EVOLUTION OF SUBSIDIARY COMPETENCES: EXTENDING THE DIAMOND NETWORK MODEL

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Abstract

Over the past decade, the literature on MNC subsidiary evolution has grown rapidly, enhancing our understanding of the determinants of subsidiary competences. We extend the 'center of excellence' concept to address the diversity and the multidimensionality of subsidiary competence and link such diversity to the host country environment. Using Rugman and Verbeke's (1993) diamond network model of competitive advantage of nations, we hypothesize the contingencies under which host environment heterogeneity leads to a specialized subsidiary competence configuration. We test our theoretical model with data from more than 2,000 subsidiaries in seven Western European countries. Our results provide new insights on the evolution of subsidiary competence and how MNCs can overcome 'unbalanced' national diamonds by acquiring complementary capabilities across borders.

Keywords: MNC environment, subsidiary competence configuration, industrial clusters, differentiated networks.

Evolution of Subsidiary Competences: Extending the Diamond Network Framework

Introduction

The complex roles played by national subsidiaries have become pivotal to the discussion of the strategy and structure of Multinational Corporations (MNCs). In the 'global firm', the subsidiaries are more or less passive recipients of resources and strategic imperatives from the parent firm, while in the 'multinational firm' they are self-sufficient entities with considerable autonomy. However, the recent decades have seen a growing body of research building on the idea of the MNC as a network of specialized, interdependent units (Hedlund, 1986; Bartlett and Ghoshal, 1989; Westney, 1990; Ghoshal and Nohria, 1997). In the network-based MNC, the role of subsidiaries is much more complex than in the global or multinational firm, as each subsidiary may simultaneously be recipient and contributor of knowledge, products, and services (Gupta and Govindarajan, 1991). By building dispersed and specialized competences in its subsidiaries, the MNC can ideally exploit national differences in comparative and competitive advantage and generate superior returns compared to its domestic and non-specialized international competitors.

Where earlier focus was on internal or structural antecedents of subsidiary competence, the environment is increasingly seen as an important and under-researched contingency (Birkinshaw and Hood, 1998, 2000; Benito *et al*, 2003). In a theoretical paper on MNC subsidiary evolution, for example, Birkinshaw and Hood (1998) highlight the importance of local environment determinism as one of the main drivers of competence building in MNC subsidiaries. A powerful and well-known model of environmentally determined competitive advantage is Porter's (1990) 'diamond model', which states that firms derive competitive advantage from the presence of local industrial clusters. However, surprisingly few studies have applied the diamond framework to the study of *subsidiary* competence evolution. Some researchers have tested the framework partially by relating some of its environmental components to the strength of local subsidiaries' competences. Almeida and Phene (2004) looked at the technological determinants of subsidiary strengths and found that the diversity of local technology positively impacts subsidiary innovation. However, Mariotti and Piscitello (1995) found that many of the variables contained in the diamond framework, such as factor conditions and infrastructure, did not impact the location decisions of firms investing in Italy. Other studies have tested the framework indirectly by using industrial cluster membership, rather than individual host country diamond elements, to predict various aspects of subsidiary strength. Birkinshaw and Hood (2000) find that membership of local cluster industries lead to higher subsidiary embeddedness, autonomy, and international sales. However, Benito (2000) examined whether subsidiary centers of excellence emerge in Norway's cluster industries and found mixed support for this proposition, concluding that the mechanism linking industrial clusters to subsidiary competence is still not well understood.

Despite its considerable promise, then, significant support for the diamond model at the subsidiary level still eludes us. Perhaps this is because the model was meant as an explanation not of subsidiary competences but of competences created in the MNC home base. In fact, it cannot be any other way inasmuch as the industrial cluster view construes both the strength of the local environment and the strength of the local MNC organization in a *unidimensional* way. If we believe that industrial clusters create competitive advantage, the MNC's internal knowledge and resource flows should be directed from home bases in such industrial cluster locations, to subsidiaries in locations where the environment is weaker. Hence, using the dichotomous independent variable of industrial cluster membership inevitably results in a dependent variable which is also dichotomous: it effectively rules out the possibility that some components of a country's diamond may be strong and others weak, and hence leaves no justification for specialized subsidiaries and multidirectional knowledge flows. However, as pointed out by Birkinshaw and Hood (2000): "it is not just cluster membership but the specific characteristics of the cluster in question that impacts the likely subsidiary role". Presently we have very little knowledge about the mechanisms and the dimensions along which these cluster characteristics work.

To fill this research gap, we need to move away from the concepts of environment and subsidiary *strength,* and towards the concept of *configuration,* which captures both the strength and the diversity of this strength across value chain activities. This paper tests the proposition that a heterogeneous diamond configuration on the host country level will lead to a specialized (i.e. diverse) competence configuration at the subsidiary level. This proposition is derived from an extension of the 'diamond network' model (Rugman and Verbeke, 1993). The paper makes the following contributions: (1) it incorporates a value chain distinction into the diamond framework; (2) it extends the diamond network model by explicitly relating it to the geographical competence distribution of the MNC; and (3) it tests the proposed model on a large sample of subsidiaries.

The remainder of this paper is structured as follows. The next section revisits Porter's (1990) diamond framework and the Rugman and Verbeke (1993) critique of the framework. Sections 3 and 4 present our contribution to this literature: an explicit model relating host country diamond heterogeneity to subsidiary specialization. First, section 3 introduces a value chain distinction into Porter's (1990) theory as a stepping-stone towards the diamond network model, which is presented in section 4. Section 5 tests the hypotheses derived from this model, and section 6 concludes and draws implications for further research.

The Industrial Cluster View of Subsidiary Competence

How do local environments influence the competitive advantage of local firms? The question is particularly relevant for the study of MNCs – firms that by definition try to leverage existing competitive strengths, or augment them, in international markets. The most famous and controversial answer to this question was undoubtedly the one provided by Michael Porter in his 1990 book *The Competitive Advantage of Nations*. Consistent with observations made by Marshall (1920), Porter proposed the simple and powerful notion that firms based in 'industrial cluster' areas could appropriate location-specific competitive advantage. Whether or not such clusters would emerge was in turn seen to be determined by a system of reinforcing environmental elements – the national 'diamond' – consisting of factor conditions, demand conditions, local competitive rivalry, and related and supporting industries. Porter (1990) hypothesized that MNCs based in industrial clusters in their home countries would be highly competitive in the global marketplace, resulting for instance in an increased export propensity from those clusters. In this process the role of the MNC subsidiary was perceived primarily as one of 'selective tapping' of ideas, with the exception of the few (and often acquired) subsidiaries in leading-edge clusters that eventually become the MNC's home base for a particular business area. In that way, Porter's contribution was positioned firmly in the traditional foreign direct investment literature, in which the MNC is seen to exploit its firm-specific advantages – developed at home – to overcome the inherent disadvantage of foreign operations (Hymer, 1976; Vernon, 1966; Hennart, 1982).

While extremely influential in many ways, Porter's seminal work was extensively criticized by IB scholars subsequent to its publication (Grant, 1991; Rugman and Verbeke, 1993; Dunning, 1993; Moon *et al*, 1995; Davies and Ellis, 2000). One of the recurring critiques was that the model is too strictly ethnocentric, in the sense that it essentially downplays the importance of resource-seeking FDI (Dunning, 1993). Porter (1990:92) insisted that tapping into parts of diamonds in foreign countries would always be a second-best solution to accessing all diamond components in the firm's home country. On the surface, such a conclusion may seem to follow directly from the broadly accepted premise that transfer of tacit knowledge occurs more effectively in case of geographical proximity and cultural similarity. However, even though knowledge transfer *between* firms may be constrained by geographical distance, knowledge transfer *within* firms may not necessarily be so; indeed, the ability to transfer knowledge across borders has been suggested as a *raison d'être* for the MNC (Kogut and Zander, 1993). As their external networks are multi-local and their internal networks international, MNCs can use FDI to access and combine dispersed and complementary sources of competitive advantage by selectively sourcing components of diamonds abroad. In that sense, MNCs have been said to approach something of a 'multi home-base' structure (Sölvell and Zander, 1995), involving several distinct bases for competence building often referred to as centers of excellence. This line of thinking is also prevalent in the model of the Metanational MNC proposed by Doz *et al* (2001) where the process of searching for pockets of knowledge wherever it can be found and mobilizing the knowledge in the global MNC network is the key to competitiveness. This implies that not only industrial clusters on the national level, but also components of the regional or even global environment, may provide an enlarged system of diamond elements – a 'double diamond' or a 'diamond network' – that the MNC can combine for competitive advantage (Rugman and Verbeke, 1993). For example, by establishing themselves in the US in the 1960's, the Japanese automobile manufacturers benefited from combining the advanced technical and supply resources in their home country – the factor conditions of the diamond – with their exposure to demanding customers and fierce competitors in the US. In the words of Dunning (1993:12), "The *principle* of the diamond may still hold good – but its geographical constituency has to be established on very different criteria."

A Multidimensional View of Subsidiary Competence

The diamond network described by Rugman and Verbeke (1993) is essentially a special case of the network-based MNC or the differentiated network (Hedlund, 1986; Bartlett and Ghoshal, 1989; Westney, 1990; Ghoshal and Nohria, 1997). It is an organizational form that combines diamond components from different countries, through a high degree of external embeddedness in each local environment and a high degree of integration between these dispersed units. While the diamond network model is thereby compatible with today's predominant view of the MNC, it has received relatively little attention in the subsidiary role literature. This is surprising as the model has clear implications at the subsidiary level. We argue that the role of the individual subsidiary in the diamond network is to *specialize* in the type of knowledge or resource that the MNC wishes to source in the host country. Whereas specialization is often asserted as a stylized fact or described as a key property of the network-based MNC, we have very little knowledge of the antecedents of subsidiary specialization. In some studies, possessing specialized resources is taken to mean simply that the subsidiary is competent at a certain activity (e.g. Frost *et al*, 2002). However, by looking at individual activities in isolation, or by averaging the competence of the subsidiary in different parts of the value chain, unidimensional constructs of subsidiary strength effectively conceal the degree of specialization. Therefore, we need to distinguish between different types of subsidiary competences.

Just as the firm can be seen as a collection of activities (Porter, 1985), a subsidiary contains a *subset* of those activities and the capabilities that reside within them[1]. Some of the subsidiary's activities may cluster into natural groups based on co-location advantages, similar skill requirements, and shared links with the environment. IB scholars have suggested several such groupings. In a factor analysis of subsidiary capabilities, for example, Forsgren *et al* (1999) found one factor consisting of product development expertise, technological expertise, and knowledge among professional staff; and another factor containing supplier relationships, advanced user contact, and insight

[1] Note that the term 'subsidiary competences' captures both the location of activities and the skill and expertise within those activities – the former being a prerequisite for the latter. A subsidiary's competence within a part of the value chain ranges from the case where the relevant activities are not performed at all in the host country, over a minimal activity volume, to the case where the subsidiary conducts the activities with high skill and expertise.

into competitors. The former was called the ‘internal’ factor and the latter the ‘business network’ factor. However, in a similar distinction, Andersson *et al* (2002) measure the embeddedness of subsidiaries along both a ‘business’ and ‘technical’ dimension, reflecting that both types of competences may actually be linked to the environment.

Building on these two studies, we propose a three-way segmentation of subsidiary competences into supply, technical, and market competences. *Supply* competences describe the firm’s skill and expertise in handling its production inputs, and include such activities as procurement and distribution of intermediary products. *Market* competences, on the other hand, are concerned with production outputs and include for example sales, marketing, and service activities. Finally, *technical* competences are needed to transform inputs to outputs and reside in the research, development, and production departments. The combination of supply and market competences corresponds to the business or business network factors described in the above studies; however we separate the two because they deal with different parts (upstream and downstream) of the subsidiary’s external network. Together, the supply, technical, and market aspects constitute the ‘competence configuration’ of the firm – a multidimensional construct capturing both the depth and breadth of the firm’s capabilities.

If we look at the diamond elements described by Porter (1990), a similar distinction can be made on the environment side. Broadly speaking, the supply environment consists of upstream business partners and raw material suppliers. The technical environment consists of labor with industry-specific skills, local research institutions, and related industries using similar technologies, thereby providing synergies and technology spillovers. The market environment consists of demanding customers and competitive rivalry, providing market inputs to the firm and pressuring it to position its product offering. The combination of supply, technical, and market environment can be called the 'diamond configuration' of a given country. The link between competence and diamond configuration is illustrated in Figure 1.

*** Figure 1 About Here ***

Figure 1 shows that the environment affects the competences of the firm through something we could call *specialized embeddedness*. The term embeddedness refers to the depth and breadth of an MNC's links, in terms of mutual adaptation, to its home and host country environments (Andersson *et al*, 2002; Andersson and Forsgren, 2000). We extend this concept by suggesting that these network links are specific to value chain activities. This means that the competences of a local MNC unit should be embedded in the local environment along the three proposed dimensions: the supply competences in the supply environment, the technical competences in the technical environment, and the market competences in the market environment. As a concrete example, market competences reside primarily in the salespeople and marketing staff – the people who have the most direct interaction with customers, as well as the necessary skills to assimilate and process information about customer trends and competitors' moves in the marketplace. As such, the firm's market competences constitute its interface with market resources in the environment, to a much higher degree than supply and technical competences do. These other competences, on the other hand, enable the firm to assimilate resources from their respective specialized environments. The internal arrows in the MNC country unit symbolize the fact that it takes a combination of all three types of resources to generate competitive advantage. In an industrial cluster, all three elements are (almost equally) strong and reinforce one another. This is why, in the view of Porter (1990), the home base of the MNC should be located in an industrial cluster where all parts of the national diamond are strong.

A 'Diamond Network' Model of Subsidiary Competence

As Figure 1 shows, a value chain distinction in itself does not alter the gist of Porter's (1990) model. It is still a model of home base-derived competitive advantage: by tapping into local resources in an industrial cluster, the MNC enables innovation, which is subsequently exploited in global markets. However, by recognizing distinct groupings of competences and environmental resources, we implicitly open up for the possibility of 'unbalanced diamonds' and specialized subsidiaries. The diamond can be said to be unbalanced if one element is much weaker or stronger than the others. Indeed, we suggest that MNCs can respond to unbalanced diamonds by linking specialized subsidiaries together in a 'diamond network'. This situation is illustrated in Figure 2.

*** Figure 2 About Here ***

The firm in Figure 2 is generating competitive advantage by using dispersed competences to access complementary diamond elements in different countries. The key mechanism of achieving this synergy is subsidiary specialization: one subsidiary has local supply competences that enable it to tap into the local supply environment, another has the technical competences to assimilate local technical resources, and the third subsidiary has market competences to enhance learning from the market environment. Such a competence distribution is crucial in the diamond network, because host country knowledge absorption requires both localized *and* specialized competences. *Localized* competences are required, as positive knowledge externalities are geographically bounded, and proximity is conducive to knowledge sourcing and technological spillovers between firms (Porter, 1990; 1998; Almeida and Kogut, 1999; Almeida and Phene, 2004; Jaffe *et al*, 1993). Hence the local external network of the firm and the embeddedness in this network is a facilitator of knowledge acquisition. This has been shown to be true for both the business (i.e. supply and market) network and the technical network of MNC subsidiaries (Andersson *et al*, 2002). *Specialized* competences, on the other hand, are necessary because absorptive capacity – the ability to assimilate knowledge from the environment – is a function of existing knowledge within a particular field (Cohen and Levinthal, 1990). Market competence is hence necessary to access the market components of the national diamond. For example, in order to benefit from demanding consumers in a certain area, the firm would need competent salespeople who can interact closely with these customers and convey market information and pressures up the value chain. Similarly, technical competence is necessary to access the technical diamond components: if the firm wants to tap into research synergies with universities, it would need engineers with the skills required to assimilate this research. Finally, to take full advantage of world-class suppliers in a certain location, skilled procurement specialists must work with these suppliers to enable tight integration and knowledge sharing in the supply chain. All of this implies that competence acquisition is reinforcing: the more competence of a certain type is acquired, the easier it is to acquire further competence of that type.

Host Country Diamond Configuration

It is instructive to compare the diamond network model to the industrial cluster view, as each scenario paints a very different picture of the way that the environment affects subsidiary competences. The subsidiaries of Porter's (1990) globally competitive firm have competence profiles inherited from their parent – if they have any significant competences at all – as they are merely implementers of the corporate strategy based on competitive advantage generated in the home base. As this type of MNC can access all diamond components in the home country industrial cluster, it has little incentive to facilitate learning abroad by locating specialized competences in its subsidiaries. Hence the relationship between the diamond configuration of the host country and the competence configuration of the subsidiary is conceptually weak.

In contrast, the MNC diamond network, as depicted in Figure 2, locates specialized competences where needed in order to access idiosyncratic environmental resources. This implies that the supply competences of a given subsidiary should be highly correlated with the strength of the supply environment in the host country, its technical competences with the technical environment, and market competences with the market environment. These relationships are the 'direct paths', symbolized by the horizontal black arrows, in the causal model presented in Figure 3. Due to the necessity of localized and specialized competences, these direct paths should be stronger than the 'cross-paths' (which are grayed out in the figure).

*** Figure 3 About Here ***

This leads us to the following hypotheses:

H1: The strength of the local supply environment positively affects the supply competence of the subsidiary.

H1b: The direct path between local supply environment and supply competence of the subsidiary is stronger than the cross-paths from local technical and market environment to supply competence.

H2: The strength of the local technical environment positively affects the technical competence of the subsidiary.

H2b: The direct path between local technical environment and technical competence of the subsidiary is stronger than the cross-paths from local supply and market environment to technical competence.

H3: The strength of the local market environment positively affects the market competence of the subsidiary.

H3b: The direct path between local market environment and market competence of the subsidiary is stronger than the cross-paths from local supply and technical environment to market competence.

However, we cannot expect these hypotheses to be universally valid, since the MNC diamond network is a complex and costly organizational form that may not be suitable for all firms in all industries. Even within network-based MNCs, not all subsidiaries will be active participants in the resource exploration process (Bartlett and Ghoshal, 1989). In particular, two contingencies determine whether a given subsidiary is likely to be a node in a diamond network: the proximity of the host country to the location of the MNC headquarters, and the degree to which the host country environment can contribute with complementary resources to other MNC units.

Geographical Proximity

The value of gaining access to specialized resources is contingent upon the ability to combine these with complementary resources through the international network of the MNC (Malnight, 1996). It is generally believed that the cross-fertilization obtained by combining different types of knowledge is conducive to innovation (Zander and Sölvell, 2000). This is consistent with the view that a firm needs to access *all* elements of the diamond in order to innovate and create competitive advantage, a key insight of Porter's (1990) model. For instance, accessing a pool of technical skills is not enough if there is no strong market environment to create the pressures and the market knowledge necessary to put these skills to their best use, or no supply environment to provide the component technology on which to apply the skills. So a firm tapping into the supply environment in one country, the technical environment in another, and the market environment in a third country (as does the firm in Figure 2) must somehow bring these crucial inputs together by transferring knowledge across borders.

This need for international knowledge transfer may create both direct and indirect costs for the network-based firm. The direct costs are related to travel, communication, and meeting expenses, administrative wages, investments in information technology, codification of knowledge, the opportunity cost of employee time, etc. The indirect costs reflect the knowledge that is lost or distorted in the process, or that which is not conveyed because it would be too costly. High geographical distance between the different units in the network is likely to aggravate these costs, making the specialized resources in an individual host country environment less valuable to the MNC.

In other words, geographical proximity is an important contingency affecting the feasibility of sourcing diamond components abroad. In markets close to the rest of the organization, and in particularly to the MNC headquarters, such sourcing could be feasible and the MNC would have a strong incentive to locate the necessary competences there in order to facilitate learning. These markets effectively constitute the MNC's 'enlarged diamond' from which to derive competitive advantage, and here we should observe a strong relationship between particular environmental strengths and the competences needed to access them. In more distant markets, conversely, selective sourcing may be prohibitively costly, and the incentives for investing in specialized local competence consequently weaker. These effects are expressed in hypotheses 4 to 6:

H4: Geographical proximity to headquarters positively moderates the direct path between the local supply environment and supply competence of the subsidiary.

H5: Geographical proximity to headquarters positively moderates the direct path between the local technical environment and technical competence of the subsidiary.

H6: Geographical proximity to headquarters positively moderates the direct path between the local market environment and market competence of the subsidiary.

Resource Contribution

Geographical distance is only one reason why a given subsidiary may not be tightly integrated with the rest of the organization, even in cases where it has access to valuable resources. For example, the MNC may already be tapping similar resources in other locations, making an otherwise valuable host country environment redundant. Also, if the MNC is based in an industrial cluster in its home country, like the scenario depicted in Figure 1, it would already possess all the resources needed to generate competitive advantage, providing limited need for sourcing in its host country environments, which are therefore likely to be used only as output markets. In both cases, we should expect the subsidiary's perceived resource contribution – the degree to which the rest of the organization depends on the subsidiary's competences – to be low. The observed resource contribution of the subsidiary is therefore closely linked to the *complementarity* between the resources in the host country environment and those of the rest of the MNC.

A subsidiary with low resource contribution is essentially a market-seeking unit – it contributes to the rest of the MNC with revenues rather than with competences. In this type of subsidiary, there is little incentive to invest in specialized competence acquisition, and the link between environment and competence configuration should therefore be weak. In contrast, subsidiaries with high contribution could be denoted resource-seeking units. In fact, the variable of subsidiary contribution has been used to identify centers of excellence in previous empirical studies (e.g. Frost *et al*, 2002), and Andersson and Forsgren (2000) show that such centers of excellence have higher degrees of external embeddedness than other subsidiaries do. In the diamond network this should be valid for each of the three competence dimensions, as we can see from Figure 2; and a strong relationship between environment and competence configuration is therefore to be expected. In short, the integration of the subsidiary with the rest of the MNC correlates with its learning from the local environment, as reflected by hypotheses 7 to 9.

H7: The contribution of the subsidiary to the rest of the MNC positively moderates the direct path between the local supply environment and supply competence of the subsidiary.

H8: The contribution of the subsidiary to the rest of the MNC positively moderates the direct path between the local technical environment and technical competence of the subsidiary.

H9: The contribution of the subsidiary to the rest of the MNC positively moderates the direct path between the local market environment and market competence of the subsidiary.

Empirical Analysis

To test the hypotheses, a series of structural equation models was run on a data set with 2,107 survey responses from subsidiary managers. The data, measures, models, and results are described in the next sections.

Data Collection

The data was collected as part of the Centers-of-Excellence project that engaged researchers in the Nordic countries, the United Kingdom, Germany, Austria, Italy, Portugal and Canada (see Holm and Pedersen 2000). The project was launched in May 1996 with the purpose of investigating headquarter-subsidiary relationships and the internal flow of knowledge in MNCs. In order to collect comparable quantitative data on acquisition of subsidiary knowledge, it was decided to construct a questionnaire that could be applied in all the involved countries. This was accomplished after several project meetings and extensive reliability tests of the questionnaire on both academics and business managers.

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

This paper is based on data from seven countries, namely Austria, Denmark, Finland, Germany, Norway, Sweden and the UK. All countries are located in the northern part of Europe. The four Nordic countries and Austria are relatively small, while Germany and the UK are among the largest in Europe. Approximately 80 percent of the questionnaires were answered by subsidiary executive officers, while financial managers, marketing managers or controllers in the subsidiary answered the remaining 20 per cent. The response rate varies between 20% (UK) and 55% (Sweden), depending on the country of investigation. The quality of the data is quite high, with a general level of missing values of not more than five percent.

The total sample covers information on 2,107 subsidiaries. It comprises all kinds of subsidiaries in all fields of business. The size of the sample is rather similar for the seven countries as it ranges from 202 subsidiaries in UK to 530 subsidiaries in Sweden. The average number of employees in the subsidiaries is 742 and the median is 102.

Measures

The configuration of the environment was measured with several items reflecting the subsidiary manager’s perception of the strength of the host country diamond. The competence configuration of the subsidiary consists of perceptual measures of the subsidiary’s competence in different value chain activities. Both sets of items were collected using 7-point Likert scales[2], and each item was then assigned to one of the six theoretical constructs discussed above (i.e. the proposed three dimensions of both environment and competence). For a list of the two sets of items and inter-item correlations, see Tables 1 and 2.

*** Table 1 About Here ***

*** Table 2 About Here ***

Geographical proximity is a dichotomous variable taking the value of 1 if the MNC was headquartered in Europe and 0 if it was headquartered outside of Europe. Since we cannot observe the overall location pattern of each MNC, we take the location of headquarters as a proxy for the geographical 'center of gravity' of the firm. Of the subsidiaries in the sample, 27% had headquarters outside Europe. Finally, resource contribution is operationalized as the degree to which the subsidiary manager perceives the rest of the MNC to be dependent on the competences of the subsidiary. Resource contribution was originally measured on a 7-point Likert scale and subsequently collapsed into a dichotomous variable, where 'low contribution' reflects values of 1-3 and 'high contribution' 4-7. Other cut-off points were tried, but this segmentation had the highest discriminating power when used as a grouping variable in the structural equation models. Incidentally, previous studies have used the same cut-off point as a way of operationalizing the 'center of excellence' construct (e.g. Frost *et al*, 2002). Although the

[2] The competence scales were coded to include 0, which means that a given activity is not performed at all in the host country.

use of cut-off points is always quite arbitrary, it was necessary to create a categorical variable since structural equation models cannot accept interval-scaled variables as moderators.

Structural Equation Models

The hypotheses are tested in LISREL models that allow for simultaneous formation of underlying constructs (the measurement model) and test of structural relationships among these constructs (the structural model). First we perform four different analyses with the same measurement model but with different structural models. These four models are *nested*, i.e. allowing an increasing number of relationships among the latent constructs, the validity of which can hence be evaluated by comparative χ^2 tests. Model 1 is the measurement model itself, where no relationships between the latent constructs are allowed. Model 2 is a highly restricted model with only the three direct paths linking the three diamond components with their respective competence types. A comparison of these two models tells us something about the hypothesized embeddedness of the subsidiaries. In model 3, we allow correlations among the environment factors as well as among the competence factors. There are specific theoretical reasons for this: different diamond components are likely to be correlated because of their reinforcing nature (Porter, 1990), and different competences are likely to be correlated because co-location economizes on international transfer costs. Comparing models 2 and 3 enables us to evaluate the validity of these theoretical expectations. Finally, model 4 adds the cross-paths as well to show whether these are significant individually and as a group. In combination, these models and the estimated relationships will enable us to evaluate hypotheses 1-3 and 1b-3b. As we hypothesize a weak impact of the cross-paths, model 3 is the causal model that corresponds most closely to our theoretical framework.

Subsequently, we test the moderating effects of geographical proximity and resource contribution by two group analyses. First the sample is split into 'low-proximity' and 'high-proximity' subsidiaries and the model is estimated for both sub-samples. Comparing the strength of the direct paths across the two groups allows us to test hypotheses 4-6. Then the same procedure is applied to compare 'low-contribution' and 'high-contribution' subsidiaries, allowing us to test hypotheses 7-9.

Validity and Reliability of Measures

The validity of LISREL models is estimated by the validity of the measurement and structural model combined, i.e. by the nomological validity. But before estimating the nomological validity of the model with the causal relations specified, it is important to judge the hypothesized relationships between constructs and items, as well as the convergent validity (i.e. the homogeneity of the constructs included in the model) and the discriminant validity (i.e. to what extent the constructs are independent). In Table 3, the constructs are judged by the factor loading for each indicator, measuring the strength of the linear relationships, and the *t*-values, a significance test of each relationship in the model (Jöreskog and Sörbom, 1993). For each construct, one item is set to have an unstandardized loading of 1. Therefore, *t*-values are not reported for that item, and the loadings of the other items are measured *relative* to that item.

*** Table 3 About Here ***

As can be seen in Table 3, the strength of the linearity in relations between constructs and items is in most cases relatively strong with standardized factor loadings all above 0.53. We can also conclude that the *t*-values are highly significant, as they are all above 13 (compared to the critical *t*-value of 3.29 at p=0.001).

Convergent Validity

To see whether the constructs were internally coherent we report several tests of convergent validity in Table 4. First, the reliability of each construct is calculated and we can see that some of the constructs fall slightly below the recommended threshold of 0.70 (Gerbing and Anderson, 1988). This could indicate that these constructs are too heterogeneous in the sense that they contain sub-dimensions not recognized by our theoretical model. However, we could not decompose the constructs further due to our relatively small number of measured items and we therefore have to leave this challenge for future research. Also, when we look at the variance extracted the picture is somewhat better: all constructs are very close to or above the recommended threshold of 0.50. Since the overall fit of the model is acceptable and the sample size is large, we believe that a marginal lack of convergent validity will only have a marginal impact at the results.

Discriminant Validity

From a theoretical point of view it is particularly important to assess discriminant validity, since the multidimensionality of the constructs is a central proposition in this paper. Our theoretical model breaks the national diamond and the subsidiary competence into dimensions that are hypothesized to be conceptually distinct, and discriminant validity is the empirical means of assessing this distinctness. Several measures of discriminant validity were obtained from the data. First, we compared model 3 to a unidimensional model in which only one broadly defined environment factor was set to influence one competence factor. Model 3 was better (based on a χ^2-difference of 1,202 with 12 degrees of freedom, significant at $p<0.001$), leading us to reject the unidimensional model. To see if this was a result of the sample size, we also checked the normalized residuals. The unidimensional model had 36% of its normalized residuals above 2.58, indicating a very bad fit to the data, while model 3 has 13% which is closer to statistical threshold of 5%.

Another test of discriminant validity is to test whether the correlations and causal paths between the latent constructs are significantly different from 1 (e.g. Burnkrant and Page, 1982). Constructing 99,9% confidence intervals around the correlations and causal paths in model 2, we can confirm that none of them are close to including 1. Finally, Fornell and Larcker (1981) suggest comparing the variance extracted for each construct with the squared correlations or paths between the constructs. Both are given in Table 4, and the variance extracted is clearly the higher of the two values for all constructs. In combination, these tests indicate that the discriminant validity of the six constructs is good.

Goodness-of-Fit

We assessed the entire model by different goodness-of-fit measures including the χ^2-value, the Goodness of Fit Index (GFI), and the Normed Fit Index (NFI), which are measures of the distance between data and model, i.e. nomological validity (Jöreskog and Sörbom, 1993). Since the nested models have different degrees of freedom we also looked at the Parsimonious Normed Fit Index (PNFI) which takes this into account.

Overall goodness-of-fit statistics for all eight estimated structural equation models are presented in Table 4.

*** Table 4 About Here ***

Of the first four models, model 3 fits the data best and is highly significant with a GFI of 0.97 and a NFI of 0.92. The χ^2-value is still both high and significant, which may indicate a problem but is more likely in this case to be a result of the large sample size (Rigdon 1998: 269). Instead, we can use RMSEA, which controls for sample size. At 0.0635 this statistic is not quite within the 'good' range (below 0.05) but it is within the 'acceptable range' (below 0.08). Parsimonious NFI is also higher for model 3 than for the other models, indicating good explanatory power per estimated relationship. As mentioned above, an inspection of the normalized residuals in model 3 showed that 13% of these were above 2.58, compared to the 5% that is statistically justifiable. The item 'Production of Goods and Services' was involved with approximately half of the high residuals. This could indicate that production may not, as hypothesized in our model, always be co-located with research and development – a proposition supported by anecdotal evidence of current off-shoring trends. However, a lack of theory and indicators of the 'production environment' forced us to keep production within the technical factor. We believe future studies should look more closely into this factor and its potential subdimensions.

Because model 3 is superior to the other models, and because it is theoretically grounded, it forms the basis of the two group analyses. The goodness-of-fit statistics for these analyses correspond approximately to that of the main model.

Results

We can test individual relationships between the constructs in the model with *t*-values, and groups of relationships with χ^2-comparisons of the nested models. Figure 4 shows model 3 with standardized factor loadings, causal paths, and correlations, and Figure 5 shows model 4 including the cross-paths.

*** Figure 4 About Here ***

*** Figure 5 About Here ***

A comparison between the χ^2-values of the nested models (cf. Table 4) indicates that the direct paths added in model 2 are highly significant as a group (χ^2=2,951, p<0.001). From Figures 4 and 5 we can see that they are so individually as well. We therefore confirm hypotheses 1, 2, and 3.

The correlations added in model 3 are also collectively significant (χ^2=597, p<0.001). Hence, the fit of the model to the data improves significantly by allowing these correlations, indicating that both the environment and the competence components are internally reinforcing, as expected[3]. This is confirmed by the fact that nearly all the correlations estimated in models 3 and 4 are significant. The one exception is the relationship between market and technical competence. This seems to indicate that co-

[3] To see this more clearly, model 4 can be compared to a similar model without correlations (not presented here). This reveals that allowing correlations weakens all the cross-paths, and thus that the indirect causality indicated in such a restricted model is largely spurious. For example, if the market environment reinforces the supply environment, and the supply environment determines the subsidiary's supply competences, the model without correlations would capture this indirect effect and falsely indicate that the market environment actually affects the supply competences.

location advantages are weaker for those two types of competences, perhaps because the exchange of information between them is less critical than the one between supply and market (i.e. supply-chain coordination) and the one between technical and supply. Also, all the correlations are quite low, the one between supply and market environment being an exception at 0.38. This confirms our view that environment and competence strength really are multidimensional phenomena.

Finally, the χ^2-values show that the system of cross-paths added in model 4 is insignificant (χ^2=6). This means that restricting the cross-paths to 0 is valid at *p*=0.05 and lower. The GFI and RMSEA statistics also suggested that model 4 is inferior to model 3, and the PNFI drop rapidly as well when we add the cross-paths. If we look at the cross-paths individually (Figure 5) we get a similar result, as only the one of them, the path from technical environment to supply competence, is significant and only at *p*=0.05. On the one hand, this could suggest that supply competences are more broadly embedded than technical or market competences are. On the other hand, as shown in Figure 5, the cross-path to supply competence is weaker than the direct path from the supply environment. All in all, we can therefore confirm hypotheses 1b, 2b, and 3b: the data generally support the specialized embeddedness hypothesis that subsidiary learning occurs primarily along the three proposed dimensions, and not across them.

Table 5 lists the standardized path coefficients for the two group analyses.

*** Table 5 About Here ***

A comparison of the low-proximity and high-proximity sub-samples shows a clear pattern: all direct path coefficients are stronger and much more significant for the high-proximity subsidiaries. Therefore, we confirm hypotheses 4, 5, and 6: proximity does matter as determinant of local resource acquisition. In fact, for low-proximity subsidiaries the relationship between environment and competence is very weak, apparently being valid only on the supply dimension. Similarly, the degree of resource contribution reinforces the direct paths in model 6, leading us to confirm hypotheses 7, 8, and 9. Still, even for low-contribution subsidiaries the technical and supply paths are quite strong. This could indicate that also some market-seeking units embed those two types of competences, for example to provide locally engineered products based on local components for increased adaptation and fit. However, these types of subsidiaries are likely to be more interested in market *attractiveness* (i.e. revenue growth and income) than in market environment *strength* (demanding customers and competition).

Discussion

In particular, three significant implications can be drawn from this study. First, our results indicate that the strength of the host country environment should be conceptualized and operationalized in a multidimensional way. Environment strength seems to vary along (at least) three distinct dimensions, which are the supply, technical, and market environment, and perhaps even further decomposition is warranted. The industrial cluster view may overestimate the reinforcing nature of the different diamond elements: the data show a correlation, but nowhere near equifinality, between the three environmental dimensions, and the discriminant validity of the three environment factors are high. This tells us clearly that 'unbalanced diamonds' exist and that MNCs need to respond to them in their FDI decisions.

The second important implication of this paper is that subsidiary competences, like the environment, should be seen as multidimensional. This is not a new idea in the literature and the center-of-excellence line of research has brought significant advances in that direction. However, our typology suggests that the dichotomous center-of-excellence distinction may be too coarse, in part because it can be difficult to draw the line between what is a center of excellence and what is not – significant competences may also exist in subsidiaries which are not denoted centers of excellence – but most importantly because it does not capture the actual variety of subsidiary competence configurations. The idea of subsidiary competence configuration captures both the overall competence and the diversity of this competence along three dimensions that are empirically robust, giving us a more complete picture of subsidiary specialization.

Finally, and tying together the two previous points, the results suggest a link between the configuration of the environment and that of the subsidiary's competences. We have shown empirically that a strong supply environment leads to strong supply competences, technical environments to technical competences, and market environments to market competences – with very weak if any interaction between the three dimensions. This result challenges the industrial cluster view of the evolution of subsidiary competences. We would acknowledge that the presence of an industrial cluster (with a strong supply, technical *and* market environment) may be a sufficient condition for subsidiary competences to arise. We know such clusters exist and we have some tentative evidence of their impact on subsidiary competence. However, industrial clusters need not be a *necessary* condition for subsidiary competence: environments with specialized resources may also be valuable to MNCs, presumably because they can be matched with complementary resources derived from other nodes in the internal network.

Whether or not this is feasible depends in turn on the proximity and the integration of the subsidiary. For example, if the subsidiary's technical environment is advanced *and* located close to the rest of the MNC, it will be attractive to have technical competences there in order to tap into this knowledge and transmit it to other parts of the organization. On the other hand, if these technical resources are located in a distant market, it may not be worthwhile to source them, as the costs of combining this knowledge with that of the rest of the firm would be too high. In a similar argument, if the subsidiary is not integrated with the rest of the MNC, knowledge transfer is difficult and the value of specialized resources is accordingly lower. There could also be some degree of reverse causality: the MNC has a strong incentive to integrate specialized subsidiaries in order to exploit their resources. In any case, the explanation of competences provided here differs from a direct knowledge spill-over explanation in the sense that it emphasizes the role of MNC and subsidiary *incentive* in the subsidiary competence acquisition process. Learning from the environment requires an effort, and such an effort is less likely to take place if this knowledge plays a limited role in the differentiated network of the MNC.

Including proximity and resource contribution as a contingency makes our model sufficiently general to include both Porter (1990) and Ghoshal and Nohria (1997) as special cases. In distant host countries, it may be prohibitively costly to assign highly specialized roles to the local subsidiaries; and in units that are loosely linked to the MNC network structure, the benefits of such specialization would be low. In both cases, the firm is likely to leave its local units to pursue their revenue markets, and generate MNC-wide competitive advantage elsewhere, for instance in the home base. In contrast, tightly integrated subsidiaries sufficiently close to one another can effectively constitute an enlarged 'diamond network' from which it is feasible to source selective environmental resources. Hence, this paper mediates in the highly polarized debate between the two 'extreme views' – the industrial cluster school of thought arguing that competitive advantage should be developed in one location, and the differentiated network school of thought arguing for competitive advantage generated by a combination of resources from a geographically dispersed network. These views rely on different assumptions, and hence each may be valid in its own right *given* the appropriate context. Geographic proximity and resource contribution are two contextual variables that, apparently, have a strong influence on the relative predictive power of the two theories.

Implications for Further Research

While the complex relationship between host country environments and subsidiary competences is still an area of uncharted territories, we hope this study may highlight some directions for further investigation. Most importantly, our findings point to the need for further efforts to explore the multidimensional nature of Porters (1990) diamond model. The relatively weak convergent validity of our constructs indicates that future studies should theorize towards an even more fine-grained and multidimensional model of environment strength and subsidiary competence, and that more comprehensive sets of measurement items should be obtained. Also, whereas Porter's industrial clusters are defined (perhaps somewhat tautologically) by their export propensity, this study has used perceptual measures of individual diamond elements to predict subsidiary competences. A more direct approach that combines the benefits of these two approaches would be to derive objective measures of the individual diamond components, for instance using well-established measures of competitive intensity, local research activity, etc. This would enable a more rigorous test of the diamond as a construct and shed some light on the emergence of industrial clusters versus 'unbalanced diamonds'.

As a contribution to the literature on subsidiary-specific advantages, the prime focus of this paper has been on the evolution of subsidiary competences. An equally important question, however, is how these competences in turn influence the role played by the subsidiary in the larger context of the MNC. In particular, the model presented here strongly implies that the configuration of subsidiary competence is related to the flows of knowledge within the MNC network, and that specialized subsidiaries should be both recipients and senders of such knowledge. We touch upon this aspect with our group analysis on resource contribution. However, further testing of the diamond network model with an emphasis on the flows rather than the stocks of resources could be useful in this respect.

Conclusion

'Modern' MNCs are often asserted to be transforming themselves into networks of specialized, interdependent units operating across borders. Yet we still have few means of measuring this specialization, and little knowledge about what drives it. This paper has attempted, based on the diamond network model of Rugman and Verbeke (1993), to fill this research gap. In particular, we posit that host country diamond heterogeneity – i.e. the presence of 'unbalanced diamonds' – may lead MNCs to locate specialized competences in host countries in order to access complementary knowledge. The unit of analysis is the specialized embeddedness of the subsidiary within its environment – the links that enable the subsidiary to absorb knowledge from its surroundings. A multidimensional specification of both environment strength and subsidiary competences may enable us to capture the richness of these links in a better way than a unidimensional specification can. A test of our model on a data set of more than 2,000 subsidiaries in seven Western European countries confirms the potential value of this approach.

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Figure 1 – Specialized Embeddedness in the MNC

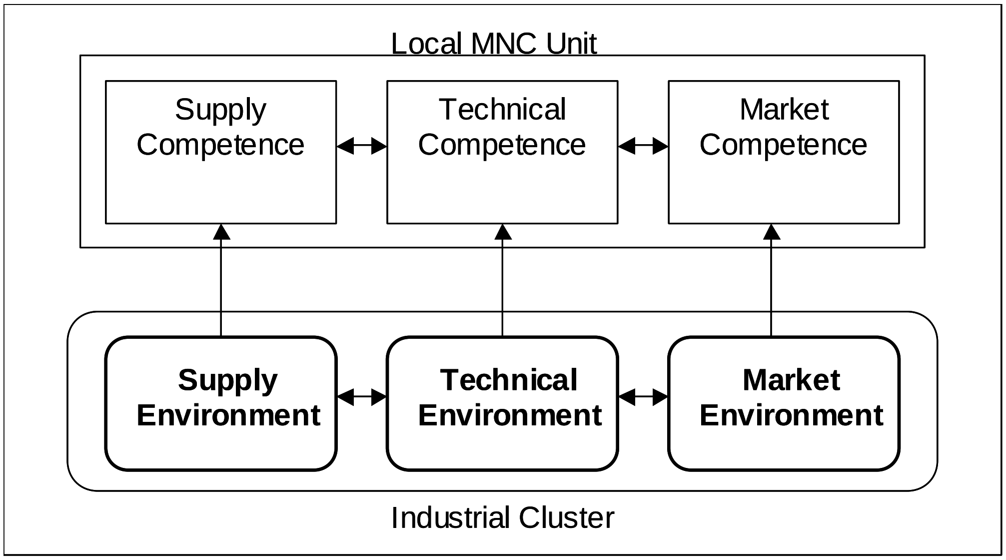


Figure 2 – The MNC as a 'Diamond Network'

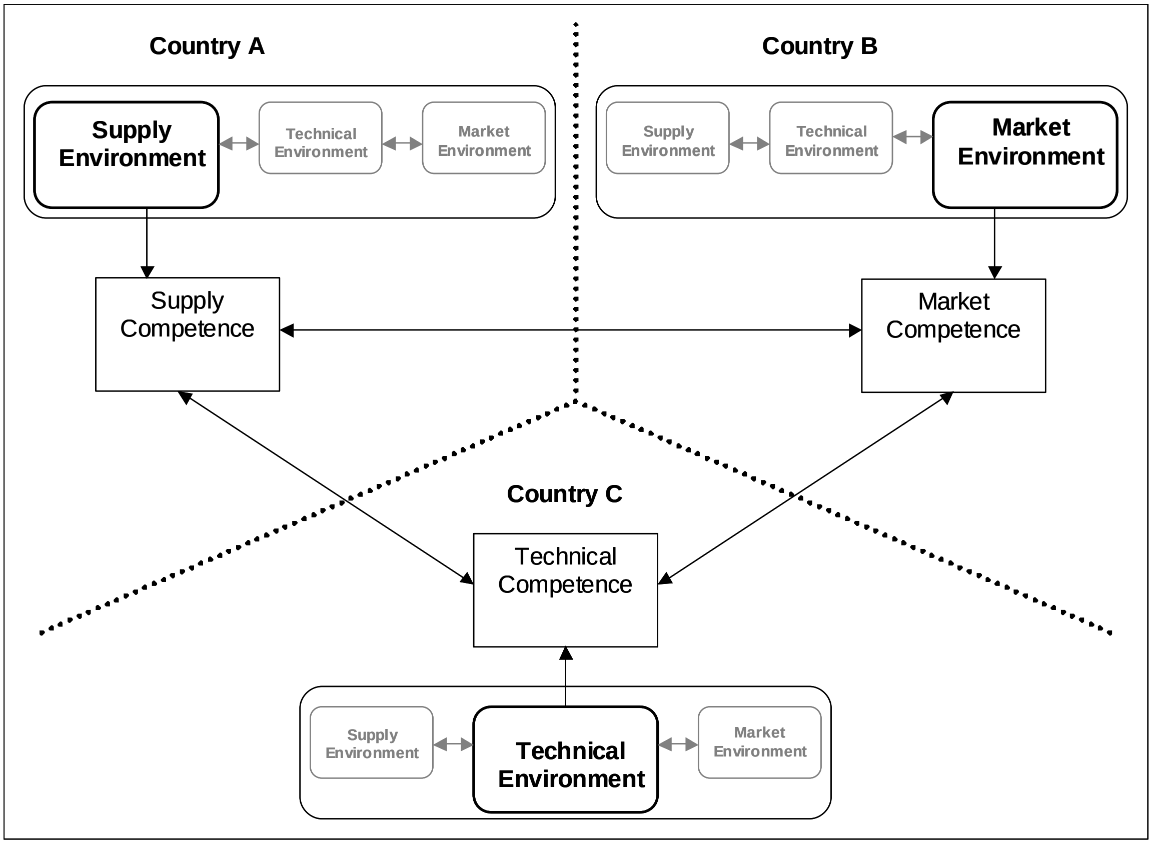


Figure 3 – Causal Model and Hypotheses

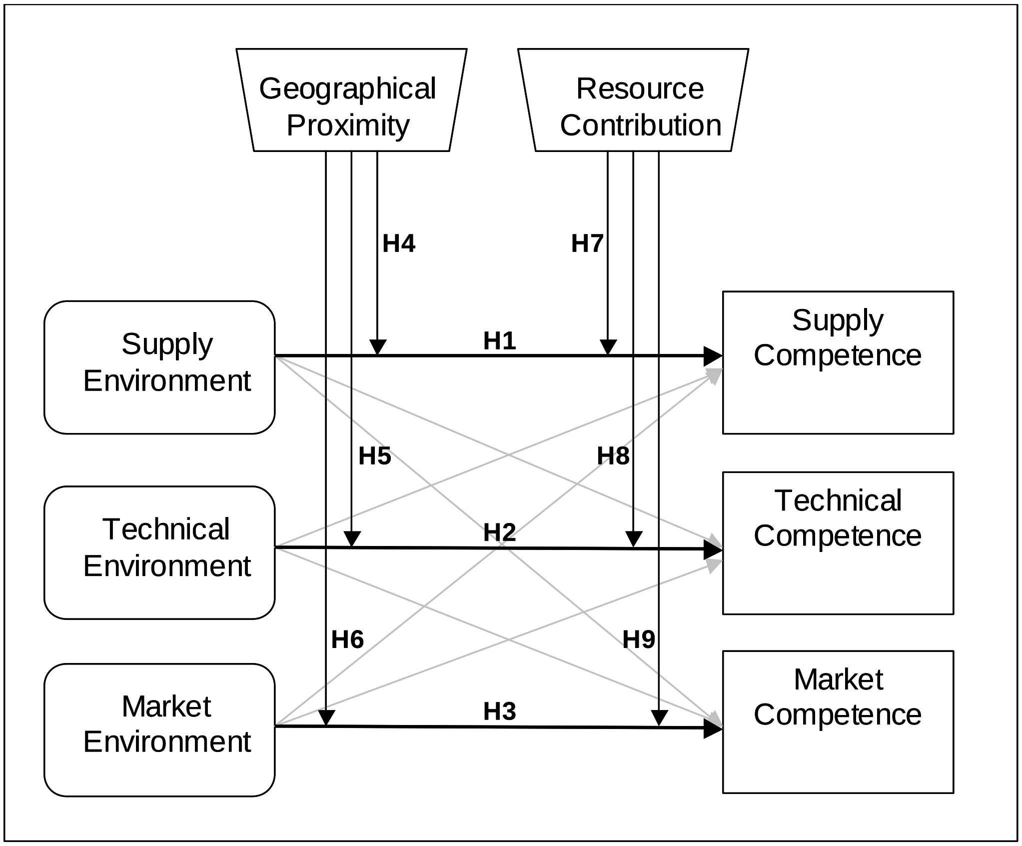
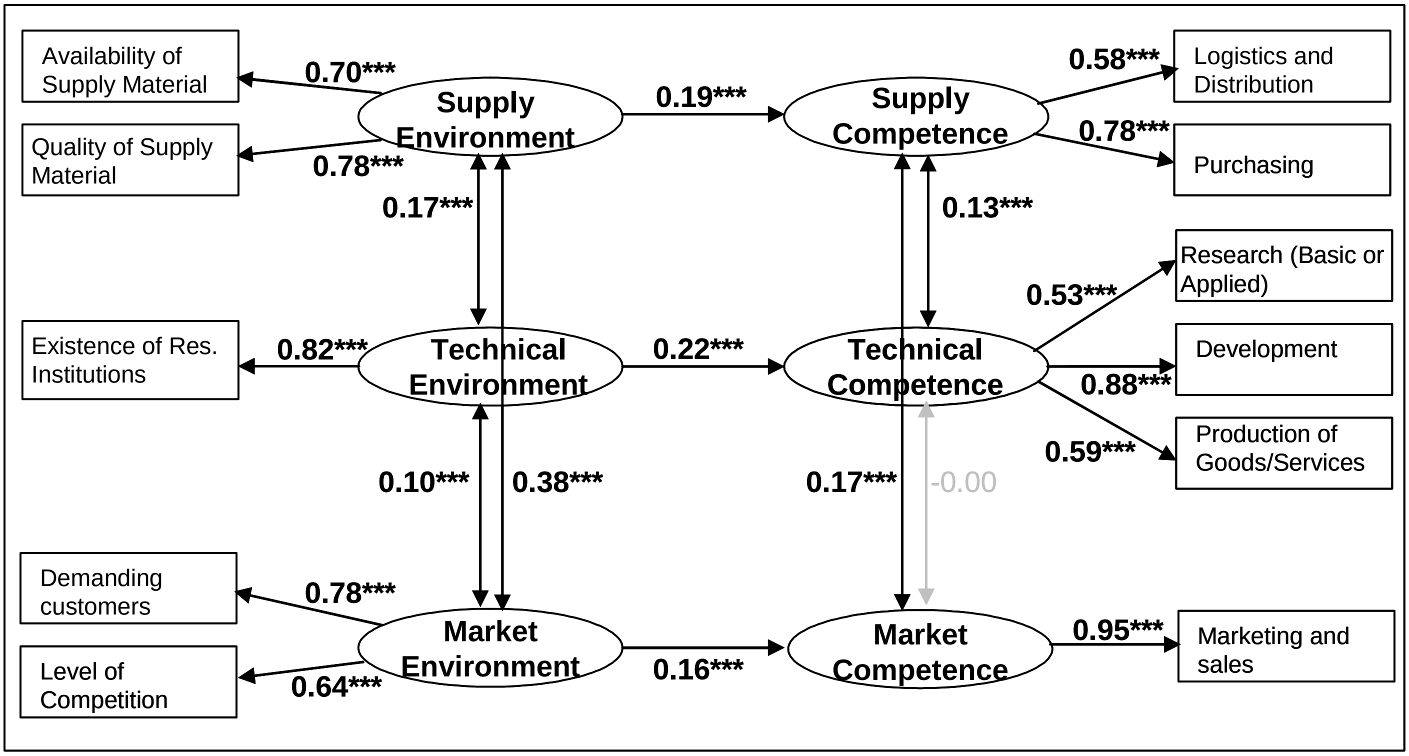
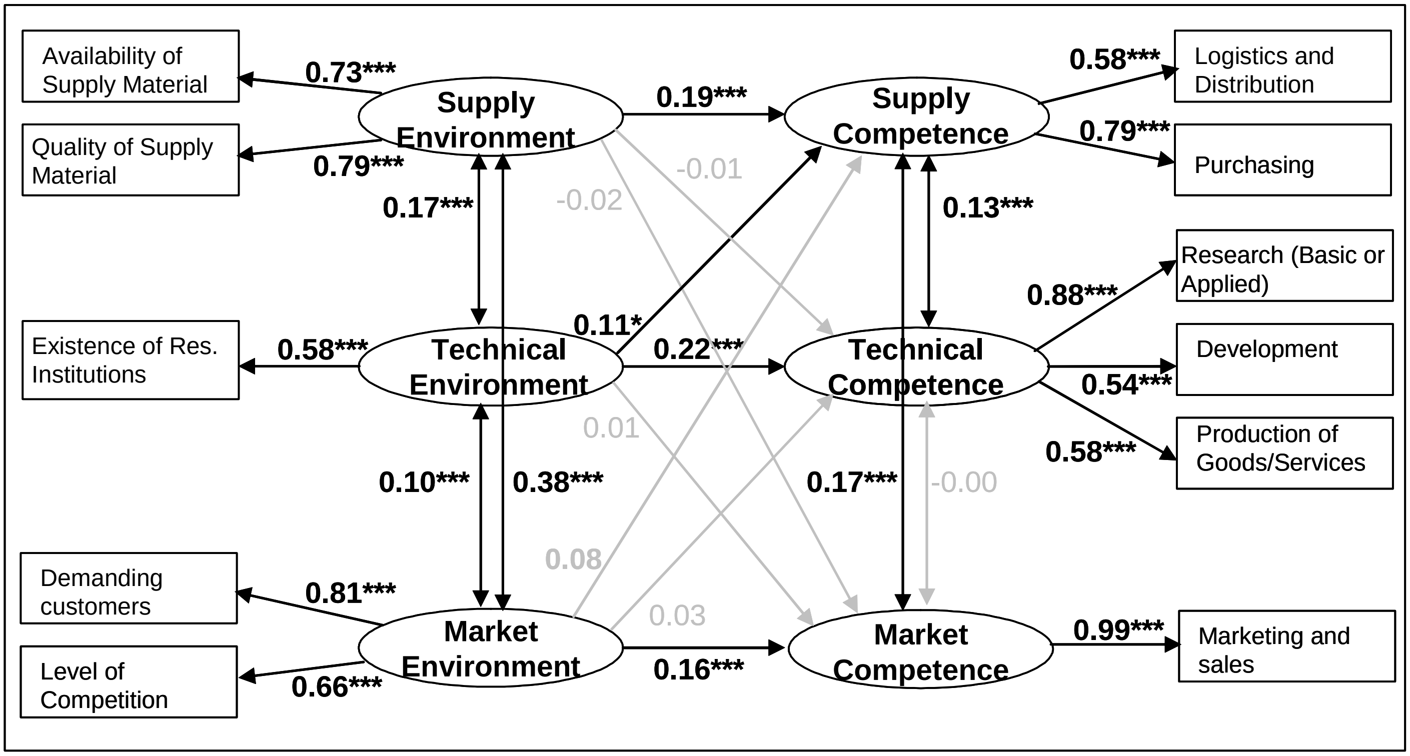


Figure 4 – Model 3 With Direct Paths, Correlations



* Significant at p<0.05.
** Significant at p<0.01.
*** Significant at p<0.001.

Figure 5 – Model 4 With Direct Paths, Correlations, Cross-paths



* Significant at p<0.05.
** Significant at p<0.01.
*** Significant at p<0.001.

Table 1 – Environment Items and Correlations

Variable	1	2	3	4
Supply Environment				
1. Availability of Supply Material	-			
2. Quality of Suppliers	0.56**	-		
Technical Environment				
3. Existence of Research Institutions	0.22**	0.15**		
Market Environment				
4. Demanding Customers	0.23**	0.34**	0.16**	
5. Level of Competition	0.21**	0.23**	0.16**	0.52**

* Significant at $p<0.05$.
** Significant at $p<0.01$.

Table 2 – Competence Items and Correlations

Variable	1	2	3	4	5
Supply Competence					
1. Logistics and Distribution					
2. Purchasing	0.21**				
Technical Competence					
3. Research (Basic or Applied)	0.06**	0.14**			
4. Development	0.12**	0.27**	0.48**		
5. Production of Goods or Services	0.12**	0.31**	0.22**	0.51**	
Market Competence					
6. Marketing and Sales	0.30**	0.48**	0.01	0.03	-0.05*

* Significant at $p<0.05$.
** Significant at $p<0.01$.

Table 3 – Factor Loadings in Measurement Model

Constructs and items	Loading*	*t***	Construct Reliability	Variance Extracted	(Highest C/P)^2
Supply Environment			0.71	0.55	0.22
Availability of Supply Material	0.70	16.7			
Quality of Supply Material	0.78	-			
Technical Environment			0.67	0.67	0.11
Existence of Research Institutions	0.82	-			
Market Environment			0.67	0.51	0.22
Demanding Customers	0.78	-			
Level of Competition	0.64	13.7			
Supply Competence			0.64	0.47	0.11
Logistics and Distribution	0.58	13.3			
Purchasing	0.78	-			
Technical Competence			0.71	0.47	0.11
Research (Basic or Applied)	0.53	17.3			
Development	0.88	-			
Production of Goods or Services	0.59	18.3			
Market Competence			0.90	0.90	0.11
Marketing and sales	0.95	-			

* Standardized factor loadings
** All *t*-values are highly significant at $p < 0.001$ (requires *t*-values above 3.29).

Table 4 – Goodness-of-Fit Statistics

Model	Description	N	χ^2	df	GFI	NFI	RMSEA	PNFI
1	Measurement Model	1936	3848*	50	0.70	-	0.2009	-
2	With Direct Paths	1936	897*	41	0.92	0.77	0.1054	0.57
3	With Direct Paths, Correlations	1936	300*	35	0.97	0.92	0.0635	0.59
4	With Direct Paths, Correlations, Cross-paths	1936	293*	29	0.97	0.92	0.0696	0.49
5a**	Low-Proximity Subsidiaries	514	98*	35	0.97	0.91	0.0603	0.58
5b**	High-Proximity Subsidiaries	1421	261*	35	0.97	0.91	0.0684	0.58
6a**	Low-Contribution Subsidiaries	820	155*	35	0.97	0.90	0.0653	0.57
6b**	High-Contribution Subsidiaries	1106	171*	35	0.97	0.92	0.0605	0.59

* All χ^2 values are significant at $p<0.001$.
** Models 5 and 6 resemble model 3, i.e. they include direct paths and correlations.

Table 5 – Moderating Effects of Proximity and Contribution

Model	Description	Direct Supply Path		Direct Technical Path		Direct Market Path	
		β	***t***	***β***	***t***	***β***	***t***
5a	Low-Proximity Subsidiaries	0.22	4.15***	0.10	1.68	0.08	1.51
5b	High-Proximity Subsidiaries	0.30	9.44***	0.26	7.60***	0.17	5.74***
6a	Low-Contribution Subsidiaries	0.21	4.85***	0.18	4.09***	0.07	1.79
6b	High-Contribution Subsidiaries	0.34	9.20***	0.22	5.29***	0.18	5.54***

All Betas are standardized path coefficients.
* Significant at $p<0.05$.
** Significant at $p<0.01$.
*** Significant at $p<0.001$.