology: The binary nature of the decision involved in (a) naturally calls for inference methods of qualitative choice (categorical) models, of the probit and logit variety; in addition, one could employ conditional chi-square tests between the choice variable and other qualitative and quantitative explanatory variables as an additional method for examining which of the explanatory variables appear to be independent of the decision of establishing a lab. For the analysis in part (b) we use inference methods that allow us to examine whether or not the establishment of a lab leads to differentiated performance and changes in absorptive capacity. These methods include (i) standard regressions with a variety of performance and AC measures as dependent variables and a number of control explanatory variables, followed by hypotheses tests on the issue of differentiated performance; (ii) a variety of moment and distributional tests on the above dependent variables trying to examine in an alternative way whether the presence of a lab matters – note that the application of distributional tests strengthens the regression and moment tests results, as they look on the entire distribution of the variables for judging differentiated performance and not just a few sample moments; (iii) nonparametric regressions, which are extremely suitable for examining whether the response of performance and AC in changes in control variables and/or lab establishment has a particular shape (other than linear) that could have an economic interpretation.

[3] See Papanastassiou and Pearce (1999) for full description.

5. Results

Each one of the two questions was estimated by three independent regression models. The definition of the variables used in the tables below as well as selected sample correlation matrices showing the strength of association between groups of variables may be found in the Appendix. The results of conditional X^2 tests that examine the lack of independence among pairs of variables of interest are also available on request.

RQ1:

Model I: Assessing the impact of AC on the likelihood of establishing an R&D lab- Table 1.

To check for this RQ, we use responses from question 7 of the questionnaire which are categorized as potential and realized AC. In particular, and based on Zahra and George (2002), those variables that relate to acquisition and assimilation are assigned as potential and those reflecting knowledge transformation and exploitation are depicted as realized. Based on the above, R&D carried out by local scientific institutions for the subsidiary and R&D carried out in collaboration with another firm fall within the potential AC group, since they directly relate to the external environment of the subsidiary, thus pinpoint the subsidiary's efforts to acquire and assimilate knowledge from surroundings. On the other hand, all other variables that indicate technology stemming from either the MNC group or the subsidiary itself show evidence of the transformation and exploitation of acquired knowledge into particular needs of the MNC and the subsidiary[4]. After controlling for location of the parent company and the type of industry we find that the likelihood of establishing an R&D lab significantly depends on the *potential* AC of the subsidiary: the higher is the dependence of the subsidiary on external AC the higher is the likelihood of establishing an R&D lab; note that other measures of AC do no enter significantly on the equation although it appears that the higher is the dependence of the subsidiary on existing AC (internal technology and R&D), the lower is the

[4] For a description of variables falling into either of the two categories, see Appendix A, section 2.

likelihood of establishing an R&D lab. It follows that exposure to external knowledge seems to enhance the further building of AC by inducing subsidiaries to develop their own R&D lab in order to be able to transform according to the fourth dimension of Zahra and George (2002) acquired knowledge to their own procedures and technologies adopted to their own needs.

The novel predictors we use, adding to the existing literature on AC, involve the roles of subsidiaries. Results indicate that subsidiaries aiming at developing and producing new products (WPM) and subsidiaries aiming at producing and exporting already existing products (SMR) are more likely to develop an R&D laboratory, unlike subsidiaries that target the internal (UK) market only (TMR).

As regards to the control variables, we find that the longer a subsidiary operates in a particular location, the most likely it is to create its own R&D unit. We also note that new companies and joint ventures decrease the likelihood of establishing a lab (if the method of establishing the subsidiary is taking over an existing company then the corresponding coefficient is positive, thus increasing the likelihood of establishing an R&D lab).

Table 1 about here

RQ2:

Model II: Assessing the impact of the type of an existing R&D lab on the importance of the lab's research as a source of technology for the subsidiary- Table 2

Once a subsidiary has reached its decision on establishing its own R&D laboratory, it enters the second phase of knowledge transformation and exploitation augmenting its existing *realized* AC by own operations and scientific personnel. Hence, at this stage,

it is important to assess the significance of the particular laboratory as a source of subsidiary's technology based on the roles that managers assign to them *ex ante*. To test this we again utilize variables capturing *realized* and *potential* AC as well as roles of subsidiaries and roles of R&D laboratories as indicated above. However, given that this is the second stage in the developmental process of subsidiary's AC, the firm has another element of *realized* AC, that of scientific personnel hired to equip the laboratory, thus we also include here the number of scientific personnel as an extra variable of *realized* AC.

Again, controlling for location of the parent company and the type of industry we find that the importance of an established lab's research as a source of technology for the subsidiary significantly depends on the number of scientific personnel (*realized* AC) while the dependence of the subsidiary on internal to the MNE group technology lowers the importance of the established R&D lab as a source of technology.

Potential AC as captured by the collaborations of the subsidiary with other firms, enhances the significance of an R&D lab as a source of technology.

With respect to the role of the subsidiary: the R&D lab appears to be of high importance as a source of technology for subsidiaries that develop and produce new products and the other way around for subsidiaries that produce and export intermediate goods. Note that, as in Model I, the impact from the role of the subsidiary in developing and producing new products is higher than that of the other roles of the firm (the coefficient of WPM1 is higher in absolute magnitude).

Turning to the type of the R&D unit, if the lab was established to either develop new products for the subsidiary's market or to carry out basic research then it increases the importance of its research as a source of technology for the subsidiary. The lab's importance as a source of technology is higher if it has been established for developing and producing new products for the firm's market than if it has been established to carry out basic research (the coefficient of LIL1 is higher in absolute magnitude).

Table 2 about here[5]

RQ3:

Model III: Assessing the impact of establishing an R&D lab on the performance of the subsidiary (as measured by total turnover)[6] - Table 3

We now turn to our last RQ namely the impact of establishing an R&D laboratory on the performance of the subsidiary. This may be considered as the third phase in subsidiary's process of benefiting from the development and enhancement of its AC. In this stage, the R&D laboratory is in operation, thus, besides realized AC belonging primarily to the MNC group, the subsidiary has further enhanced its AC by developing its own research unit, hence in addition to variables of realized and potential AC used above, we hereby include the presence of an R&D lab[7].

It appears that the *realized* AC as measured by the presence or not of an R&D laboratory increases the subsidiary's sales. Also, in regards to the *realized* AC, the higher is the dependence of the subsidiary on internal technology (from within its MNE group) the higher its performance.

Regarding the roles of the subsidiaries, those established in order to produce and export existing products turn out to have higher sales contrary to subsidiaries that were established in order to develop and produce new products.

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[5] The table presents only variables that are statistically significant besides the control variables.

[6] A number of performance variables are possible. Our focus on sales is in line with the focus of the resource-based view (RBV), and in particular Penrose's view (see Pitelis, 2002, for an extensive discussion).

[7] We do not include the number of scientific personnel here, because this belongs to the R&D lab, so by including the existence of the laboratory by definition includes the scientific personnel engaged in this.

Table 3 about here[8]

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6. Concluding remarks and policy implications

The goal of our research effort is to make a new proposal in the modeling of AC where the focal unit of analysis is the MNC subsidiary by bringing together different conceptual perspectives. Building on Zahra and George (2002) and Veugelers (1997) we use the existence of an R&D lab as a measure of a subsidiary's AC and we explore the impact of potential and realized AC on the performance of a subsidiary by Developing and testing 3 RQs, using primary data collection through a questionnaire. Our results point to the significance of the *potential* AC in further enhancing the AC of a subsidiary as it may be captured by the development of an R&D laboratory, whilst realized AC (captured by the scientific personnel) enhances the significance of an existing R&D unit as the subsidiary's source of technology.

Clear implications follow from the above vis-à-vis managerial practice, notably the performance of a subsidiary and the MNE group as a whole is the benefit from the establishment of an R&D lab, by enhancing the subsidiaries AC. Further research, with additional data and further hypotheses and tests, is needed to support our early findings – we are pursuing some of these directions but also hope to motivate others.

[8] Again, only significant variables are presented in this table.

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Table 1: Assessing the impact of AC on the likelihood of establishing an R&D lab[9]

Dependent Variable: LAB

Estimation Method: ML - Binary Logit

Observations used in estimation: 173

Robust std. errors from QML covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-5.662122	1.559341	-3.631100	0.0003
EU	2.718055	0.925917	2.935529	0.0033
AM	2.243892	0.950761	2.360101	0.0183
PAC	2.687756	0.968915	2.773986	0.0055
SDH	1.060391	0.393084	2.697620	0.0070
YO	0.027714	0.009201	3.012031	0.0026
NC	-0.887073	0.548129	-1.618367	0.1056
JV	-1.513314	0.808497	-1.871762	0.0612
TMR1	-0.492587	0.225744	-2.182062	0.0291
SMR	0.590326	0.231013	2.555379	0.0106
WPM1	0.918695	0.240056	3.826997	0.0001
EXTT	0.837603	0.416383	2.011615	0.0443
EXST	0.101017	0.292255	0.345646	0.7296
MNET	-0.158813	0.226687	-0.700584	0.4836
MNERD	-0.023550	0.218030	-0.108011	0.9140
COLRD	-0.255565	0.351836	-0.726375	0.4676

Log likelihood	-85.52783	Hannan-Quinn criter.	1.292046
Restr. log likelihood	-118.8690	Avg. log likelihood	-0.494381
LR statistic (15 df)	66.68235	McFadden R-squared	0.280487

[9] OWNRD is not included as an explanatory variable since this is the RQ we are trying to assess (i.e. whether the decision of establishing own laboratory depends on realized and potential AC.

Probability(LR stat)	1.73E-08

Table 2: Assessing the impact of the type of an existing R&D lab on the importance of the lab's research as a source of technology for the subsidiary

Dependent Variable: OWNRD

Estimation Method: ML - Ordered Logit

Observations used in estimation: 86 (if LAB = 1)

Robust std. errors from QML covariance

	Coefficient	Std. Error	z-Statistic	Prob.
EU	-2.019458	1.368237	-1.475956	0.1400
AM	-2.480446	1.471074	-1.686146	0.0918
PAC	-3.202927	1.550129	-2.066232	0.0388
SDH	-0.188542	0.664942	-0.283547	0.7768
AGE	0.009156	0.010890	0.840768	0.4005
NOPER	0.002468	0.001102	2.239616	0.0251
RPS1	-1.000947	0.470813	-2.125999	0.0335
WPM1	1.379544	0.390908	3.529072	0.0004
MNET	-1.025456	0.485460	-2.112338	0.0347
COLRD	1.277805	0.585120	2.183834	0.0290
IIL1	1.004037	0.337238	2.977232	0.0029
LIL1	1.583681	0.597474	2.650630	0.0080

Log likelihood	-50.51169	Hannan-Quinn criter.	1.695812
Restr. log likelihood	-73.99900	Avg. log likelihood	-0.587345
LR statistic (12 df)	46.97463	LR index (Pseudo-R2)	0.317400
Probability(LR stat)	4.71E-06		

Table 3: Assessing the impact of establishing an R&D lab on the performance of the subsidiary as measured by total turnover

Dependent Variable: LOG(TS)

Estimation Method: Least Squares

Observations used in estimation: 173

Robust std. errors from HC covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.223286	0.491904	0.453921	0.6505
LAB	0.786801	0.255314	3.081696	0.0024
EU	1.051849	0.339233	3.100665	0.0023
AM	1.160466	0.351942	3.297321	0.0012
PAC	0.516958	0.304377	1.698414	0.0913
SDH	0.103364	0.226592	0.456166	0.6489
SMR	0.441065	0.124627	3.539085	0.0005
WPM1	-0.213338	0.127404	-1.674501	0.0959
MNET	0.426315	0.121013	3.522895	0.0006

R-squared	0.241091	Mean dependent var	3.123141
Adjusted R-squared	0.204071	S.D. dependent var	1.626555
S.E. of regression	1.451129	Akaike info criterion	3.633182
Sum squared resid	345.3471	Schwarz criterion	3.797226
Log likelihood	-305.2702	F-statistic	6.512446
		Prob(F-statistic)	0.000000

Appendix A

1. Definitions of variables

EU	Dummy for Europe
AM	Dummy for Americas
PAC	Dummy for Pacific
SDH	Sector dummy for high technology
SDM	Sector dummy for medium technology
YO	Years of operation
TO	Subsidiary established through take over
NC	Subsidiary established through new company
JV	Subsidiary established through joint venture
TS	Total sales
SG	Proportion of sales in MNE group
SE	Proportion of sales that is exported
EG	Proportion of exports to group
IG	Proportion of exports as intermediate goods
TMR1	Question 6a in Appendix B
SMR	Question 6b in Appendix B
RPS1	Question 6c in Appendix B
WPM1	Question 6d in Appendix B
EXST	Question 7a in Appendix B
MNET	Question 7b in Appendix B
OWNRD	Question 7c in Appendix B
MNERD	Question 7d in Appendix B
COLRD	Question 7e in Appendix B
EXTT	Question 7f in Appendix B
LAB	Dummy for existence of an R&D lab
AGE	Age of lab
NOPER	Number of researchers
GROWTH	Growth dummy (subjective)
DECLINE	Decline dummy (subjective)
SL1	Question 9a in Appendix B
LIL1	Question 9b in Appendix B
SLMNE1	Question 9c in Appendix B
IIL1	Question 9d in Appendix B

2. Groupings of variables in *realized* and *potential* AC

EXST	Question 7a in Appendix B	Realized AC
MNET	Question 7b in Appendix B	Realized AC
OWNRD	Question 7c in Appendix B	Realized AC
MNERD	Question 7d in Appendix B	Realized AC
COLRD	Question 7e in Appendix B	Potential AC
EXTT	Question 7f in Appendix B	Potential AC
LAB	Dummy for existence of an R&D lab	Realized AC
NOPER	Number of researchers	Realized AC

3. Correlation matrices

Correlation Table 1. Establishment of a Lab with Scope of Subsidiary

	LAB	TMR1	SMR	RPS1	WPM1
LAB	1.000000				
TMR1	-0.193141	1.000000			
SMR	0.112956	0.290524	1.000000		
RPS1	0.007929	0.060247	0.220117	1.000000	
WPM1	0.390211	-0.333628	-0.098711	-0.026497	1.000000

Correlation Table 2. Establishment of a Lab with Sources of Knowledge

	LAB	EXST	MNET	MNERD	COLRD	EXTT
LAB	1.000000					
EXST	0.046118	1.000000				
MNET	-0.031362	0.043305	1.000000			
MNERD	-0.077378	0.079981	0.143637	1.000000		
COLRD	0.112507	0.010974	0.108118	0.144122	1.000000	
EXTT	0.248561	-0.000445	0.058629	0.003448	0.462554	1.000000

Correlation Table 3. Importance of Own R&D as a Source of Technology with Scope of Subsidiary

	OWNRD	TMR1	SMR	RPS1	WPM1
OWNRD	1.000000				
TMR1	-0.090670	1.000000			
SMR	-0.159754	0.328076	1.000000		
RPS1	-0.115502	0.087797	0.215389	1.000000	
WPM1	0.452945	-0.328012	-0.295203	-0.134186	1.000000

Correlation Table 4. Importance of Own R&D as a Source of Technology with Other Sources of Knowledge

	OWNRD	EXST	MNET	MNERD	COLRD	EXTT
OWNRD	1.000000					
EXST	0.017283	1.000000				
MNET	-0.173422	-0.039133	1.000000			
MNERD	-0.121749	0.058517	0.313032	1.000000		
COLRD	0.157028	0.037127	0.059171	0.197637	1.000000	

EXTT	0.171421	-0.044613	-0.058248	-0.096421	0.411263	1.000000

Correlation Table 5. Importance of Own R&D as a Source of Technology with Function of an Established Lab

	OWNRD	SL1	LIL1	SLMNE1	IIL1
OWNRD	1.000000				
SL1	-0.084189	1.000000			
LIL1	0.193100	0.237736	1.000000		
SLMNE1	0.176796	-0.059662	0.030708	1.000000	
IIL1	0.223316	-0.419027	-0.196662	0.343903	1.000000

Appendix B

Questionnaire

1. How your company was originally established? (please tick relevant answer)
    a) by the takeover of an existing UK company
    b) by the creation of a new company with its own production facilities
    c) s a joint venture with an existing UK company
2. What is the current sales/turnover of the subsidiary?
3. What percentage of the sales of the whole MNE group of which the subsidiary is part, does its sales represent?
4. What proportion of your production is exported?
5. What percentage of your exports go to other parts of the MNE group?
6. Please grade each of the following roles in terms of their importance in your operation as:

    (4) our only role
    (3) our major role
    (2) a secondary role
    (1) not a part of our role

    a) to produce for the UK market products that are already established n our MNC's group product range

    b) to play a role of the MNC's European supply network by specializing in the production and export of part of the established product range

    c) to play a role of the MNC's European supply network by producing and exporting component parts for assembly elsewhere

    d) to develop, produce and market for the UK and/or European or (wider) markets, new products additional to the MNE group's existing range

7. Please grade the following sources of technology for your operation as:

(4) our only source of technology

(3) our major source of technology

(2) a secondary source of technology

(1) not a source of technology

(a) existing technology embodied in established products we produce.

(b) technology of our MNE group from which we introduce new products for the UK/European market that differ from other variants introduced in other markets

(c) R & D carried-put by our own laboratory

(d) R&D carried out for us by another R&D laboratory of our MNE group

(e) R & D carried out in collaboration with another firm

(f) R&D carried out for us by local scientific institutions (e.g., universities, independent laboratories, industry laboratories)

g) development and adaptation carried out less formally by members of our engineering unit and production personnel

8. If your subsidiary has its own R&D laboratory to support its operations

a) when was it set up?

b) How many scientific personnel does it employ?

9. If your subsidiary has its own R&D laboratory to support its operations, please grade as:

(4) its only role

(3) its major role

(2) a secondary role

(2) not a part of its role

(a) adaptation of existing products and/or processes to make them more suitable to our markets and conditions

(b) to play a role in the development of new products for our distinctive markets

(c) to provide advice on adaptation and/or development to other producing subsidiaries of our MNE group

(d) to carry out basic research (not directly related to our current products) as part of a wider MNE group level research program

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