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MNE Competence-Creating Subsidiary Mandates: An Empirical Investigation

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Abstract

The determinants of R&D-intensity differ between subsidiaries in an MNE. The qualitative nature of R&D behavior (and hence also the extent of investment in R&D) differs, depending upon whether a subsidiary achieves a competence-creating output mandate. Using data on UK subsidiaries of non-UK MNEs, we find that the R&D investments of subsidiaries with mandates is both qualitatively and quantitatively different from that of subsidiaries that do not. The R&D of mandated subsidiaries depends upon local infrastructure, subsidiary strategic independence and product diversification; but for non-mandated subsidiaries R&D depends instead upon entry mode, and local demand conditions.

Short title: MNE Competence-Creating Subsidiary Mandates.

Keywords: MNEs, Competence, R&D, Subsidiary, Mandates, Internationalization.

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1. The Emergence of Competence-Creating Subsidiaries

Historically, multinational enterprises (MNEs) located R&D in their subsidiaries abroad mainly for the purposes of the adaptation of products developed in their home countries to local tastes or customer needs, and the adaptation of processes to local resource availabilities and production conditions. In this situation subsidiaries were dependent on the competence of their parent companies, and so their role was essentially just competence exploiting, or in the terminology of Kuemmerle (1999) their local R&D was 'home-base exploiting'. In recent years instead, linked to the closer integration of subsidiaries into international networks within the MNE, some subsidiary R&D has gained a more creative role, to generate new technology in accordance with the comparative advantage in innovation of the country in which the subsidiary is located (Cantwell 1995, Papanastassiou and Pearce 1997, Cantwell and Janne 1999, Pearce 1999, Zander 1999a). This transformation has led to a quantitative increase in the level of R&D undertaken in at least those subsidiaries that have acquired this kind of competence-creating mandate, and in these subsidiaries there has been a qualitative upgrading in the types of research project away from the purely applied towards the more fundamental; although the research undertaken is generally of an (increasingly) specialized kind, to take advantage of the particular capability of local personnel and the other local institutions with which the subsidiary is connected.

The shift towards internationally integrated strategies within MNEs is partly grounded on a 'life cycle' effect within what have become mature MNEs, which have now created a sufficient international spread in their operations that they have the facility to establish an internal network of specialized subsidiaries, which each evolve a specific

regional or global contribution to the MNE beyond the concerns of their own most immediate market (Cantwell and Piscitello 1999). Thus, subsidiaries that began as local market-oriented (import-substituting) units are gradually transformed into more export-oriented and internationally integrated operations. While some of the subsidiaries within such a network may have essentially just a competence-exploiting or an 'assembly' role, others take on a more technologically creative function and the level and complexity of their R&D rises accordingly (Cantwell 1987). Competitively stronger MNEs are more likely to locate R&D abroad, and to have a greater variance in the levels of R&D across their subsidiaries, with R&D becoming concentrated in sites where local conditions are most conducive to technology creation (Cantwell and Kosmopoulou 2000).

Corresponding to the adoption of internationally integrated strategies in MNEs and the associated attainment of a competence-creating mandate by selected subsidiaries (while others continue to fulfill primarily just a competence-exploiting role), two new strands of international business strategy literature have emerged. The traditional international business literature provided an analysis at the level of the corporate group of the hierarchical control relationships developed by parent companies over what were assumed to be uniformly competence-exploiting subsidiaries, in which all subsidiaries depended upon transfers of resources and expertise from the corporate control center in the MNE's home country. Thus, the traditional literature examined the organizational structures that were appropriate to systems of centralized power and control (e.g. Brooke and Remmers 1970), and the conditions for the internalization within MNEs of intermediate product markets that were the foundation for systems of hierarchical control in place of markets (Buckley and Casson 1976).

The first strand of more recent literature has continued to be set out mainly at the level of the corporate group, but it has focused on the distinction between competence-creating and competence-exploiting subsidiaries in the internationally integrated network of the MNE. Since competence-creating subsidiaries require a greater degree of strategic independence to be successful this led to the consideration of more complex organizational strategies (Doz 1986, Hedlund 1986, Porter 1986, Bartlett and Ghoshal 1989), while the emergence of competence-creating foreign centers within corporate groups brought a sharper focus on the asset-seeking motives of MNEs as opposed to the better established market-seeking and resource-seeking activities (Dunning 1995, 1996). The specialist literature on the internationalization of corporate R&D has also been shifted in this same direction when analyzing the international corporate group. While at one time supposing that R&D is decentralized if the requirements of local subsidiary adaptation outweigh the benefits of scale economies in locationally concentrating R&D in the home country (Ronstadt 1977, Lall 1979, Mansfield, Teece and Romeo 1979), much of the latest research focuses on the distinction within MNEs between the characteristics of R&D in competence-creating as opposed to competence-exploiting subsidiaries (Kuemmerle 1999, Zander 1999a).

The second strand of more recent literature has instead begun to examine strategy at the level of the subsidiary rather than the level of the corporate group as a whole, but it has focused almost exclusively on those subsidiaries that have acquired a competence-creating role or gained strategic independence, and has not tended to consider the (we will argue contrasting) behavior of competence-exploiting subsidiaries. This literature has developed the analysis of subsidiary-level organizational strategies when subsidiaries are

based in foreign centers of excellence (Birkinshaw 1998, Taggart 1998, Andersson and Forsgren 2000, Ensign, Birkinshaw and Frost 2000, Holm and Pedersen 2000, Simões and Nevado 2000). Like in the first strand of literature, there is an equivalent specialist literature on the internationalization of R&D that has examined subsidiary-level R&D strategies, but which has also tended to express special interest in the strategies of the competence-creating subset of subsidiaries (Pearce 1999, Håkanson and Nobel 2000).

In contrast, in this paper we go a step further than either of these two newer strands of international business strategy literature, by combining a subsidiary-level analysis with a direct comparison between the behavior of competence-creating and competence-exploiting subsidiaries. Thus, we include evidence on both types of subsidiary in our study of the determinants of localized R&D strategy, so as to contrast the distinctive features that mark out behavior in each type of subsidiary. Figure 1 summarizes the relationship of our distinction between competence-creating and competence-exploiting subsidiaries with the other related taxonomies that can now be found in the international corporate strategy literature.

2. R&D in Competence-Creating vs. Competence-Exploiting Subsidiaries

The Determinants of Competence-Creating Mandates

In connection with our objective of distinguishing between the R&D behavior of competence-creating and competence-exploiting subsidiaries, the first step is to understand the determinants of the process by which subsidiaries acquire such competence-creating mandates. Our approach is to treat the achievement of a competence-creating mandate as an endogenous strategy determined by the firm and not as a variable exogenous to the firm. However, we leave open whether the mandate is the

outcome of a deliberate strategic decision or a gradually evolved strategy. Hence, we do not consider here the logistics of how mandates are actually achieved. It is likely that subsidiaries gradually evolve the capabilities needed for them to be accorded a competence-creating role, rather than only developing such capabilities once a mandate has been awarded by the MNE (see Birkinshaw and Hood 1998) - but we are concerned with the factors that influence the likelihood that a competence-creating mandate will be achieved by a subsidiary. In their turn, these factors will indirectly affect the level of subsidiary R&D, since for obvious reasons R&D will tend to be higher in those subsidiaries that are involved in local competence-creating functions, as compared to subsidiaries that are not. Hence, the determinants of the mandating decision will regulate an inter-group variation in the magnitude of local R&D when distinguishing between the competence-creating and competence-exploiting groups of subsidiaries. In this section we first review these influences upon the mandating decision and thus the gap in R&D-intensity between groups, and then secondly examine the qualitative differences in intra-group behavior, in which we suggest that the drivers of R&D in each type of subsidiary are different since the motives for undertaking localized R&D are distinct.

The first influence on the likelihood of a subsidiary gaining a competence-creating mandate is the characteristics of the location in which it is situated. A region with a good local infrastructure, a science base and a more skilled work force is more attractive for the location of the R&D facilities of foreign-owned MNEs (Cantwell and Iammarino 2000, Cantwell and Piscitello 2000b), and in such locations subsidiaries are more likely to gain competence-creating mandates on behalf of their corporate group, and to use this mandate more effectively once they have it. Due to the complexity of

technological learning, and the significance of maintaining face-to-face contacts, the localization of technological contacts tends to occur at a regional level within host countries (Jaffe, Trajtenberg and Henderson 1993, Almeida 1996, Cantwell and Iammarino 1998).

Apart from the locational environment in which it operates, a second intra-firm influence on the likelihood that a subsidiary acquires a competence-creating role is the extent to which it has previously achieved strategic independence in the MNE. In order to geographically disperse its competence-creating capability so as to take advantage of the innovative opportunities that can be derived from differentiated expertise in the locations in which it is active, the MNE must allow at least some of its subsidiaries a greater measure of strategic independence, while establishing an integrated network structure that permits some coordination of their efforts (Prahalad and Doz 1987, Bartlett and Ghoshal 1989). Building on this MNE-level perspective, a recent subsidiary-level literature has suggested that the greater is the extent of subsidiary autonomy, the better is the ability of the subsidiary to form favorable external network linkages with other companies and institutions in its own local environment (Birkinshaw, Hood and Jonsson 1998, Andersson and Forsgren 2000). In its turn, the greater is the local embeddedness of the subsidiary, the higher the likelihood that it will acquire a competence-creating mandate. In the specific context of the internationalization of R&D, it has been shown that compared to adaptive subsidiary R&D facilities the creative subsidiary R&D establishments have adequate independence to have developed stronger external and internal network relationships that foster innovation (Nobel and Birkinshaw 1998).

The Different Motivation of Local R&D in Competence-Creating Subsidiaries

So as argued above, R&D will tend to be higher in subsidiaries that acquire competence-creating mandates as opposed to those that don't, and the award of such a mandate is likelier when the subsidiary is located in a regional center of technological excellence and has gained a higher degree of strategic independence. However, it is important to recognize that R&D facilities may well continue for the purposes of adaptation in essentially competence-exploiting subsidiaries and not only in subsidiaries with a competence-creating mandate. As noted above, historically most international corporate R&D was of this kind, having the objective of adapting products for local markets and processes to local resource and production conditions, and much foreign-located R&D in MNEs is still of this kind. Our central argument here is not simply that more R&D will now gravitate to subsidiaries with a competence-creating mandate once the objective is to establish an internationally integrated system for innovation in place of an independent collection of multi-domestic operations with diffused adaptation (although it will), but rather that this new kind of R&D will be differently motivated than in the past, and so qualitatively distinct in its determinants. Our empirical approach aims to examine whether there is such a qualitative difference as well as a quantitative gap in subsidiary R&D-intensity, and if so to ascertain the nature of this qualitative difference in motivations in terms of the factors that influence investments in R&D.

The most notable potential difference between the determinants of R&D behavior in competence-creating as opposed to competence-exploiting subsidiaries may be with respect to the effect of the mode of entry (by acquisition or greenfield venture) on local R&D-intensity. A number of studies have shown that a substantial proportion of

internationalized R&D facilities in MNEs result from acquisition (e.g. Håkanson 1981). This raises immediately the question of the motivation for acquisition. If the motives are mainly financial, or if they relate to other parts of the acquired business than to those subsidiaries that bring with them local R&D facilities, then we would expect a post-acquisition integration process to reduce such R&D to eliminate duplication within the new group, so R&D-intensity in acquired subsidiaries will tend to become lower. This would be consistent with the findings of Hitt, Hoskisson, Ireland and Harrison (1991) that acquisitions tend to reduce R&D-intensity and curtail the process of championing new products and processes within the firm.

However, matters will surely be different when one of the motives for acquisition is the asset-seeking objective of diversifying the technological capability of the firm by incorporating new competence-creating subsidiaries whose profiles of innovation tend to be complementary to that of the MNE rather than involving a duplication of effort. There is evidence that since around 1980 internationalization has been positively associated with such corporate technological diversification (Cantwell and Piscitello 2000a), but this must be predominantly attributable to subsidiaries that have gained competence-creating status. Thus, Zander (1999b) has found that acquisitions are especially likely to promote the diversification of technological capabilities within the MNE when their competence-creating ability is valued as part of an international acquisition strategy explicitly for this purpose, while Simões and Nevado (2000) find that acquisitions targeted as centers of excellence develop an effective competence-creating role more rapidly. So in this event the effect of acquisition on R&D-intensity will tend to be positive in competence-creating subsidiaries, whereas it tends to be negative in other subsidiaries.

Apart from the differential effect of acquisitions on subsidiary R&D when distinguishing subsidiaries with competence-creating mandates from those without, we can expect as well a difference in the impact on R&D associated with product or business diversification in the subsidiary. Hitt and Hoskisson and Kim (1997) found that although in general the degree of internationalization of the firm has a positive effect on R&D-intensity, the interaction effects of internationalization with product diversification are negative. In other words, we might expect that when subsidiaries are engaged in diversification away from the main lines of business activity of the MNE, this will tend to lower the extent of their local R&D. A resource-based view of the firm would suggest some trade-off between developing new competence through R&D-related efforts and establishing new product lines outside the familiar markets of the firm. However, clearly this argument only really applies with respect to competence-creating subsidiaries. Conversely, competence-exploiting subsidiaries that are mainly drawing upon the established technological expertise of the MNE in order to serve new product markets may need to do more local R&D rather than less, since the intensity of effort required for local product adaptation will be if anything greater. On the other hand, this influence may be constrained by the need to also devote more resources to local marketing activity, and a lack of local capabilities may lead the subsidiary to try and pass on much of the increased R&D requirement to facilities in the parent company. Even so, we would expect that any negative effect of subsidiary product diversification on local R&D would be much weaker in the case of competence-exploiting subsidiaries.

3. Methodology, Research Hypotheses and Data

The Estimating Procedure

Once a firm chooses whether to locate research-based (competence-creating) or assembly-based (competence-exploiting) production at a site, it must then decide the extent of R&D activity it wishes to undertake at the host location. Our empirical measurement of whether or not a subsidiary has achieved a competence-creating mandate is closest to Cantwell (1987) in the typologies of Figure 1. This is because we distinguished on a 5-point scale subsidiaries that reported the functional scope of their output mandate as being limited to sales and service, assem

standard in the modal choice literature on FDI (Czinkota, Ronkainen and Moffett, 1996; Devereux and Griffith, 1998; Grant, 1995; Mudambi and Ricketts, 1998).

In the model, a subsidiary achieves a competence-creating mandate when the expected value of such a strategy exceeds the expected value of a purely competence-exploiting strategy of assembly or simple manufacturing in the location in question. The variable of interest is the difference between the expected value of a subsidiary with a competence-creating mandate and the expected value of one with a purely competence-exploiting role. The difference between these two expected values is a function of measurable location, firm and industry attributes. The actual outcome also involves an error term, attributable at least in part to unobservable factors (e.g., Buckley and Carter, 1998; Casson, 1996; Caves, 1996). The difference itself is a latent variable and not observable, but the outcome with regard to the subsidiary is observable. This generates a binary observed variable, $MAND_i$, (=1, where the subsidiary achieves a competence-creating mandate and =0, where it does not).

The decision regarding the level of R&D expenditure (and hence the R&D/sales ratio) is also determined by firm, industry and location characteristics, with the binary $MAND_i$ variable providing an additive difference. Several of the variables affecting the *strategic* outcome regarding the competence-creating mandate also affect the *operational* choice of level of R&D spending. Thus, many variables affect both the quality as well as the quantity of R&D undertaken by the subsidiary.

$$RD_i = \beta' \mathbf{X}_i + \theta\, MAND_i + u_i \qquad (1)$$

The actual value, RD_i, is attributable in part to unobservable factors, some of which are the same as those affecting $MAND_i$. This means that $MAND_i$ suffers from

problems of endogeneity. This is because the firm exercises some measure of strategic control over $MAND_i$, so that it is not a 'given' characteristic, like age. The choice with regard to $MAND_i$ is affected by some of the same factors that affect RD_i. Firms have some degree of choice in selecting between the two categories in $MAND_i$ based on their resources and capabilities. Treating $MAND_i$ as a normal exogenous variable leads to selection bias (Heckman, 1979).

The severity of bias is determined by the extent of choice exercised by the firm. So long as the choice is not completely pre-determined based on firm and location factors – a very extreme position – some bias appears. The effects of selection bias appear in both the mean and the variance of the estimator of θ in (2). Most importantly, the estimated standard error of θ is biased downwards, so the probability that it will appear significant is increased. See Appendix 1 for more details.

We estimate $MAND_i$ and RD_i as a system, correcting for the problem of selection bias. We run specification tests on these system estimates to confirm that treating $MAND_i$ as endogenous choice variable is justified.

Research Hypotheses

The first set of variables expected to influence the achievement of a competence-creating mandate relate to its location. The more munificent the location in terms of conducting highly skilled activities associated with R&D, the more likely the subsidiary is to obtain an competence-creating mandate (Cantwell and Iammarino 2000). The measurement of the quality of the subsidiary's location is a difficult task, since it is akin to good art – easy to recognize, but difficult to define. Rather than measuring it directly

by examining various measures of labor skills, infrastructure quality and so on, we chose an all-inclusive negative measure.

The government investment incentive programs provide the most generous benefits for firms locating in the poorest quality locations. Such locations are characterized generally by low labor skills and high unemployment, poor infrastructure and many other drawbacks (Mudambi, 1998). There is evidence that even lucrative investment incentives are insufficient to attract high-quality R&D investment by MNEs (Cantwell and Mudambi, 2000).

Hypothesis 1(a): *Location in an area covered by government investment incentives lowers the probability of a subsidiary achieving a competence-creating mandate.*

Subsidiaries with competence-creating mandates are trying to tap into the munificence of the location (Pearce 1999, Andersson and Forsgren 2000, Ensign, Birkinshaw and Frost 2000, Håkanson and Nobel 2000). Hence, we expect that better quality locations will see a higher R&D-intensity in mandated firms. Non-mandated firms, on the other hand, are simply trying to adapt products to local markets and resource conditions. We expect the quality of the location to have no effect on the R&D-intensity of such firms.

Hypothesis 1(b): *Location in an area covered by government investment incentives lowers the R&D-intensity of subsidiaries with competence-creating mandates, but has no effect on the R&D-intensity of subsidiaries without competence-creating mandates.*

The degree to which subsidiaries exercise control over their own affairs varies greatly. At one extreme are subsidiaries that must refer to headquarters for virtually every decision. At the other extreme are strategically independent subsidiaries that enjoy wide latitude. Subsidiary strategic independence has been found to evolve over time (Birkinshaw and Hood 1998). Strategic independence involves control over such decisions as the choice of suppliers, the hiring of management staff and functions that extend beyond the geographical boundaries of the host country like international marketing. Thus, such independence has also been found to be associated with the allocation of subsidiary world mandates (Birkinshaw and Morrison 1995).

Hypothesis 2(a): *A higher degree of subsidiary strategic independence increases the likelihood that the subsidiary achieves a competence-creating mandate.*

For a subsidiary with a competence-creating mandate, it is probable that strategic independence will cumulatively reinforce the mandate. Strategic independence provides such a subsidiary an increased ability to build its local competence, and tends to increase its creative contribution to the MNE (Birkinshaw, Hood and Jonsson 1998). Thus, strategic independence leads to a higher level of R&D-intensity. However, strategic independence in a subsidiary without a competence-creating mandate is unlikely to lead it to increase its R&D-intensity, since its objectives are generally to exploit the existing competencies of the MNE. Increasing strategic independence may lead it instead to increase the level of other functions like local marketing.

Hypothesis 2(b): *An increasing degree of strategic independence increases the R&D-intensity of subsidiaries with competence-creating mandates. Increasing strategic*

independence does not affect the R&D-intensity of subsidiaries without competence-creating mandates.

MNEs can set up wholly controlled subsidiaries either by acquiring a local firm (acquisition entry) or by setting up a *de novo* operation (greenfield entry). Hennart and Park (1993) report that for Japanese multinationals entering the US, firms with weak competitive advantages use acquisition entry. This suggests that in technologically weaker firms acquisitions may be driven by market structure and cost considerations in a drive to achieve competitive advantage. For such firms, any competence acquisition is not a major factor. If so, it is likely that acquisitions reduce the likelihood of a scope for local innovation in the acquired facility (Hitt, Hoskisson, Ireland and Harrison 1991). Further, acquisition entry is usually associated with an influx of new senior employees from a different corporate culture (Sambharya, 1996).

Hypothesis 3(a): *Acquisition entry reduces the likelihood that the subsidiary will achieve a competence-creating mandate.*

Subsidiaries without competence-creating mandates are likely to be the result of non-competence-seeking acquisitions. In such cases, the parent MNE typically is not looking for competencies in the acquired unit. Thus, R&D-intensity is likely to fall as duplication is eliminated. However, acquired subsidiaries with competence-creating mandates are likely to be the result of purposive asset-seeking. In such cases, duplication is not such an important issue, since R&D complementarity would have been one of the drivers of the acquisition (Zander 1999b, Simões and Nevado 2000).

Hypothesis 3(b): *Acquisition entry reduces R&D-intensity for subsidiaries without competence-creating mandates; it does not reduce it for subsidiaries with competence-creating mandates.*

Along with mode of entry, the subsidiary's main line of business (LOB) is a critical choice. The parent MNE can choose to enter the host market its main LOB or in another LOB. MNEs are likely to serve new markets initially from existing competencies. This follows from the analysis of Penrose (1959), who suggests that firms evolve incrementally – adapting resources to existing markets or using existing resources in new markets, but rarely doing both at the same time in the first instance.

Hypothesis 4(a): *Entry outside of the parent MNE's main line of business reduces the likelihood that the subsidiary will achieve a competence-creating mandate.*

Returning to the analysis of Penrose, she notes that the firm is resource-constrained. Subsidiaries with competence-creating mandates are all heavily committed to their creative tasks. Those that have to contend with a new LOB must expend resources on other new functions associated with developing it and have fewer resources available for the R&D function. On the other hand, subsidiaries without competence-creating mandates have less responsibility and less binding resource constraints, and they may need more R&D for the purposes of new product adaptation. For such subsidiaries, the impact of entering a new LOB is likely to have a smaller effect on R&D-intensity.

Hypothesis 4(b): *Entry outside of the parent MNE's main LOB leads to lower R&D-intensity for subsidiaries with competence-creating mandates. Such entry has no effect on the R&D-intensity of subsidiaries without competence-creating mandates.*

The primary function of subsidiaries without competence-creating mandates is to serve the local market. Their role is predominantly demand or output driven. Hence, the higher the level of local sales, the more the incentive to undertake process improvements, as well as to differentiate output to bolster margins. Both these activities lead to increased R&D-intensity in the adaptation of the firm's output to local conditions. However, the primary function of subsidiaries with competence-creating mandates is to tap into the local knowledge and resource base to augment the firm's overall strengths. This role is predominantly supply or input driven. For such subsidiaries, higher or lower local output should not affect R&D-intensity.

Hypothesis 5: *Increased local output leads to a higher R&D-intensity in subsidiaries without competence-creating mandates. Such increases do not affect the R&D-intensity of subsidiaries with competence-creating mandates.*

Similar reasoning suggests that increased financial risk associated with local sales should reduce the commitment to undertake R&D activities in subsidiaries without competence-creating mandates. Further, increases in such local output risk should not affect the R&D activities of subsidiaries with mandates.

Hypothesis 6: *Increased financial risk in local operations leads to a lower R&D-intensity in subsidiaries without competence-creating mandates. Such increases do not affect the R&D-intensity of subsidiaries with competence-creating mandates.*

In addition to the above factors, we introduce a number of control variables. First, we control for home country effects by introducing MNE parentage dummies. The two largest home countries of the MNE parents in the sample are the US and Japan. Second, although the sample is restricted to a single industry (engineering and

engineering-related activities) to make the R&D activities comparable across firms, we nonetheless control for intra-industry variation but introducing sub-industry dummies.

We expect the quantitative level of R&D-intensity to be sensitive to a number of other factors. Hence, in addition to the above, we control for differences in relative parent-subsidiary risk by introducing a relative home country / host country risk measure. Differences in R&D-intensity can stem from differences in subsidiary performance relative to other subsidiaries. We attempt to capture this by introducing the difference between the subsidiary's rate of return and the overall rate of return of the parent. Further, there may be duration effects over above those captured in the strategic independence measure. We capture these by introducing the duration of the subsidiary's operations in the host country. Finally, the extent to which the subsidiary is externally focused, e.g., focused on exports from the host country, may influence its R&D-intensity. We control for this effect by introducing a measure of external focus.

Data

R&D is a very industry-specific activity. The differences in strategies and R&D intensities between firms are likely to be highly industry-specific. These industry effects will almost surely wipe out any more subtle strategic choice effects in a diverse data set. With this in mind, we restrict our focus to a single industry group, so that the strategies and expenditures are generally comparable. We focus on firms in engineering and engineering-related industries.

The current study uses three levels of data: industry-level data, location-specific data and firm-level data. Industry-level data are used mainly for classification purposes and were drawn from Dun & Bradstreet indexes (Dun & Bradstreet 1994, 1995). The

engineering and engineering-related industry group roughly corresponds to subsections 24(1&2), 26-32 and 34-35 under the 1992 UK Standard Industrial Classification code (Office of National Statistics, 1992). Location-specific data relate to the classification of the local area in terms of Regional Selective Assistance (RSA) program and are based on the relevant Department of Trade and Industry (DTI) assisted areas map (August, 1993). Data comparing location risk characteristics of the host country (the UK) with those in the companies' home countries were drawn from the financial markets publication *Euromoney*. The firm-level data were derived from a large 1995 postal survey of FDI into the UK, supported by telephone and field interviews. Appendix 2 includes definitions all the variables used in the estimation, along with the source of the data. Descriptive statistics related to all these variables are presented in Table 1.

The sample frame for this survey was constructed from Dun & Bradstreet indexes (Dun & Bradstreet 1994, 1995), supplemented by the London Business School company annual report library. The sample frame yielded a preliminary list of 601 firms with personal contact names. Firms where separate data for the parent firm were unavailable were deleted. The final usable sample frame consisted of 568 firms. The survey was mailed out in two waves of 224 and 344 in March and April 1995.

The first (pilot) wave focused on entries into the Midlands region (the most successful region in the UK in terms of attracting FDI), while the second wave targeted entries into the rest of the country. In order to improve the response rate, the questionnaire had to be short, concise and of current interest or salient to the respondent (Heberlein and Baumgartner, 1978). Two reminders were faxed to the companies that had not yet responded ten and twenty-one days after the survey was mailed out.

Overall, 244 responses were received to the mail survey (42.96%). Of these, 7 were found to be UK firms mistakenly identified as non-UK firms, and 12 were unusable for various other reasons, leaving 225 (39.61%) valid responses for evaluation. The response rate is well within the range expected for an unsolicited mail survey.

Non-response bias was investigated with the widely used method suggested by Armstrong and Overton (1977). This involved comparing early and late respondents. Two sets of late respondents were defined corresponding to those who responded after receiving the first reminder and those who responded after receiving the second faxed reminder (the first set includes the second). Each set of late respondents was compared to the early respondents on the basis of six sample measures. The comparisons were carried out using a χ^2 test of independence. In both cases, the responses from early and late respondents were virtually identical.

Survey responses were tested for veracity by comparing postal responses to responses obtained from field interviews. A total of 28 field interviews were carried out. Using a χ^2 test of independence, responses from field interviews were found to be virtually identical to those obtained from the postal survey on the basis of four sample measures. Finally, 20 respondents were randomly selected and interviewed by telephone to confirm their survey responses.

4. Estimation and Results

Summarizing the firm-specific data

Two problems arise in using most of the firm-specific variables. First, several of them are categorical and/or ordinal. Second, several of them are highly correlated with one another. These problems are addressed by running the problem variables through

principal component factor analysis. The latent root criterion is used to determine the number of factors (or summary variables) extracted. Since the variation in each variable is unity after it has been standardized, each factor should account for the variation in at least one variable if it is to be considered useful from a data summarization perspective (Churchill, 1995). The factor analysis results are presented in Table 2. There are 3 factors with eigenvalues greater than unity. The three factors are termed 'strategic responsibilities' (STRAT), 'external orientation' (EXTERNAL) and 'process responsibilities' (PROCESS), on the basis of the varimax rotated factor loading matrix.

The first factor, STRAT, explains 30.7% of total variance. The extent to which supplier decisions are made by the subsidiary (SUPPLY), the extent to which the subsidiary has responsibility for hiring management staff (HIRE) and for the international marketing function (MKT) and the percentage of subsidiary top management from the host country (UK) all load heavily on this factor.

The second factor, EXTERNAL, explains 26.2% of total variance. The percentage of the subsidiary's output that is exported (WEXPORT), its export experience as a percentage of total tenure (EXPT) and the geographic scope of its output mandate (GSCOPE) are the variables that load heavily on this factor.

The third factor, PROCESS, explains another 14.4% of total variance. The subsidiary's process engineering responsibilities in operations (PROC) and training (TRAIN) are the variables that load on this factor. In interview with managers at several of the responding firms, it became clear that a considerable amount of training that occurred at these subsidiaries is of the operational or process type. This would explain the loading pattern that emerged.

Overall, the three factors account for almost 77% of the variance of all the underlying variables. The communalities of the individual variables are very high as well, with the lowest value in excess of 70% and the highest value near 90%.

Estimating R&D strategy and intensity

As discussed above, the competence-creating mandate, MAND, is specified to be endogenous to the firm. We assume that the decision process is sequential, so that the competence-creating strategy is selected first, and the level of R&D-intensity (RD) is selected conditional on the mandating decision. With this assumption, equation (1) may be estimated using a single-equation (or limited information) approach. We estimate it using two alternative econometric models - a conventional instrumental variables (IV) model and a selection model using the Heckman procedure. Within the selection model, we also generate estimates separately for firms with and without competence-creating mandates using the so-called 'treatment model' (Greene, 1993). Both models allow us to endogenize the strategy choice variable, MAND.

The strategic decision model involved in granting a competence-creating mandate is estimated using binomial probit. Maximum likelihood estimates of this equation are reported in Table 3. These results identify some industry, location and firm factors that seem to underlie the choice of a competence-creating strategy in the context of FDI (Cantwell, 1989; Holm and Pedersen, 2000). Since we are specifying the decision structure to be sequential, explanatory variables used in this model cannot include any which chronologically follow the competence-creating vs. competence-exploiting mandating decision. This excludes the use of many firm-specific measures.

The fit of equation (1) to the data is very good, as measured by the likelihood ratio test. Location in a Development area (R1) appears to exert a negative influence on the chance of achieving a competence-creating mandate. It would appear that the negative labor and infrastructural factors associated with a Development area greatly reduce its probability of serving as a research-related hub for an MNE. Thus, we find evidence supporting Hypothesis 1(a).

Finally, the factor score STRAT appears to significantly increase the probability of gaining a competence-creating mandate. Thus, the more strategically independent a subsidiary in terms of human resource management and marketing, the more likely it is to gain an independently creative research-related role as well. This evidence supports Hypothesis 2(a).

The entry mode (ACQ) does not appear to significantly influence the probability of the subsidiary achieving a competence-creating mandate. Hypotheses 3(a) does not receive support from the data. In the case of the entry line of business (DIVERS), the parameter estimate is negative, but its significance is marginal even at the 10% level, so the evidence in favor of Hypothesis 4(a) is weak at best.

Of the control variables, only Japanese parentage (JAPDUM) seems to increase the probability of gaining a competence-creating mandate. This may related to the strategy of Japanese firms in the European Union as a whole and reflect a synergy with their large-scale operations in US. Cantwell and Mudambi (2000) report similar results.

We now turn to our estimates of equation (1). Both IV and selection model estimates are reported in Table 4. The selection model enables us to explicitly estimate the selection parameter, λ. As the first stage estimates determining the probability of the

strategy selection are probit estimates, the selection parameter is a hazard rate computed from the normal distribution. In the selection model, the direct effects of strategy selection (MAND) are separated from the indirect effects (λ). While the IV model does not allow us to explicitly estimate the selection parameter, these linear estimates tend to be more robust than the non-linear Heckman selection estimates and serve as a useful robustness check. We will therefore focus on the results of the selection model.

When the selection model is applied to the entire sample (Table 4, col.3), the problem that arises is that the parameters of the regressors are restricted to be the same for subsidiaries that have competence-creating mandates (MAND=1) and those which do not (MAND=0). This restriction may well be questioned. Indeed, testing this restriction using a generalized 'F' test, we find that it is rejected. The way out is to estimate RD separately for subsidiaries with a competence-creating mandate (Table 4, col.5) and those that have not (Table 4, col.4). Greene (1993) suggests a procedure that may be used to generate such estimates and calls it the 'treatment' model. He notes that while the estimates thus obtained are not efficient, they are consistent. (See Appendix 1 for details. Shaver (1998) makes similar use of the treatment model.)

The estimates of the treatment model are also presented in Table 4 and they provide us with the means of testing our remaining hypotheses. Locations in Development and Split (R1 and R2) areas have a very negative influence on RD for subsidiaries that have competence-creating mandates. Local development characteristics play little role if such a mandate is lacking. This demonstrates that supply-related development characteristics are critical to the success of competence-creating subsidiaries, as their greater degree of research creativity requires a satisfactory

educational and skill base locally, and the presence of other innovative enterprises with which to interact. This provides support for Hypothesis 1(b).

For all firms taken together, the degree of strategic independence of the subsidiary cannot be separately distinguished from the effect of the competence-creating mandate. However, once firms with or without the mandate are divided, STRAT has a significant effect on R&D within the mandated group, but not for other firms. This might be thought of as a kind of cumulative effect. That is, once a firm has been given a competence-creating mandate, its capacity to fulfill that mandate will be strengthened by the extent to which the subsidiary is able to develop its own independent strategy, which will facilitate its own greater local creativity and warrant increased local R&D. Yet crucially this effect of subsidiary strategic independence is absent if the subsidiary itself is not mandated to be a constituent part of an internationally integrated network within its corporate group. Therefore the estimates provide support for Hypothesis 2(b).

The negative influence of ACQ appears for subsidiaries that do not have a competence-creating mandate, and the negative influence of DIVERS appears for subsidiaries that do. Again, these are very important results in the light of other recent research in the areas of corporate diversification and mergers and acquisitions. Other evidence has suggested that whereas at one time product diversification and technological diversification were complementary (or more precisely, they were different representations or ways of measuring of the same phenomenon), in more recent times they may be substitutes as a wider range of technologies is now needed to support a narrower range of products (Cantwell and Piscitello, 2000a). This is indeed what our findings here suggest: that with a competence-creating mandate, a higher extent of

product diversification tends to be a hindrance to investing in the creation of new technologies. However, this effect does not apply to subsidiaries without this competence-creating function, for which the overwhelming goal in research is to adapt products (whether they are distinctive to that subsidiary or not) to the relevant markets. Meanwhile, cross-border acquisitions may broadly speaking be divided into those motivated mainly by financial considerations, and those that are motivated by new asset acquisition and a synergy of complementary productive resources. Hence, as shown in Table 4, in competence-creating subsidiaries the latter motives dominate and acquisitions or greenfield ventures behave little differently in their need for research, but in the absence of such a mandate the tendency is for acquired firms to eliminate R&D duplication and to become more focused on the better exploitation of existing assets. These estimates therefore provide evidence in support of Hypotheses 3(b) and 4(b).

The estimates reported in Table 4 demonstrate that the R&D behavior of subsidiaries with competence-creating mandates is not just quantitatively but also qualitatively different from that of other subsidiaries, in that the determinants of R&D-intensity differ. Conversely, the positive influence of SALES, and the negative effect of FINRSK for all firms considered together are seen to emanate from subsidiaries that do not have a competence-creating mandate. They do not appear to influence RD for subsidiaries that have a mandate. For competence-creating subsidiaries the size or scale of local production and the variability of local demand matters less. We find support for both Hypotheses 5(b) and 6(b).

Turning to the control variables, there is one other especially notable difference in the two sets of estimates of Table 4. This is the observation that both Japanese

(JAPDUM) and US (USDUM) parentage seem to increase RD for subsidiaries with a mandate, but not for subsidiaries without one. While Japanese- and US-owned MNEs have a smaller share of internationalized subsidiary R&D than European-owned MNEs, they are more likely to develop cross-border networks for innovation within Europe, since they do not have a home base on which to focus attention within the European area. Thus, when Japanese- and US-owned subsidiaries gain competence-creating mandates, they tend to have greater opportunities for becoming sources of new knowledge within their respective European corporate groups.

Finally, following Shaver (1998), we ask: if subsidiaries in each category behaved like subsidiaries in the other, what would be their chosen R&D-intensity? We address this question by computing the average R&D-intensity for firms with competence-creating mandates using their average characteristics and their estimated coefficients from Table 4. Then we pair the average characteristics of subsidiaries with mandates with the estimated coefficients for subsidiaries without mandates. We do the same, in reverse for subsidiaries without mandates. These results are reported in Table 5. When firms behave to type, the estimated R&D-intensity is a good fit to actual category average (compare the estimates on the diagonal in Table 5 with those reported in Table 1). However, if mandated subsidiaries behaved like non-mandated subsidiaries, their estimated R&D-intensity would become negative. The same occurs if non-mandated subsidiaries behaved like mandated subsidiaries. Clearly there is a qualitative difference in the way in which the two sets of subsidiaries conduct R&D.

What this demonstrates is that if non-mandated subsidiaries were to be asked to fulfill a competence-creating role, they would be unable to do so, and hence their R&D

we tend to fall towards zero (the estimated R&D-intensity appears to be negative). Conversely, the qualitative distinction in R&D types applies just as well the other way, i.e., if mandated subsidiaries were expected to play a mere competence-exploiting role, they would also be unable to do so. This reaffirms that the subsidiary-level strategy divergence we have identified is critical.

5. Concluding Remarks

Our findings are consistent with other studies that have pointed to the emergence of global networks for innovation within MNEs in recent years. In this literature, it has been proposed that a subsidiary can contribute more creatively to technology generation within such a network, the better is the local infrastructure in the location in which it is sited, which increases its potential skill base and local linkages with other innovative firms and research institutions; the wider is the functional scope of its mandate, which broadens its potential role within the MNE network; and the more mature it is, having had time to evolve away from a principally domestic orientation and towards more closely internationally integrated relationships.

We suggest that the decision regarding the achievement of a competence-creating mandate to an MNE subsidiary is an endogenous one. Thus, subsidiaries obtain or do not obtain such mandates depending firm-, industry- and location-specific factors. We find that treating the mandating decision as endogenous rather than exogenous gives us a clearer picture of MNE R&D investment behavior. We show that the R&D investments of subsidiaries with competence-creating mandates are both qualitatively as well as quantitatively different from that of subsidiaries without such mandates. In particular, supply-related local development potential and the degree to which subsidiaries are

separately granted strategic independence both positively influence R&D in competence-creating subsidiaries, but not in other kinds of subsidiary. There is also a trade-off between technology-creating investments and product diversification in subsidiaries with competence-creating mandates, but not in other subsidiaries. However, there is no effect of the choice between acquisition and greenfield modes of entry in subsidiaries with mandates, unlike the negative impact of acquisition on local R&D in subsidiaries without mandates. Likewise, there is no effect on R&D in mandated subsidiaries from the extent and variability of local demand, which clearly influence R&D in non-mandated subsidiaries since they conduct R&D primarily to adapt established products to local markets. These findings are very much in line with our expectations, but we believe they are novel results from our appropriate modeling of MNE R&D strategy decisions. The purposes and nature of R&D differ in these two types of subsidiary strategy, and so the determinants of R&D differ too. The tasks and the character of technology management diverge from their traditional pattern once subsidiaries achieve a competence-creating mandate.

Figure 1

Alternative views of the competence-creating vs. competence-exploiting subsidiary mandate decision in the contemporary international business literature

Competence-creating subsidiary mandate	*Competence-exploiting subsidiary role*
Research-related production (Cantwell 1987)	Assembly-type production
Strategic asset-seeking investment (Dunning 1995, 1996)	Market-servicing investment
Element of internationally integrated MNE innovation network (Porter 1986, Doz 1986, Bartlett and Ghoshal 1989, Cantwell 1994)	Either element of multi-domestic strategy or non-innovating part of an internationally integrated network
Home-base augmenting investment (Kuemmerle 1999)	Home-base exploiting investment
Contributor to organizational heterarchy (Hedlund 1986)	Lower order part of organizational hierarchy
Center of excellence subsidiary mandate (Birkinshaw 1998, Holm and Pedersen 2000, Simões and Nevado 2000)	Location in a site that is not a major center of excellence or a key hub

Appendix 1

Competence-creating mandates and selection bias

We are interested in the achievement of competence-creating mandates by subsidiaries. Subsidiaries obtain a mandate when the expected profitability of such a strategy is greater than that associated with a purely competence-exploiting strategy. This variable, which is defined as $MAND_i^*$ relates to the i^{th} firm and is driven by its resources and capabilities. These resources, capabilities and environmental factors may be gathered together in a vector **Z**, so that

(1) $$MAND_i^* = \mu' \mathbf{Z}_i + e_i$$

$MAND_i^*$, however, is a latent variable. The observed variable is $MAND_i$, where

(2)
$MAND_i = 1 \quad MAND_i^* > 0$ (*competence-creating mandate obtained*)
$MAND_i = 0 \quad MAND_i^* \leq 0$ (*competence-exploiting strategy undertaken*)

This is a dichotomous choice model (Maddala, 1983). MAND is chosen by the firm and is therefore an endogenous variable.

The decision regarding R&D expenditure (and hence the R&D / sales ratio denoted by RD) is also determined by firm, industry and location characteristics, with the binary MANDi variable providing an additive difference. The variables that affect R&D spending can be gathered together in a vector **X**, which may share several variables with **Z**. The estimation of RD may be specified as:

(3) $$RD_i = \beta' \mathbf{X}_i + \theta\, MAND_i + u_i$$

Treating MAND as a normal exogenous variable in estimating the level of R&D-intensity (RD) ignores its endogeneity – the common variables in **X** and **Z** mean that e_i and u_i are correlated. In other words, there is 'selectivity' correlation between MAND* and RD, that may be defined as ρ. The direct estimation of (3) generates selectivity bias (Heckman, 1979). The effects of selection bias appear in both the mean and the variance of the estimator of θ in (3). The estimate of θ is biased in the direction of the correlation between the errors u_i and e_i. The estimated standard error of θ is biased downwards, so the probability that it will appear significant is increased. For a more technical treatment of the problem of selection bias, see Greene (1993).

Assuming that the joint distribution of MAND* and RD is bivariate normal, we have what is called a 'selection' model. Defining the vector of industry and firm factors affecting RD as **X** and the standard normal distribution and density functions as $\Phi(.)$ and $\phi(.)$, we have

(4) $$E[RD_i] = \beta' \mathbf{X}_i + \theta\, MAND + E[u_i \mid MAND]$$

$$= \beta' \mathbf{X}_i + \theta \, MAND + \beta_\lambda \, \lambda$$

where λ is the selection parameter, i.e., the adjustment for the effects of incidental truncation.

There are two problems with the standard selection model in the context of MNE mandating choice. (a) The estimated parameter vector, β', is restricted to be the same for both competence-creating and competence-exploiting strategies. (b) The coefficient on the selection parameter, β_λ, is difficult to interpret, since it is also restricted to be the same for both strategy choices.

One way around this is to estimate the R&D-intensity equation separately for subsidiaries with competence-creating mandates and those without, while accounting for the incidental truncation created by the selection. Thus, λ is estimated from the strategy choice equation (1) as

(5) $\lambda_i(MAND=1) = \phi(\mu' \mathbf{Z}_i) / \Phi(\mu' \mathbf{Z}_i)$

$\lambda_i(MAND=0) = -\phi(\mu' \mathbf{Z}_i) / [1-\Phi(\mu' \mathbf{Z}_i)]$

Equation (4) can then be estimated separately for INVs and sequential FDI firms. Explicitly, this amounts to estimating the following equations:

(6a) $E[RD_i \mid MAND=1] = \beta' \mathbf{X}_i + \theta + E[u_i \mid MAND=1]$

$= \beta' \mathbf{X}_i + \theta + \rho \, \sigma_u \, \lambda(\mu' \mathbf{Z}_i \mid MAND=1)$

$= \beta' \mathbf{X}_i + \theta + \rho \, \sigma_u \, [\phi(\mu' \mathbf{Z}_i) / \Phi(\mu' \mathbf{Z}_i)]$

and

(6b) $E[RD_i \mid MAND=0] = \beta' \mathbf{X}_i + E[u_i \mid MAND=0]$

$= \beta' \mathbf{X}_i + \rho \, \sigma_u \, \lambda(\mu' \mathbf{Z}_i \mid MAND=0)$

$= \beta' \mathbf{X}_i + \rho \, \sigma_u \, [-\phi(\mu' \mathbf{Z}_i) / \{1-\Phi(\mu' \mathbf{Z}_i)\}]$

Appendix 2

Variable definitions

VARIABLE	DEFINITION	SOURCE
Dependent variables		
MAND	1, the UK subsidiary has achieved a competence-creating mandate*	Survey, supplemented by company annual reports
	0, otherwise	
RD	UK subsidiary's R&D/sales ratio, 1994	Survey, supplemented by company annual reports
Industry variables		
ELEC	1, if UK subsidiary is in an electrical engineering and related industry	***Business Register***
	0, otherwise	
MECH	1, if UK subsidiary is in a mechanical engineering and related industry	*Business Register*
	0, otherwise	
CHEM	1, if UK subsidiary is in a chemical engineering and related industry	*Business Register*
	0, otherwise	
Location variables		
RLOCRSK	Relative country risk, home country/host country (U.K.); average, 1993-1994	*Euromoney***
R1	1, if UK subsidiary is in a Development area***	DTI
	0, otherwise	
R2	1, if the UK subsidiary is in a Split Development/Intermediate area***	DTI
	0, otherwise	
Firm variables		
ABROR	UK subsidiary's ROR on capital less parent firm's corporate ROR on capital, 1994	Survey, supplemented by company annual reports
FINRSK	Variance of UK subsidiary's rate of return on capital, 1986-1994	Survey, supplemented by company annual reports
SALES	UK subsidiary turnover, 1994 (£million)	Survey, supplemented by company annual reports
DIVERS	0, if entry into the UK is in parent's main line of business @	Survey, supplemented by company annual reports and DTI data
	1, otherwise	
ACQ	1, if entry into the UK is through acquisition	Survey, supplemented by DTI data
	0, otherwise	
DT	Duration of UK subsidiary operations (years)	Survey, supplemented by company annual reports

USDUM	1, if parent firm HQ is in the US 0, otherwise	Survey, supplemented by company annual reports
JAPDUM	1, if parent firm HQ is in Japan 0, otherwise	Survey, supplemented by company annual reports
SUPPLY	Extent to which decisions on suppliers are made in the UK (7 pt. Likert scale)	Survey
HIRE	Extent to which UK subsidiary has responsibility for hiring management staff (7 pt. Likert scale)	Survey
TOPMGMT	Percentage of UK subsidiary top management (directors and above) from host country (UK)	Survey, supplemented by company annual reports
MKT	Extent of responsibilities in the international marketing function (7 pt. Likert scale)	Survey
WEXPORT	Exports as a percentage of UK subsidiary output	Survey, supplemented by company annual reports
EXPT	Years of exporting as a percentage of total duration of UK operations	Survey, supplemented by company annual reports
GSCOPE	Geographical scope of UK subsidiary's output mandate – (1) UK only; (2) UK and mainland Europe; (3) Worldwide	Survey, supplemented by company annual reports
PROC	UK subsidiary's process engineering operational responsibilities (7 pt. Likert scale)	Survey
TRAIN	Extent to which UK subsidiary has responsibility for training in process engineering (7 pt. Likert scale)	Survey

* MAND is generated on the basis of the functional scope of the UK subsidiary's output mandate. Output mandates were categorized as: (1) Sales and service; (2) Assembly; (3) Manufacturing; (4) Product development; (5) International strategy development. A competence-creating mandate is operationalized as a subsidiary whose output mandate is either (4) or (5).

** *Euromoney* risk index, which includes economic performance, political risk, debt indicators, debt default, credit ratings, access to bank, short-term and capital market finance, and the discount on forfeiting

*** Based on the Department of Trade and Industry (DTI) Assisted Areas map (revised, August 1993).

@ The parent firm's main line of business is defined to be its largest non-UK sales segments whose cumulative contribution to the entropy index of diversification just exceeds 60%. This definition is based on Hitt *et al* (1997).

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Table 1
Summary statistics

VARIABLE	MEAN	S.D.
Dependent variables		
MAND	0.2444	0.4307
RD	4.1822	2.7963
Industry variables		
ELEC	0.4267	0.4957
MECH	0.4089	0.4709
CHEM	0.1644	0.4307
Location variables		
RLOCRSK	1.4808	1.0830
R1	0.4089	0.4927
R2	0.1200	0.3257
Firm variables		
ABROR	–0.6821	3.9101
FINRSK	3.6927	5.1599
SALES	374.6445	327.7262
DIVERS	0.2089	0.4074
ACQ	0.6311	0.4836
DT	9.8889	5.5050
USDUM	0.2044	0.4042
JAPDUM	0.0711	0.2576

* RD measured separately for firms with MAND=0 and MAND=1

Variable	Mean	S.D.
RD – All firms	4.1822	2.7963
RD – Firms with MAND=0	2.9118	2.5490
RD – Firms with MAND=1	5.0182	2.9334

Table 2
Factor analysis of firm-specific qualitative variables
Varimax Rotation

Variable	**Factor Loadings**			*Communality*
	Factor 1 STRAT	*Factor 2* EXTERNAL	*Factor 3* PROCESS	
SUPPLY	**0.884**	0.330	0.241	0.804
HIRE	**0.812**	–0.057	–0.164	0.791
TOPMGMT	**0.809**	0.021	0.027	0.754
MKT	**0.792**	0.124	–0.002	0.760
WEXPORT	0.018	**0.860**	0.061	0.814
EXPT	0.204	**0.891**	0.084	0.802
GSCOPE	0.020	**0.902**	0.203	0.891
PROC	0.117	–0.026	**0.898**	0.712
TRAIN	0.004	–0.102	**0.794**	0.735
*Eigenvalue**	3.6847	2.1784	1.3084	-
Variance	3.0008	2.4226	1.3802	6.8875
% Variance	0.307	0.262	0.144	0.768

Loadings of variables associated with particular factors are shown in bold.

* The eigenvalue for the 4th factor is 0.7206.

Table 3
Estimating the probability of a subsidiary competence-creating mandate:
Maximum Likelihood Probit Estimates

REGRESSAND:
Binary variable: MAND=1 (Subsidiary has competence-creating mandate);
MAND=0 (Subsidiary has no competence-creating R&D mandate)

REGRESSOR	PARAMETER ESTIMATE ('*t*' STAT)
CONSTANT	–0.4152 (1.49)
R1	–0.5336 (2.53)*
R2	–0.0780 (0.26)
STRAT	0.2235 (2.39)*
ACQ	0.1444 (0.65)
DIVERS	–0.4666 (1.60)
USDUM	0.1664 (0.68)
JAPDUM	0.6988 (2.06)*
MECH	–0.0317 (0.12)
ELEC	0.0007 (0.00)
DIAGNOSTICS	
Log-likelihood	–114.9804
Restricted Log-Likelihood	–125.1335
Likelihood Ratio Test: $\chi^2(9)$ 'p' value	20.3063 0.0161
Iterations	5

Note: 't' statistics in parentheses.
* Estimate significant at the 5% level.
** Estimate significant at the 1% level.

Table 4
Estimating R&D-intensity
IV and selection estimates

REGRESSAND: RD (R&D/Sales ratio)

REGRESSOR	IV ESTIMATES	SELECTION MODEL		
		ALL FIRMS	TREATMENT MODEL	
			MAND=0	MAND=1
(1)	(2)	(3)	(4)	(5)
CONSTANT	2.87 (2.58)**	1.70 (1.08)	1.27 (0.40)	–60.68 (1.94)
R1	0.4761 (0.63)	0.3116 (0.44)	0.6597 (0.52)	–24.58 (2.16)*
R2	–0.4042 (0.56)	–0.5031 (0.97)	0.1478 (0.25)	–4.945 (2.67)*
STRAT	0.2307 (0.79)	0.2229 (0.71)	–0.0056 (0.01)	10.066 (2.19)*
ACQ	–1.63 (2.80)**	–1.50 (3.50)**	–1.53 (2.79)**	5.33 (1.79)
DIVERS	–1.50(1.97)*	–1.54 (2.25)*	–1.589 (1.45)	–22.7 (3.28)**
SALES	0.114×10^{-5} (2.38)*	0.15×10^{-5} (2.71)**	0.21×10^{-5} (3.40)**	0.55×10^{-6} (0.44)
FINRSK	–0.062 (2.04)*	–0.063 (2.02)*	–0.04 (2.99)**	–0.0607 (0.78)
USDUM	0.1148 (0.19)	–0.2478 (0.53)	–0.6573 (1.14)	8.4592 (2.33)*
JAPDUM	–1.1738 (1.54)	–1.7528 (1.53)	–2.5155 (1.19)	29.972 (2.12)*
MECH	0.3925 (0.63)	0.2866 (0.64)	–0.1767 (0.35)	0.4333 (0.28)
ELEC	0.4150 (0.76)	0.3361 (0.86)	0.1254 (0.29)	0.5503 (0.59)
RLOCRSK	–0.0032 (1.06)	–0.0005 (0.31)	0.7×10^{-4} (0.05)	–0.0027 (0.32)
ABROR	–0.0702 (1.19)	–0.0424 (1.08)	–0.0625 (1.44)	13.076 (1.25)
DT	–1.0198 (1.19)	–0.10 (0.33)	–0.0696 (0.22)	–0.2583 (0.28)
EXTERNAL	0.1429 (0.64)	0.1018 (0.64)	0.094 (0.56)	–0.909 (1.67)
MAND	6.36 (3.86)**	4.464 (3.65)**	-	-
λ	-	–2.275 (2.13)*	–3.138 (0.55)	59.963 (2.12)*
DIAGNOSTICS				
Adj. R^2	0.2925	0.3397	0.4031	0.2150
Log-likelihood	–520.2024	–494.5561	–361.2707	–116.8958
Restricted Log-likelihood	–550.1274		–413.5909	–133.2159
LR Test: χ^2; (d.f.)	59.8500 (16)	111.1426 (17)	104.6404 (16)	32.6402 (16)
SSE	2093.700	1068.790	697.962	225.927
Model Stability: F(17,191); 'p' value	-		1.7621* (0.035)	
n	225		170	55

Note: 't' statistics in parentheses
* Estimate significant at the 5% level.
** Estimate significant at the 1% level.

TABLE 5
Estimated Average R&D Intensity
Firms with and without Competence-Creating Mandates

Percent		CHARACTERISTICS: AVERAGE VALUES	
		MAND=0	MAND=1
ESTIMATED COEFFICIENTS	MAND=0	3.182	-4.093
	MAND=1	-9.693	5.338