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RESOURCE-BASED STRATEGY AND MANAGERIAL POWER IN NETWORKS OF INTERNATIONALLY DISPERSED TECHNOLOGY UNITS

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A linking of the Resource Based View of the firm, Resource Dependency Theory and the Vroom-Yetton model of leadership is used to show that when important technical (R&D) resources are located offshore for strategic and efficiency reasons, resource-based power goes with them. The extra-national technology units that embody those strategically important resources should be managed with inclusive methods that respect that power shift. Theoretical, empirical and managerial implications are drawn from this analysis. Copyright © 2001 John Wiley & Sons, Ltd.

Many transnational firms now locate significant portions of their R&D (technology) work outside their home countries and consequently must manage networks of internationally dispersed technology units (Boutellier, Gassmann and von Zedtwitz, 2000; Chiesa, 1996a, b; Coughlan and Brady, 1996; Dalton and Serapio, 1995; Florida, 1997; Gates, 1995; Granstrand, Hakanson and Sjolander, 1992; Kuemmerle, 1997; Medcof, 1997; Niosi, 1999; Pearce and Singh, 1992a, b; Penner-Hahn, 1998; Rhyne and Teagarden, 1995; Serapio and Dalton, 1999; Zander, 1997). Those extra-national technology units perform a number of functions running the gamut from the support of offshore marketing and manufacturing activities to the appropriation of cutting edge and/or cost effective technological resources located at extra-national sites (Albertini and Butler, 1995; Bartlett and Ghoshal, 1990; Granstrand *et al*., 1992; Hakanson, 1990; Kuemmerle, 1997; Malnight, 1995; Ohba, 1996).

When the strategic question of whether to locate technical work offshore is considered, the issue of control is an important concern (Granstrand *et al*., 1992). Technology work at remote locations is more difficult to control than that which is close to home, and the dangers of duplication of work by different sites, drift away from strategic focus, and the leakage of proprietary technology are all increased. Strategy makers must weigh these and other risks against whatever the positives may be. Unfortunately, the literature on power and control in networks of internationally dispersed technology units, although it clearly demonstrates the importance of such issues to managers, provides no consensus concerning best practice (Asakawa, 1996; Bartlett and Ghoshal, 1990; Pearce and Singh, 1992a, b; Behrman and Fischer 1980; Brockhoff and Schmaul, 1996; Buckley and Brooke, 1992; Cheng, 1994; De Meyer and Mizushima, 1989; Nobel and Birkinshaw, 1998; Stock, Greis and Dibner, 1996). The solutions proposed to the problem of control usually focus on managerial and operational approaches. For example, some authors propose that control can be maintained by increased communication between the offshore units and home base (De Meyer and Mizushima,

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1989; Granstrand *et al*., 1992). Frequent communication purportedly allows headquarters to better monitor the activities of far-flung units and to take corrective interventions in a timely manner. Other authors report that the exertion of authority is commonly used in an attempt to maintain control (e.g., Asakawa, 1996), typically by providing rules, procedures and the requirement that important decisions be made at headquarters. Although these approaches are not without their virtues, they do have their problems, such as the destructive friction they can create within the organization (Asakawa, 1996). There is also evidence that approaches to control vary over time (e.g., Malnight, 1996) and recently there has been a trend among some firms to reassert more central control over their dispersed technology units, although significant decentralization is still present (Gassmann and von Zedtwitz, 1998, 1999; Gerybadze and Reger, 1999).

This stream of research is also characterized by a lack of theoretical integration. Most of the organizing constructs are primarily descriptive and/or based upon management practice, as ascertained through questionnaire and interview studies.

It will be argued in this paper that the control issues described above are ultimately rooted in strategy. Once a particular strategic course is adopted, certain power dynamics are inevitably set into play that may be ameliorated by improvements in communication and the exertion of hierarchical control, but cannot really be resolved. To explain the strategic roots of these power dynamics, and the managerial issues they engender, this paper will draw concepts from three theories: The Resource Based View of the firm (Barney, 1991; Teece, Pisano and Shuen, 1997); Resource Dependence Theory (Cool and Henderson, 1998; Harpaz and Meshoulman, 1997; Inkpen and Beamish, 1997; Oliver, 1991; Pfeffer and Salancik, 1978; Yan and Gray, 1994), and the Vroom-Yetton model of leadership and decision making (Field and House, 1990; Pasewark and Strawser, 1994; Vroom and Jago, 1988; Vroom and Yetton, 1973). One outcome of this theoretical integration will be prescriptions about how strategically important extra-national units should be managed, and explanations as to why they should be managed differently from units with little strategic importance. In essence, this paper will build theoretical links among strategy, power and management in transnational technology networks, and generate a set of theory-based prescriptions for practising managers. This should help ameliorate the two major difficulties in this literature noted above, the lack of integrating theoretical models and the lack of consensus about best practice.

HETEROGENEITY AMONG EXTRA-NATIONAL TECHNOLOGY UNITS

Empirical studies over the last many years have demonstrated that extra-national technology units serve a number of purposes and there have been a number of attempts to classify them using various criteria (Behrman and Fischer, 1980; Cheng, 1994; Cordell, 1973; Hakanson and Nobel, 1993a, b; Hewitt, 1980; Hood and Young, 1982; Medcof, 1997; Nicholson, 1994; Pearce and Singh, 1992a, b; and Ronstadt, 1977, 1978). Of these, Medcof (1997) developed a classification that captured the essence of many previous taxonomies by proposing that units could be classified into eight categories based upon the technical activities they perform and the geographical areas over which they have collaborative relationships. The eight categories are: Local Research Units, Local Development Units, Local Marketing Support Units, Local Manufacturing Support Units, International Research Units, International Development Units, International Marketing Support Units, and International Manufacturing Support Units (see Medcof, 1997: 308). For example, Local Marketing Support Units are technology units which support marketing activities in a single country through such avenues as providing technical assistance to customers and helping with incremental modifications to products for local markets. In contrast, International Research Units engage in basic research and collaborate with other research units spread across a number of countries. There is also a tradition of classifying overseas technology units into two broad categories (Archibugi and Michie, 1995; Chiesa, 1996a; Florida, 1997; Granstrand *et al*., 1992; and Kuemmerle, 1997, 1999). For example, Kuemmerle (1997, 1999) has suggested that extra-national technology units engage in two general types of activities. Those engaged in **home-base-augmenting activities** appropriate marketing and scientific knowledge that is available at offshore sites for the firm's present or future use. Those engaged in **home-base-exploiting activities**

use the firm's current technical capabilities to support operations such as marketing and manufacturing at home or abroad.

Classifications of overseas technology units such as those of Medcof (1997) and Kuemmerle (1997, 1999) certainly bring increased coherence to this area of study, but they remain functional and practical classifications that lack attachments to more fundamental theoretical concepts. In short, they make an important contribution to our understanding and they are very probably useful in practical management discussions, but they have, as yet, not taken us to deeper levels of understanding. We will now show that a deeper level of understanding can be provided by the Resource Based View of the firm.

The Resource Based View (RBV) of the firm (Amit and Schoemaker, 1993; Barney, 1991; Dierickx and Cool, 1989; Peteraf, 1993; Rumelt, 1984; Teece *et al*., 1997; Wernerfelt, 1984, 1995) postulates that competitive advantage comes from having resources that create value in the marketplace and are unique. Although various scholars develop this theme in different ways, and develop somewhat different implications from it, they all agree that value and uniqueness are the basis for strategic importance. Barney (1991) states that the value of a resource depends upon its efficiency and effectiveness (i.e., its role in exploiting opportunities and/or neutralizing threats). He says that uniqueness derives from being rare (at most, only a few other firms have the resource), having imperfect imitability (other firms cannot imitate or acquire it) and being non-substitutable (there are no strategically equivalent resources available to other firms).

The RBV has been applied to transnational technology strategy by a number of writers (Cheng, 1998; Duysters and Hagedoorn, 1998; Florida, 1997; Henderson and Cockburn, 1994; Kuemmerle, 1999; Medcof, 2000; Methe and Yoshihara, 1998; Toyama and Methe, 1997). A very commonly stated proposition is that organizations place technology units overseas in order to appropriate the unique and valuable technology resources located there. For example, International Development Units collaborate across national boundaries to create new products for large international markets. Very often the individual International Development Units embody technical capabilities that are unique in the firm, and in the world, and are the key to developing market-leading products. Empirical studies generally support this idea that MNCs appropriate unique and valuable technologies at extra-national sites.

However, empirical studies have identified a variety of types of extra-national technology units and suggest that not all of them have high value and uniqueness (Behrman and Fischer, 1980; Cheng, 1994; Cordell, 1973; Hakanson and Nobel, 1993a, b; Hewitt, 1980; Hood and Young, 1982; Medcof, 1997; Nicholson, 1994; Pearce and Singh, 1992a, b; and Ronstadt, 1977, 1978). For example, the function of Local Marketing Support Units (Medcof, 1997) is, generally, to help local customers and to tweak products for sale in the local market. Although every market is unique in some ways, by and large the roles of these units are quite similar regardless of where they are. They provide the generic technical support that must be provided in any technology-driven market and, therefore, are not really unique within their own firms or in the industry. Neither are they very valuable. They are located within the marketing function and they make a contribution that is no more valuable than other marketing activities, such as advertising and direct sales. In short, most Local Marketing Support Units do not play strategically important roles. The same can be said for most Local Manufacturing Support Units. They usually adapt technology developed at home to a particular overseas context and help maintain its function once it is operative. Their work is embedded in the manufacturing process and is much the same everywhere. These studies suggest the following proposition.

> *Proposition 1: Extra-national technology units are heterogenous with respect to the uniqueness and value of the resources they embody and, therefore, in their degree of strategic importance.*

Various authors have anticipated this idea by ordering extra-national technology units (and/or their technical work) along continua of various kinds. For example, Taggart (1998) suggested a dimension of "R&D complexity" with customer support as the least complex and the production of new technology (research) as the most complex. Nobel and Birkinshaw (1998) suggested a three-category typology, based primarily on the work of Pearce (1989), which has "local adaptor" as the least strategically important and "international creator" as the most. However, these earlier continua have only tenuous links to a theoretical base.

The explicitly drawn relationship between technology unit types and the theoretical concepts of uniqueness and value developed here advances our understanding in this respect and, as we shall see, enables clear links to other theories. The first such link will be to a theory of organizational power.

VALUE, UNIQUENESS AND ORGANIZATIONAL POWER

The theoretical links among uniqueness, value and organizational power will be made using Resource Dependency Theory (RDT), originally formulated some years ago (Pfeffer and Salancik, 1978) but found useful recently by several authors (Cool and Henderson, 1998; Harpaz and Meshoulman, 1997; Inkpen and Beamish, 1997; Oliver, 1991; Yan and Gray, 1994). RDT states that the power of an organization depends upon the resource dependency relationships it has with other organizations. If a focal organization is highly dependent upon another organization for an important resource (for example, an input to its manufacturing process), that other organization will have power over the focal organization. Although RDT was originally formulated to discuss relationships between organizations, the theory has also been found to be readily applicable to relationships among units within organizations (e.g., Harpaz and Meshoulman, 1997). Here we will consider dependency relationships among a firm's home-country headquarters and its extra-national technology units. RDT proposes that three factors are critical in determining the dependence of one organizational unit upon another and therefore their relative power.

1. **Resource Importance**. The more important the resources controlled by a unit, the more other units will be dependent upon it, and the greater will be its power over those other units.
2. **Alternatives**. The fewer the alternative sources there are for a resource controlled by a unit, the more other units will be dependent upon it for the resource, and the greater will be the power of that unit.
3. **Discretion**. The greater the degree of unfettered discretion that a unit has in the deployment of a resource, the greater will be others' dependence on it, and the greater will be its power.

Maximum dependency, and therefore maximum power, occur when one unit has unfettered discretion over a resource of high importance to another unit, and there are no alternative sources.

RDT can be theoretically connected to the RBV because of the nearly identical meanings of certain of their fundamental concepts. The RBV holds that competitive advantage comes from unique and valuable resources. The concept of value in the RBV is very close in meaning to that of importance in RDT. For example, a resource has high value if it is the basis for the firm's success in a large market. In that case it can be said that the resource is important to the firm, and the more the resource is the basis for success (value), the more the firm depends upon it. The organizational unit which embodies that resource thus has a basis for organizational power. The concept of uniqueness from the RBV is very close in meaning to the concept of alternatives in RDT. If a resource is unique to a particular organizational unit, there is no alternative source for it, and the resource will be a basis for organizational power. Two propositions follow from this.

Proposition 2: The greater the value (importance) to an organization of the resources embodied in a particular organizational unit, the greater will be the dependency of the organization upon that unit, and the greater will be the power of that unit within the organization.

Proposition 3: The greater the uniqueness of a resource embodied in an organizational unit, the greater will be the dependency of the organization upon that unit, and the greater will be the power of that unit within the organization.

These two propositions, when combined with the basic premises of the RBV concerning value, uniqueness and strategic importance, yield another.

Proposition 4: Organizational units have power directly proportional to the strategic importance of the resources they embody.

VARIATION IN MANAGEMENT APPROACH

It will now be shown that the amount of power embodied in an organizational unit (and by implication, its strategic importance) determines how

it can best be managed. This will be done by examining in more detail the nature of the dependence that results from the uniqueness and value of extra-national units. Uniqueness and value can create a number of different kinds of dependency with varied implications for different aspects of organizational function. Here we will explore those aspects of dependency that are most relevant to the activity of managing. This will allow us to be theoretically specific about which management approaches are most appropriate for units with different degrees of strategic importance. We are taking this approach because we are faced with a conceptual gap between the concept of dependence at the strategic level, as we have already discussed it, and dependence as it must be understood in the context of management. What we will do here is to provide a conceptual bridge between those two facets of dependence in order to link the realms of strategy and management. As will be seen, that theoretical link will be developed using the Vroom-Yetton model of leadership (Vroom and Jago, 1988; Vroom and Yetton, 1973).

The premise that different kinds of extra-national technology units should be managed in different ways is not new (Chiesa, 1996a; Nobel and Birkinshaw, 1998; Reger, 1999; Stock *et al*., 1996). However, this idea is usually based upon the practical experience of managers and no fundamental theoretical basis has yet been offered for it. Here, we will develop a theoretical explanation and use it to generate a number of normative propositions.

THE VROOM-YETTON MODEL

The Vroom-Yetton model (Field and House, 1990; Pasewark and Strawser, 1994; Vroom and Jago, 1988; Vroom and Yetton, 1973) states that there is a variety of ways to make decisions and that a manager should choose the way that is most appropriate given the nature of the problem to be solved and the context in which the decision is to be made. The model provides a number of criteria for deciding which decision making mode to adopt.

Turning first to the available decision making modes, the model proposes a spectrum of modes that vary in the degree to which subordinates are involved in the decision making process.

Autocratic	The leader makes the decision all alone
Consultative	The leader makes the decision after consulting with subordinates to collect information and perspectives
Inclusive	The leader involves subordinates in a process of decision-making by consensus.

Although these three are the core types of decision making, the model includes variants on each. We will use just the three core types in our discussion here. The original statement of the model uses the term "group" to refer to the third decision making mode. Here the term "inclusive" is used since it captures better the essence of that mode.

The Vroom-Yetton model proposes five criteria to be considered when deciding which of these decision modes to use. These include the importance of the technical quality of the decision itself, the commitment to the decision of those who must implement it, its timeliness (is the decision made quickly enough to be implemented in the window of opportunity for effective intervention), the cost of the human capital used to make the decision, and the degree to which the decision process provides a learning opportunity for members of the organization. Some of these five factors are more concerned with the temporal and organizational context of the decision than with the quality of the decision itself.

The model suggests that, of the five criteria, two are of overwhelming importance relative to the others, namely, the technical quality of the decision and the effectiveness of its implementation. The technical quality of the decision depends upon having the information necessary to make it, and upon structuring the problem effectively in the first place so that the decision is appropriately framed to solve the problem it is intended to solve. The effectiveness of the implementation depends upon having people with the abilities and motivation necessary to execute the decision. To preserve the clarity of our primary theoretical thrust, we will carry forward our argument using only these two most fundamental criteria.

The essence of the Vroom-Yetton model is that the optimal decision-making mode is contingent upon whether the leader is dependent upon others for information, problem framing capabilities, and/or commitment in implementation. If

the leader is able to frame the problem effectively alone; has all the necessary information; and knows that subordinates will effectively carry out the decision, even if they do not participate in its making; it is most effective for the leader to make the decision autocratically. In contrast, if subordinates have some of the understanding and knowledge needed to frame and make the decision, but are likely to implement it effectively even if they are not involved in a consensus building process, the consultative approach will be most effective. Finally, if subordinates have knowledge and understanding necessary to frame and make the decision, and are unlikely to implement it effectively unless they are involved in a consensus-based process for making it, then the inclusive approach is best.

Decision making by top management teams in technologically intensive MNCs involves the considerations described by the Vroom-Yetton model (Birkinshaw, 1995; Birkinshaw and Hood, 1998; Chiesa, 1999; Coughlan and Brady, 1996; Pearce, 1997). Such teams must decide upon the degree to which they will include managers and scientists from their subsidiaries in their strategic and resource allocation decision processes. Some case studies (e.g., Birkinshaw, 1995, Birkinshaw and Hood, 1998; Coughlan and Brady, 1996) indicate that inclusion in those top level decisions at global headquarters can be key to advancing the interests of extra-national technology units and such inclusion is sometimes actively sought by the managers of those units. It seems likely that in most of these organizations all of the Vroom-Yetton decision modes will be used to some extent, but that each organization will have a bias for using some more than others. The predominant mode will set the tone for the organization, and the organization's structure is essentially the enactment of that dominant mode. If the managers in an organization customarily make their decisions using the autocratic mode, the organization will be said to have an authoritarian and centralized structure. If they typically use the inclusive approach, the structure will be said to be decentralized and participative.

The Vroom-Yetton model can, therefore, be used to provide prescriptions about the degree to which the managers and scientists of extra-national technology units should be included in headquarters decisions about strategy and resource allocation. If the resources of an extra-national technology unit are highly unique, the members of that unit are probably the only ones within the organization who have a complete and deep understanding of them. The managerial and technical leaders of that unit will be essential in framing and solving problems which involve that technology. Headquarters should involve the unit to at least the consultative level when making important decisions which involve a consideration of that technology.

Proposition 5: Extra-national technology units which embody technology resources that are of high strategic importance (unique and valuable) should be included in decisions concerning that technology, to at least the level of consultation.

However, many of the decisions that must be made by technology intensive MNCs involve several technologies which are not all embedded in one unit (Zander, 1997). The complexity of such decisions often means that their framing and solution can be done effectively only through a collaborative, iterative interaction among the relevant overseas units and headquarters. A good solution is assured only when all have agreed that all important considerations have been addressed.

Proposition 6: Decisions which involve multiple strategically important technologies, embedded in multiple technology units, should be made by inclusive decision making processes.

There is considerable evidence that International Research Units and International Development Units operate under the conditions referred to in Proposition 6 (Granstrand *et al*., 1992; Nobel and Birkinshaw, 1998; Pearce and Singh, 1992a, b). They are strategically important since they are involved in the creation of unique, multi-technology products intended for sale in large markets which span a number of countries (high value).

Proposition 7: International Research Units and International Development Units should be managed by headquarters through inclusive decision making processes.

But decision implementation is also an important consideration in this context. A decision taken concerning a technology will usually require experts in that technology for its effective implementation. So headquarters is also dependent upon extra-national units for the execution of decisions involving the

strategically important technologies they embody. Organizational culture influences the degree to which members of extra-national units are inclined to participate in decision execution. If culture has engendered a strong sense of commitment to the organization, members may enthusiastically tackle the job of implementation regardless of how the decision was made. Other cultures may make it more difficult to mobilize members of the organization, particularly if they believe the decision was a poor one or was reached by an inappropriate method. The Vroom-Yetton model posits that participation in consensus-based decision making increases the probability that organizational members will enthusiastically implement a decision.

Proposition 8: The need for the inclusion of extra-national technology units in headquarters decision making increases with the degree to which the commitment of those units to the solution is in question.

This logic focuses upon strategically important technology units, but many extra-national technology units are not strategically important. A set of propositions can be developed for extra-national technology units of low strategic importance, including Local Marketing Support Units and Local Manufacturing Support Units.

Proposition 9: The lower the strategic importance of the technology embodied in an extra-national unit, the greater the probability that it can be effectively managed through processes that involve little or no consultation with headquarters.

Proposition 10: Local Marketing Support Units and Local Manufacturing Support Units can be effectively managed through processes that involve little or no consultation with the headquarters unit.

Proposition 11: The greater the degree to which the commitment to decision implementation of members of Local Marketing Support Units and Local Manufacturing Support Units is at issue, the greater the need to use consultative and perhaps inclusive decision making processes.

EMPIRICAL EVIDENCE

Given that the above propositions are predominantly prescriptive, we might ask if transnational firms actually practice them. There is evidence that at least some management teams deploy power as the propositions suggest. For example, Nobel and Birkinshaw (1998), in their study of Swedish multinationals, identified three different kinds of overseas technology units and found that they are controlled by headquarters through different mechanisms. One type, "local adaptors", similar to Medcof's (1997) local support units (low strategic importance), are managed primarily by formalization, a form of autocratic control which involves the provision of rules and procedures by headquarters. Another kind of unit, "international creators", similar to Medcof's (1997) International Research Units (high strategic importance), are controlled primarily through socialization, which involves frequent inter-unit visits and the exchange of personnel, implying inclusion in decision making processes. Corporate headquarters appears to be appropriately managing them by collaborative mechanisms involving rich communication links. These matchings of strategic importance and control/communication modes seem, on the face of it, to be consistent with the prescriptions developed above.

Taggart (1998) compared extra-national manufacturing subsidiaries which were increasing the complexity of their technology work to those which were decreasing the complexity. His continuum of "R&D Complexity" roughly parallels that for strategic importance presented here, but is based upon somewhat different premises. He found that subsidiaries which were taking on increasingly complex technical work (increasing strategic importance) were moving to less autocratic control by headquarters, while those moving to less complex technical work were moving towards more autocratic methods of management by headquarters. Although not a direct test, this is consistent with the propositions developed above.

Brockhoff and Schmaul (1996) also found evidence of firms following the prescriptions developed here, in their study of multinationals in Germany. Their data show that some overseas technology units are controlled, not by headquarters, but by other overseas units of the firm which are

not primarily concerned with R&D. For example, an extra-national marketing unit might house an extra-national technology unit. We can surmise that these technology units are marketing support units doing work of low value and uniqueness. Brockhoff and Schmaul's data show that these units have little autonomy, which is consistent with Proposition 10. Brockhoff and Schmaul linked these function and control contingencies to performance, an important element of their research which should be pursued in future empirical studies.

Asakawa (1996), however, reported cases involving less adroit deployment of power. He found that some of the Japanese companies in his sample increased their hierarchical authority over offshore units that appeared to be acquiring too much autonomy. This created increased tension between headquarters and offshore units. It was in areas of high strategic importance, such as intellectual property and research initiatives, that such tensions were most likely to occur. This is consistent with Proposition 6 which states that inclusive rather than autocratic processes should be used with units that embody strategically important technologies.

The empirical evidence just reviewed suggests that the theoretically based prescriptions developed here are followed by at least some management teams. However, this evidence is, at best, suggestive, since none of these studies was designed specifically to test these propositions. Since many of these propositions are prescriptive, direct tests of them should include explicit measures of organizational performance. Direct tests might evaluate the proposition that technology units which do strategically important work will have more resource-based power than those which do less important work. This could be tested using questionnaires which gather senior managers' perceptions of the strategic importance of the work of technology units, and correlating those with measures of the resource-based power of those units. Measures of resource-based power can be found in the RDT literature. Measures of hierarchical management methods, such as those used by Nobel and Birkinshaw (1998), and measures of organizational conflict could also be applied to test whether hierarchical management methods, when inappropriately applied to organizational units that are strong on resource-based power, create excessive organizational conflict.

THEORETICAL AND METHODOLOGICAL EXTENSIONS

The development of the propositions in this paper has relied upon Medcof's (1997) classification of technology unit types. That classification is based upon a long tradition of empirical research which stresses the function and geographic region of collaboration of extra-national technology units. We will now go on to show that the theoretical points developed in this paper can be used to put this hitherto descriptive classification into a more rigorous theoretical framework. The essence of the integration involves using the RBV to clarify the strategic importance of the various unit types in the taxonomy. This application of the theory to the taxonomy will strengthen them both.

One part of the application of RBV to the taxonomy was discussed during the development of Proposition 1. There it was argued that research units and development units are strategically more important than support units because they (research and development units) embody resources that are more unique and valuable than those in support units. Some other authors have made similar points (e.g., Niosi, 1999; Nobel and Birkinshaw, 1998; Pearce and Singh, 1992b) but have not put them on as clear theoretical basis as has been done here. Niosi (1999) implies that technical support is in the realm of tactics and research and development are in the realm of strategy.

However, the relative strategic importance of research and development units is yet to be resolved. The empirical evidence here is mixed. For example, Taggart (1991) found that, in his sample of American and European pharmaceutical firms, marketing issues, and the related product development activities, were more strategically important than research and science issues in determining whether to locate technology units at extra-national sites. In contrast, Florida (1997) found that, among foreign firms locating R&D units in the U.S., science and research issues were more strategically important than those related to markets and product development. Gerybadze and Reger (1999), in a single study, found both kinds of cases, and their explanation provides an avenue for us to theoretically reconcile the mixed findings.

Gerybadze and Reger (1999) propose that, depending upon a number of factors, the firms in their sample pursued one or the other of two

regimes of innovation. Some firms pursued innovation based primarily upon leading edge science and research. Others depended less on cutting edge science and more on the effective coupling of their technical know-how to the evolving product needs of customers in their lead markets. Gerybadze and Reger state that in the case of science and research-based innovation (in genetic engineering and artificial intelligence, for example); "leading researchers and world-class research laboratories are the most sought-for critical assets" (1999: 265). In contrast, those pursuing a lead-market regime of innovation put more stress on effective collaboration with leading-edge, demanding customers; and the ability to involve them in product development activities such as the probe and learn process. Firms following the lead-market regime were more likely to be found in such industries as factory automation and medical technologies.

These descriptions of Gerybadze and Reger (1999) suggest that industries and firms vary in the degree to which science-based and product development-based resources have strategic value. Research units have more value and strategic importance to firms pursuing a science-based strategy, and that strategic importance is enhanced if the research resources in the unit are unique. Development units have more value and strategic importance to firms pursuing a collaborative-product-development strategy, and that strategic importance is enhanced if the customers accessed are unique and a unique working relationship is established with them.

Gerybadze and Reger (1999) suggest that the decision to locate technology units at extra-national sites depends heavily upon the state of resources in the firm's home country. They found that firms generally find it advantageous to locate technology units physically close to appropriate centers of excellence, whether they be in science or in lead markets. If the type of excellence sought by the company can be found in the home country, the firm will locate its technology unit at home. If such a center is not found at home, the firm will seek an overseas location that does have such excellence.

In summary, we see that the RBV can provide a theoretical underpinning for descriptive taxonomies such as those of Kuemmerle (1997, 1999) and Medcof (1997), thus blunting the criticism that such taxonomies are a-theoretical and shallow. The theoretical analysis suggests that the uniqueness and value of support units is so low that their strategic importance is clearly below that of research units and development units. However, no such general rule can be used to rank order research and development. Depending on the strategy of the firm (science or market oriented) either research or development might have the greater value and, therefore, greater strategic importance.

This application of the RBV to the taxonomy shows RBV's value in helping to understand transnational technology management and opens up another avenue for future research and theory development. It provides more conceptual clarity with respect to strategic importance, and also has the advantage of being theoretically linked to RDT and the Vroom-Yetton model.

Although the suggestion here is to pursue further research, it should be borne in mind that this task will have significant challenges. The definition and empirical measurement of value and uniqueness are tasks which RBV theorists have not yet accomplished in an entirely satisfactory manner. Any progress on it through studies of extra-national technology units could provide a contribution to the broader enterprise being pursued by RBV theorists and empiricists.

Turning to another area of theoretical concern, in recent years there has been a movement towards developing strategic approaches to technology management and to integrating technology strategy with the strategy of the firm (Chester, 1994; Kenney and Florida, 1994; Mitchell, 1992; Pearson, Brockhoff and von Boehmer, 1993; Ransley and Rogers, 1994; Rhyne and Teagarden, 1995; Schilling, 1998). Evidence indicates that such integration is achievable and that it contributes to firm performance, at least in technology-driven industries (Dussauge, Hart and Ramanantsoa, 1992). This paper has contributed to this larger movement by showing that a theory of strategy, the RBV, is applicable to transnational technology management in an explicit way that can be drawn out into implications for management.

There have also been calls to make more use of organizational theory and organizational behavior in the study of technology management and international business. Cusumano and Elenkov (1994) propose that more effective integration of the management and strategy literatures will enable us to understand international technology management better. Doz and Prahalad (1991) propose the application of more organization theory in the study of

diversified multinational firms. This paper is very much in the spirit of those proposals in its linking of the RBV, RDT and the Vroom-Yetton model in the understanding of transnational technology management.

IMPLICATIONS FOR MANAGERS

In the introduction to this paper the attempts of managers to solve control problems using authoritarian approaches and/or increased communication were mentioned and their limitations alluded to. Now that our theoretical analysis is complete we can better understand those limitations.

The propositions above suggest that attempts to solve control issues using authoritarian approaches are more likely to be successful with extra-national units of low strategic importance than with units of high strategic importance. Success with autocratic modes in some quarters may partially explain the tendency to try and apply them in all situations, even when they are inappropriate.

Our discussion of the costs of not using inclusive management with extra-national units of high strategic importance has emphasized the costs of failing to mobilize the knowledge, problem framing capabilities, and solution implementation capabilities available in the organization, but there can be other costs as well. Those other costs are suggested by the theoretical connection we have made between strategic importance and power. When powerful, strategically important units are mismanaged there can be serious disruptions to organizational function (Oliver, 1991; Pearce, 1997). Pearce (1997) shows that bargaining activities among powerful actors can be very dysfunctional and can create very high transaction costs. He emphasizes that such dysfunctions are particularly likely to occur when the parties to the bargaining are beset by the kind of factionalism that can occur when they do not share the sense of common purpose that is sustained by consensual decision making. Oliver (1991) provides a more detailed explanation and description of the dysfunctional actions that an organization or an organizational unit might take in response to authoritarian pressures from outside. Oliver's principal categories of responses are acquiescence, compromise, avoidance, defiance and manipulation. She proposes that the likelihood that a unit will resist such outside pressures will be a function of its power. Powerful units have considerable capacity for destructive countervailing activity. Rowley (1997) develops this theme even further. It follows that an extra-national technology unit will be more able to resist headquarters and engage in defiance and manipulation when it (the extra-national unit) has high power in the organization. This can be put in the form of two propositions.

Proposition 12: Extra-national technology units of high strategic importance are more likely to respond to unwanted authoritarian influence attempts from headquarters with defiance and manipulation than are extra-national units of low strategic importance.

Proposition 13: Extra-national technology units of low strategic importance are more likely to respond to unwanted authoritarian influence attempts from headquarters with acquiescence and compromise than are extra-national units of high strategic importance.

This discussion of the countervailing power of strategically important extra-national technology units provides a point of contact between the theoretical developments in this paper and another very important body of theory, transaction cost economics (Williamson, 1975, 1985). The Vroom-Yetton model is an attempt to prescribe ways to make decisions more efficiently and effectively. One of its basic assumptions is that inclusive decision making is more expensive (cost of participant's time) than is consultative decision making, and consultative is more expensive than autocratic (independent of the issue of the quality of the decision). The Vroom-Yetton model recommends the use of the least expensive decision making mode that is able to deliver the required level of decision quality. If we take the decision making activity to be a transaction, we see that the Vroom-Yetton model is fundamentally about transaction costs and that an underlying theme in the theoretical developments in this paper is the tradeoff between transaction costs and decision quality. For example, it is prescribed that autocratic methods (low transaction costs) are most effective when the extra-national units involved have little to contribute to decision (and implementation) quality. Inclusive methods (high transaction costs) are prescribed when the extra-national units involved have a great deal to

contribute to decision and implementation quality, and failure to include them could lead to power struggles that drive transaction costs even higher. This line of reasoning, which might draw on some work that has already been done on transaction costs and transnational technology management (e.g., Crosier, 1998), holds promising theoretical possibilities, but it is beyond the scope of this paper to pursue them.

The other often-mentioned approach to exerting control over overseas technology units, the use of communication, also has its problems, as revealed by the theoretical analysis presented above. Basic communication is simply the exchange of information and can be accomplished electronically or by traditional methods (Nobel and Birkinshaw, 1998). Simple transmission of information may be quite effective when authoritarian and consultative decision making processes are being used but inclusive decision making requires more. As stated in Proposition 6, when complex information is to be provided by multiple, strategically important and unique technology units, collaborative problem framing and commitment to the implementation of the solution have high importance. In such cases, inclusive methods of decision making are prescribed and communication merely for the transmission of information is not enough. This prescription is complicated by indications that creating more communication among the periphery units of a network has much the same effect as shifting resources to the periphery. The communications in the periphery create power in the periphery (Medcof, in press).

This consideration of the shortcomings of autocracy and simple communication as control modes in transnational technology networks is not apparent in the usual advice proffered in the literature. Academic and business writers frequently laud the value of hierarchy and communication but fail to appreciate that the most important reason for loss of control is the shift of resource-based power offshore when strategically important technical resources are located there. The failure of the literature to even mention this possibility, even though power and control are the focus of discussion, suggests a certain myopia on the part of managers and researchers.

This myopia seems, also, to extend to discussions of the decision to locate technology work offshore rather than in the home country. This is an extremely complex decision and it will not be possible to do justice to all of its nuances here. However, we can consider how the propositions developed above fit, broadly, into that decision process.

Most discussions of the decision to locate technology work offshore focus on the strategic business reasons for doing so, and the attendant increments (or decrements) in certain costs associated with the move (Chiesa, 1996a, b; Gassmann and von Zedtwitz, 1998, 1999; Gerybadze and Reger, 1999; Granstrand *et al*., 1992; Kuemmerle, 1997, 1999). The costs considered include such things as salaries for the sophisticated human resources necessary for technical work, tax concessions (or the lack thereof) negotiated with offshore governments, telecommunication costs, and the critical mass in size necessary to justify certain fixed costs. Although some early work gave considerable prominence to such costs, more recently the consensus of opinion has moved to a position well expressed by Gerybadze and Reger (1999: 262), "Dynamic value drivers are more important than cost considerations". The dynamic value drivers are, of course, the strategic imperatives. These include, according to Gerybadze and Reger (1999), the need to have R&D located close to dynamic, forward-driving markets (preferably large) where leading edge innovations are occurring; the need to be close to the emergence of industry standards, both formal and *de facto*, which determine future product function and features; the need to locate R&D technical specialists close to advanced manufacturing facilities and their attendant suppliers; and the need to locate research in milieus with strong, scientific infrastructures. Different firms will give different priorities to these considerations but most who locate technical work overseas are driven by at least one of these imperatives.

The focus on strategic reasons, with costs as a secondary factor, will probably lead to an improved understanding of the decision to locate technology work overseas, but it leaves out the considerations developed in this paper. The literature does not factor into the decision the feasibility of the management approaches that may be required to coordinate the extra-national technology work. Given the acknowledged importance of structure for the success of transnational technology networks, and the many studies indicating that managers consider it important; and the demonstration in this paper that it is theoretically important; it is somewhat surprising that structure has not been identified in

the literature as an important consideration in the deliberations about whether or not to go overseas.

This structural issue is a classic case of the interaction of the social and economic subsystems of the organization. When strategically important resources are located overseas for strategic and efficiency reasons, the social system of the organization is also changed. Potentially countervailing power is placed in the hands of offshore managers, who, unless managed appropriately, may resist and/or subvert the strategic aims of headquarters. That resistance can take the form of protracted, divisive and acrimonious negotiations which can send transaction costs soaring. This paper suggests that inclusive management methods are appropriate but, as the Vroom-Yetton model suggests, inclusive methods involve higher transaction costs than consultative and autocratic methods. Consequently, management teams who locate important resources offshore should expect their transaction costs to rise, no matter how they handle it, thus eroding some, if not all, of the expected efficiencies.

This analysis suggests that when strategically important technical work is located overseas, resource-based power goes with it. Putting strategically important work offshore carries with it the necessity of managing that work with systems that respect the location of the resource-based power. An inclusive method of management is recommended. If a top management team is not prepared to use inclusive methods, it should resist the temptation to place strategically important technical work at extra-national locations.

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