Governing Knowledge Processes in MNCs: The Case of German R&D Units abroad[1]

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ABSTRACT

Over the last decade, the number of German owned R&D units in foreign countries rose drastically. This paper empirically investigates a series of contingency factors that might influence the coordination and control of these units. The analysis builds on a newly developed database covering about fifty percent of all German corporations with foreign R&D activities. The results show that besides the mission of the lab, the use of coordination instruments depends on the size of the local lab, as well as cultural and geographical distance.

INTRODUCTION

Learning in high-technology firms takes place preponderantly in R&D units. Traditionally, companies used to locate these units in close proximity to corporate headquarters and their coordination and control was not of major concern for most managers (Brockhoff, 1998; Reger 1997). More recently though, along with a sharp increase in foreign R&D spending, the issue of finding appropriate coordination and control instruments to manage these R&D units has moved up the agenda of R&D managers. A recent survey reveals, that today more than 42 percent of all managers perceive coordination and control as the major obstacle in managing a network of foreign R&D Units (Ambos, in press). Yet, our knowledge concerning the management and control of these units is limited (Brockhoff, 1998; Cheng and Bolon, 1993). Most previous studies deal with questions as to where to establish an R&D unit (Kuemmerle, 1999; Hakanson and Nobel, 1993) and how to organise an R&D Network (De Meyer and Mizushima, 1989; Gassmann and v. Zedtwitz, 1999). Which factors determine the use of different coordination and control modes has received little attention. Recent exceptions include Nobel and Birkinshaw (1998), Reger (1997) and Asakawa (2001), although these studies are limited in focus (e.g. focussing on just one or two contingency factors), or in relying on qualitative observations only. This paper presents an empirical attempt to simultaneously examine various contingency factors which may influence the coordination and control of R&D units abroad.

The paper is organized as follows. In the first section we briefly review the literature on coordination and control in multinational corporations as well as previously identified contingency factors and put forward some research hypotheses. The second section lies down the methodology of the study. The third section presents the statistical analysis. The final section

discusses the findings and puts them into a broader perspective. Avenues for further research are discussed.

THEORETICAL BACKGROUND

Coordination and Control in the MNC

Coordination is defined as "integrating or linking together different parts of an organisation to accomplish a collective set of tasks" (Van de Ven et al. 1976). In order to achieve coordination, companies use various mechanisms ranging from centralised control to the use of taskforces and socialisation. Numerous classification schemes to reduce the complexity of coordination and control have been presented (Martinez and Jarillo, 1989; Khandwalla, 1975; Harzing, 1999). For purposes of our study we use Harzings (1999) typology distinguishing between direct and indirect control, and personal versus impersonal control.

Using her approach we can discriminate four ways in which a MNC controls its subsidiaries: Centralised personal control, formal bureaucratic control, output control as well as socialisation and networks (see table 1 for examples). Personal control involves the direct involvement of headquarter personnel in the supervision of the subsidiary while bureaucratic formalised controls impose direct yet impersonal structures like formalisation and standardisation. Output control in contrast, reflects the workings of the market mechanism. The last category subsumes a broad range of instruments all related to the creation of a common set of believes (socialization) or informal networks. In the following section we focus on subsidiary control and subsequently state the hypotheses related to the control of R&D units abroad.

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A Subsidiary Perspective of control

MNC research has produced various and often competing models to explain the type and intensity of MNC control over its subsidiaries. There are two streams of research: One, focusing on the MNC as a whole, the other on subsidiary specific factors that influence subsidiary control. The classical works of Stopford and Wells (1972); Franko (1973); Egelhoff (1988) and Bartlett and Ghoshal (1989) have spawned numerous studies subscribing to the former perspective. More recently research efforts have been shifting away from the MNC to contextual issues related to the subsidiary in explaining coordination and control (e.g. Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1997). The reason for this shift in interest to the subsidiary level may be found in the increasing importance of the latter in assimilating and processing knowledge of strategic importance to the MNC. The different resources in its possession, as well as the strategic task context of the subsidiary abroad require differentiated specific approaches to control (Nohria and Ghoshal, 1997; Schmid, 1999; Hakanson, 1990; Gupta and Govindarajan, 1991). A series of studies dealt with various topics related to these issues. Bartlett and Ghoshal (1986), Gupta and Govindarajan (1991) as well as Nobel and Birkinshaw (1998) focused on the mission of the subsidiary abroad; Garnier (1982) and Picard (1979) on its size; Harzing (1999), Gates and Egelhoff (1986) researched the impact of the length of its establishment; Asakawa (1996a) and Andersson and Forsgren (1996) on network embeddedness, and Wolf (1994), Harzing (1999) and Baliga and Jaeger (1984) on the cultural distance between the MNC and the

subsidiary abroad. We would expect that these factors also influence control of international R&D units. Thus, in a first attempt to advance our understanding of subsidiary control in an R&D context, we build on these existing studies to derive some preliminary hypotheses. Wherever appropriate we split our hypotheses in two classes: One focussing on overall control, the other on the predominant mode of control (e.g. social control or output control).

Hypotheses

Size of the R&D unit

Of all contingency factors examined, subsidiary size probably attracted most attention. Overall, considering a power dependency perspective, we would expect larger units to be equipped with valuable resources enhancing the bargaining power of local subsidiary management. Consequently, we expect these units to be able to resist control (Prahalad and Doz, 1981).

H1: The degree of MNC control over its subsidiary is negatively related to the subsidiaries size.

Existing research shows conflicting evidence about the relationship between personal centralised control and subsidiary size. Schmaul (1995), Hedlund (1981) and Picard (1979) found a negative relationship between centralised personal control and subsidiary size. This relationship was not supported by studies conducted by Wolf (1994), Garnier (1982), and Gates and Egelhoff (1986). As some studies could show, indirect control mechanisms (output control and socialization) tend to be positively correlated to subsidiary size (Egelhoff, 1988; Wolf, 1994). We are seeking evidence on these issues by putting the following subhypotheses to the test.

H1a: The size of the local R&D unit is negatively related to the degree of personal centralised control and the degree of formal bureaucratic control.

H1b: Size is positively related to output control as well as the degree to which the subsidiary is controlled by socialisation and networks.

Age of the R&D unit

Intuition suggests, that personal centralized control of the subsidiary decreases over time as uncertainties diminish. This relationship finds support in the work of Gates and Egelhoff (1986), and Wolf (1994). However, a variety of studies do not find support for this relationship (see Garnier, 1982; Picard, 1979; Harzing, 1999; and Schmaul, 1995). To provide additional evidence, we will put the following hypothesis to empirical test:

H2: Personal centralised control is negatively related to the age of the subsidiary.

Mission of the subsidiary

Researchers have emphasised the importance of the subsidiaries' mission as a factor shaping control (Bartlett and Ghoshal, 1989; Gupta and Govindarajan, 1991, 1994; Martinez and Jarillo 1991; Pearce and Singh, 1992). In regard to R&D units abroad, Håkanson (1990: 262) notes that "the existence of different roles makes it increasingly impossible to run foreign subsidiaries using standard systems; incentives, control systems and degrees of autonomy must be differentiated". Various typologies for R&D units abroad attempt to distinguish them according to a number of differing criteria (see e.g. Ronstadt, 1978; Behrman and Fischer, 1980; Håkanson

and Nobel, 1993; Chiesa, 1996, 2000; Beckmann, 1997; Kuemmerle, 1999). Often the emerging categories are incompatible and cannot be usefully applied to study issues of control. This paper distinguishes four different R&D unit missions. Following suggestions of Kuemmerle (1999) and Chiesa (2000), our strategic missions are the result of two contextual dimensions: the type of technological mandate and the degree of responsibility for a given technology area. (1) Local adapters, (2) autonomous centres of competence, (3) integrated researchers and (4) global development units. The R&D unit missions used in this study are explained more closely in the following section.

Local adapters adapt products to local markets, while *autonomous centres of competence* aim at the creation of new competencies (Kuemmerle, 1999). The latter have sole responsibility for a technology, possessing all the necessary resources to achieve their mission. *Integrated research units* resemble autonomous centres of competence but do not possess the sole responsibility for a given technology. As a consequence, work-related interdependencies are high. *Global development units* aim at the exploitation of MNC competencies. In contrast to local adapters, they rely on close cooperation with other R&D units within the MNC network.

We would assume global development units and integrated research units to experience a higher level of total control, based on the fact that high interdependencies will spur a need for control. The following hypothesis is the basis for testing the relationship between differentiated missions and the control associated with them.

H3: The overall level of control is higher for integrated research units and global development units than for local adapters and autonomous competence centres.

Degree of external embeddedness

Research in international management emphasises the importance of subunits' embeddedness (Ghoshal and Bartlett, 1990; Andersson and Forsgren, 1996; Asakawa, 1996b). Andersson and Forsgreen in one of a scant number of studies on this issue suggest that higher degrees of embeddedness result in lower perceived control by the subsidiary. This supports Asakawas (1996b) findings, of higher tensions in headquarter subsidiary relationships for R&D units with high network embeddedness. Emerson (1962) and Cook (1977) take this strain of thought further by suggesting, that high embeddedness should promote subsidiary power and diminish headquarter control. Hence, high embeddedness may shield the subsidiary from headquarter control. We hypothesise that:

H4: The overall level of control is negatively related to the level of embeddedness in the local community.

Cultural Distance

While embeddedness in the local research community may affect headquarter control over the subsidiary, there is evidence that this may also be the case with cultural distance. Intuition and first evidence on Japanese MNC in Europe (Asakawa, 1996) suggest R&D units in distant cultures will experience an overall lower degree of control. One could argue that dissimilarity favours decentralized and autonomous decisions. Thus, we advance the following hypothesis:

H5: The overall level of control will be negatively related to cultural distance among the local R&D unit and headquarters

High cultural distance between the MNC and its subsidiary abroad should be reflected in low social control (Baliga and Jaeger 1984; Rosenzweig and Singh 1991). Overcoming high cultural distance by means of social control may divulge to many resources hence bureaucratic means of control may be more appropriate. Empirically, we find little support for this proposition (see e.g. Wolf, 1994; Garnier, 1992 Harzing, 1999). For the moment being, we side with the prescriptive studies and propose the following:

H5a: Control via Socialization and Networks is negatively related to cultural distance between the MNC and the R&D unit abroad.

H5b: Formalized bureaucratic control and output control is positively related to cultural distance between the MNC and the R&D unit abroad.

Geographical Distance

Like cultural distance between MNC and the subsidiary, geographical distance may create challenges for coordination and control. Allen (1985) and Katz and Allen (1982) note that geographical distance results in diminishing communication intensity. Higher geographical distance should, for obvious reasons, also reduce the feasibility of direct and personal control. There is good reason to believe that in this case control would be formalised and bureaucratic, because it would not seem to matter for a report to travel 200, 2.000 or 20.000 miles (Wolf, 1994).

H6a: Personal centralised control is negatively related to the geographical distance of the local R&D unit.

H6b: Formal bureaucratic control will be positively related to the geographical distance of the local R&D unit.

METHODOLOGY

Measurement

To assess the use of *coordination instruments,* the scale developed by Martinez and Jarillo (1991), which was also used by Harzing (1999), was adapted to fit the context of R&D subsidiaries. To measure *personal centralized control* we asked questions assessing the degree of local autonomy and the degree of direct supervision. *Bureaucratic formalized control* was measured by asking managers to indicate the degree to which standardized processes and procedures were applied and the degree to which formalized rules and policies were enforced (e.g. manuals and written policies). *Output control* assessed the utilization of formal reporting systems and the existence of integrated planning systems. Finally, we measured *control by socialization and networks* by assessing the degree of shared values among managers, the degree to which expatriate managers were used to coordinate a particular unit and to which degree a given unit engages in the exchange of R&D personnel. The scale reliability was good for this type of study (Cronbach's alpha between 0.72 and 0.67).

In line with Harzing (1999), we composed a measure of "total control" encompassing all the described items. Cronbach's alpha for this measure is an acceptable 0.73. The measures for all independent variables are summarized in the appendix.

Sample and Data Collection

Data were collected from R&D directors of German MNCs conducting R&D on a global scale. Since no data source was available on foreign R&D activities of German firms, a pre-contact was made with all German top 500 corporations. This first stage investigation revealed a total population of 106 Companies with foreign R&D activities, representing the population to be investigated. A mail survey was used as the primarily means of data collection. Two telephone reminders ensured a high response rate. The participants were offered a summary of the results and an invitation to participate in a workshop on the topic at the University of Hamburg. These efforts led to a response of rate of 46,23% providing data on a total of 134 foreign R&D units. The participating corporations represent the full spectrum of German leading industries, with chemicals, automotive and machinery constituting the biggest share. In aggregated terms the participating corporations spend 26.1 billion Euro on R&D, representing approximately 66% of total privately funded R&D expenditures in 1999 (Stifterverband, 2001).

RESULTS AND DISCUSSION

To test the combined influence of the proposed contingency factors, multiple regression was applied. In total four models were constructed, using the four control mechanisms (i.e. personal centralized control, formal bureaucratic control, output control and social control) as the dependent and the contingency factors as the independent variables. In addition a fifth model examined the impact of the independent factors on total control. The data were checked to comply with the requirements of regression analysis. (Linearity, equality of variance and normality). Plotting standardised residuals against standardized predicted values showed no major violations of them. A careful examination of the independent measures for undesirable

colinearity ensured us that multiple regression was appropriate. Since we wanted to create parsimonious models, stepwise selection (a combination of forward selection and backward elimination) was used to identify the subset of variables that were good predictors of the dependent variable. Table 2 summarizes the results of the regression analysis.

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All regression models are highly significant. The adjusted R square differs considerably among the models. It is lowest for bureaucratic formalized control (10%) and highest for control through socialisation and networks (24%). In the following we report on the results in detail. As in the preceding section we center our discussion on the six contingency factors. The concluding section will try to integrate our findings and put them into a broader perspective.

Size

Overall our results show a high and positive impact of *R&D unit size* on coordination and control. Across all models larger units experience a higher degree of formal bureaucratic control (β= 0.157), a higher degree of output control (β= 0.161) and a higher degree of social control (β= 0.183). As a consequence total control also increases with the size of the local R&D unit (β= 0.186). Yet, these findings provide only partial support for our hypotheses. Subscribing to a resource dependency perspective we expected that total control would relate negatively to R&D unit size. Our results show the opposite, since larger R&D units experience a higher level of control than smaller units. Thus, hypothesis (H1) is not confirmed by empirical evidence.

Similarly, (H1a) has to be rejected, since contrary to our expectations; size is unrelated to personal centralised control, and positively to formal control. (H1b), is confirmed by a positive relationship of output control and social control to unit size.

The lack of support for (H1a) may be explained by countervailing forces (Hedlund 1981). This author argues, bargaining power stemming from size be compensated by the increasing strategic importance of the R&D unit, resulting in strong central control by headquarters. Following this reasoning, a higher degree of formalization could be interpreted as HQ attempts to control without forcing direct invasive control upon the R&D unit.

Age and external embeddedness.

The age of the subsidiary is unrelated to control (H2) and external embeddedness (H4). This is in line with prior research findings (see Harzing, 1999; Schmaul, 1995 and Garnier, 1982). Recurring lack of empirical support for these relationships seems to indicate that no such relationships exist. Subscribing to a power dependency perspective we predicted that embeddedness into the local research community would serve to stifle corporate control (H4). Other than Andersson and Forsgren (1996) we could find no relationship between total control and embeddedness.

R&D unit mission

Better support was obtained for our hypothesis concerning the strategic mission of an R&D unit. As predicted, we observe a higher degree of total control in integrated research units (β= 0.158) than in local adaptors (β= -0.219) and autonomous centers of competence (β= -0.157). Thus hypothesis (H3) is supported. We did not form any hypothesis concerning the different

modes of control. Yet, a reflecting on models 1 – 4 provide some interesting insights on how headquarters control their foreign R&D units. We note that bureaucratic formalized control does not seem to apply to autonomous centers of competence (β= -0.233). This sort of control is likely not to be suitable to its task. Similarly, control through socialisation seems be inappropriate for this type of R&D unit (β= -0.303). These findings are inconsistent with prior research by Nobel and Birkinshaw (1998), but do support the work of Asakawa (1996b) and Gupta and Govindarajan (1994). As for the other missions, we find that local adopters score low in all models (personal centralized control: β= -0.217; formal bureaucratic control: β= -0.191; output control: β= -0.241; social control: β= 0.219). Perhaps product or technology adaptation may not be seen as a major issue and therefore not justify sophisticated means of control. Alternatively we might expect this type of unit to be firmly integrated into the local production process. Further research is needed to bring clarity to this issue.

Cultural and Geographic Distance

Reporting on the two distance measures, we see total control rise along with cultural distance (β= 0.195). In particular, cultural distance does have significant and positive impact on personal centralized control (β= 0.206) and on output control (β= 0.267). These findings only partially support our hypotheses. Building on Baliga and Jaeger (1984) and Rosenzweig and Singh (1991) we predicted a negative relationship between social control cultural distance (H5a). We could find no empirical support for this relationship. We do find support for (H5b), however. MNCs apply higher output control to R&D units, which are culturally distant. The positive relationship between cultural distance and personal centralized control, evident in model 1 closely resemble Harzings' (1999) findings. Harzings argument that MNCs trade impersonal

controls (e.g. output and bureaucratic formalized control) against personal centralized ones is only partially supported by our data. Further theory building is needed, before we can draw any further conclusions.

Glancing at the *geographical distance* variable, we observe a positive influence between distance and total control (β= 0.177). R&D units in distant countries will experience a higher degree of personal centralized control (β= 0.165), a higher level of formal bureaucratic control (β= 0.143) and a higher level of social control (β= 0.128). We hypothesised a higher degree of formal bureaucratic control with higher distance, which was confirmed (H6b). It is noteworthy that previous studies justify explain the increased of formal bureaucratic control with the infeasibility of other control modes in relation to geographical distance (e.g. personal centralized control). This argument found no support in our research. Contrary to our hypothesis we find both modes to be positively related to geographical distance. Thus, (H6a) had to be rejected. As with cultural distance our findings will need some further discussion and we will come back to this point in the concluding section.

CONCLUSION

The aim of this paper has been to empirically investigate the relationship between different control mechanisms and common contingency factors in the context of international R&D. The absence of empirical studies in the field of international R&D, as well as often contradictory findings led to our search for a model explaining the use of control in international R&D organizations.

We find personal centralized control to be dependent on the strategic mission of the local R&D unit as well as the geographic and cultural distance between the headquarter and the local

R&D unit. The degree of formal bureaucratic control depends on the size of the local R&D unit, its strategic mission as well as the geographical distance between headquarters and the local unit. Output control is primarily dependent on the size of the local R&D unit, and cultural distance. It finds much less application among local adapters. Finally, we find that social control is primarily dependent on the size of the R&D unit, its strategic mission as well as the geographical distance.

Three key findings may constitute an interesting basis for further research activity in this area.

The most striking result is the overall importance of the strategic mission of an R&D unit. In all five models, strategic missions and mandates have a clear bearing on coordination and control. This gives ground to recent attempts stretching the importance of the strategic mission as a determining force in determining modes of control (Gupta and Govindarajan, 1991; Nobel and Birkinshaw, 1998 or Asakawa, 2001). Yet up to today we lack a widely accepted typology (Medcof, 1997). Further research in this area may bring a deeper understanding to this issue.

Second, we emphasise that almost all of our propositions relating to power dependency theory fail to gain support. In our sample, neither the usually proposed negative relationship between size of the subsidiary nor the negative relationship between control and external embeddedness could be found (e.g. Prahalad and Doz, 1981; Andersson and Forsgren, 1996). Notwithstanding the fact that this may be due to measurement error, we lean to conclude that, at least in R&D units, power is not a major issue. Other most probably strategic, considerations may move headquarters to use specific control instrument.

The third finding relates to our two distance measures. Along with common suggestions high cultural distance was expected to lead to a lower degree of overall control, especially social control. (Baliga and Jaeger, 1984; Rosenzweig and Singh, 1991). Authors studying the

internationalisation patterns of the firm (Stöttinger and Schlegelmilch, 1998; Granstrand, 1999) or its performance (O'Grady and Lane, 1996) repeatedly argue the concept of cultural distance to be "past its due date" (Stöttinger and Schlegelmilch, 1998: 365) or of "decreasing relevance" (Granstrand, 1999: 293). Our results tell a different story. Cultural distance has an impact on control patterns. Further, we are somewhat puzzled by the positive influence of our distance measures on control. We offer two tentative explanations: This study examined German MNCs only. German firms rank high in uncertainty avoidance (Hofstede, 1991). We would expect German firms to exercise strong control whenever the environment is perceived as uncertain or unfamiliar. Seen in this light german firms acquiring foreign subsidiaries with the mission to bring technologies "home" may stifle the creativity of foreign R&D units with an excessive desire for control by headquarters.. There is evidence from interviews, which we conducted, in a large German firm, which has massively acquired R&D facilities in the USA. Having foreign subsidiary personnel together with headquarter personnel on one table it was evident that major struggles for control were the central issues of headquarter subsidiary relations. Similar observations characterise Japanese acquisitions in the USA. Perhaps control issues related to cultural distance are of specific importance when innovation, creativity and the search for new knowledge are considerations of strategic importance. Specifically uncertainty avoidance may be the killer of the goose, which lays the golden egg. Further research on this topic may yield interesting insights.

Our findings have to be interpreted with some caution. As mentioned at the outset, company level factors might also influence control. Second, along with a shift to more networks structures, a dyadic perspective on control as applied in this study, might increasingly become inappropriate (Forsgren and Pahlberg, 1992).

Table 1: Examples of Coordination Instruments

Control Mechanism	Examples
Personal centralized control	• Close behavioural control of subsidiary managers through supervision • Centralization or decentralization of decision making
Formal bureaucratic control	• Standard procedures • Manuals, charts • Rules and procedures • Written policies • Job descriptions
Output control	• Planning and goal setting • Formal reporting systems • Technical reports • Internal markets
Control via socialization and networks	• Socialization • Expatriation of managers • Transfer of R&D personnel • Integrative teams and taskforces • International trainings • In-house trade fairs

Table 2: Linear regression models for type of control and subsidiary level contingency factors

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Size of R&D unit		0,157***	0,161*	0,183**	0,186**
Age					
Strategic Mission					
Local adaptors	-0,217***	-0,191**	-0,241***	-0,219***	-0,294***
Autonomous centres of competence		-0,233**		-0,303***	-0,157*
Integrated research unit	0,276***				0,158*
External embeddedness					
Cultural distance	0,206***		0,267***		0,195**
Geographical distance	0,165**	0,143*		0,128*	0,177**
Model Statistics					
R	0,491	0,364	0,363	0,457	0,529
R^2	0,241	0,133	0,132	0,208	0,280
adj. R^2	0,213	0,101	0,108	0,195	0,240
F-Score	8,665	4,173	5,581	8,529	6,941
Sign.	0,000	0,003	0,001	0,000	0,000

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

APPENDIX: MEASUREMENT OF VARIABLES

Size of the R&D Unit was measured as the number of employees in the R&D Unit.

Age of the R&D Unit was measured as the number of years since the R&D unit was founded.

Cultural Distance was measured using the procedure suggested by Kogut and Singh (1988). Using the host country as a proxy for national culture we assigned cultural value scores to each R&D unit. Subsequently we calculated a distance measure between the home country cultural profile and the profile of the host culture respectively.

Geographical Distance was assessed by calculating the geographical distance (in kilometres) between the headquarter and the local R&D units.

Strategic Mission of an R&D unit was determined along the two pre-described dimensions. In accordance to Kuemmerle (1999) the technology mandate was measured on a continues scale, asking managers to indicate the percentage of work devoted to capability augmenting activities in relation to capability exploiting. The variable was clearly bi-modal, and was subsequently split at the 50 percent mark. As a measure for sole responsibility, we used the work-related interdependencies of the unit assuming that lower interdependencies will reflect the unit's independence from other actors. Subsequently we performed a median-split to obtain four strategic R&D missions.

External embeddedness was measured in a two step process (v. Boehmer, 1995). Data were obtained concerning the existence and the collaboration intensity of seven external partners (competitors, suppliers, customers, other firms, private research institutions, universities, local governments or other institutions). In the following, network embeddedness was assessed by dividing the actual network density by the total possible network density.

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