Capital Investment and Network Logic

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Abstract

The industrial network framework is discussed from the perspective of capital investment theory. To our knowledge this is the first time that these academic fields are considered together. The theory and method described allow an understanding of the forward projection of firm networks from a specific time, so providing a new way to examine the dynamics of networks.

Capital investment decisions are usually irreversible and this creates some assurance concerning the future for parts of the business network. The 'shadow' of a past capital investment decision is projected into the future, providing 'net momentum'. Conversely, the 'shadow' of the future acts as a form of 'environmental power' that constrains and enables other firms' interactions in the present. Together these effects have a strong impact on network logic.

Value nets are applied as a formal way of bounding parts of the network so that strategic investment decisions can be formalized. A new definition of net centrality is proposed based on a time perspective. Net time centrality is defined by resource connections between firms, with the connections weighted by the remaining investment period at a specific point in time.

The variations in investment time periods across the actors in a value net will need to be coordinated for each firm to achieve reasonable returns. The firm with the largest investment in future resources is likely to have considerable strategic control within the value net and so is likely to most strongly influence the timing of change by the firms in the net.

Key words: future network, real options, net momentum, net time centrality, environmental power, value net

1. Introduction

Understanding industrial organization with a relationship and network approach requires examination of the connections between firms. When connections are considered the network takes shape as an unbounded expanse of firms stretching spatially and temporally. The network of firms is a dynamic concept, which extends through time: both backwards and forwards.

When resources and activities are considered from a network perspective their joining across firms leads to the concepts of a 'resource constellation' and an 'activity pattern' (Håkansson and Snehota, 1995). The acting together of the resource constellation and activity pattern across the network provides the path for embedding of raw materials into products for final customers. The way the acting together occurs is a reflection of network logic, which has been defined as the organization of resources and activities relative to each other according to ways accepted by enough actors (Håkansson and Snehota, 1995).

However, for firms with new to the world resources, the resource constellation and activity pattern also lead to a 'lock-out effect'. There is no place for a new resource in the current constellation. Likewise new activities may not fit into an activity pattern. In both cases, there must be adjustments to other resources/activities and also likely to inter-firm connections, so that new resources and activities are accepted into the firm network.

In a network setting firm capital investment decisions must be considered in a new way. Investments in new resources and activities must be matched with the capital investments of partner firms, and together these investments must find a place within the network resource constellation and activity pattern. We have found no research paper that integrates the concepts of network and capital investment decisions. Easton and Araujo (1994) describe investment in networks from a theoretical perspective, but do not capture the managerial implications of capital investment in a network.

In this paper we consider the concepts of capital investment decision-making and how investment decisions must be thought of within a network of firms. The remainder of the paper is structured in the following manner. First, we discuss the characteristics of capital investment decisions and in particular the field of 'real options'. Second, we discuss the nature of the network and note that a specific focus is required to integrate investment decisions within a network framework. At this point we introduce the concept of a value net (Möller and Svahn, 2003; Parolini, 1999) and briefly discuss three analytically defined nets that provide different boundaries to managerial decision making. Next, we consider the nature of capital investment decisions in current business nets. We leave discussion of capital investments in the other value nets to future research, as the characteristics of each net is quite different. Finally, we conclude with thoughts for future research and managerial implications.

2. Investment Decisions

Investment decisions are composed of two inter-related parts: financial and capital investment decisions (Northcott, 1992). Financial decisions are concerned with the funding mechanisms and costs of obtaining funds. Capital investment decisions relate to firm resource and activity implementation. While capital and financial elements of the decision are interrelated this paper is not concerned with financial investment.

There are many ways to define capital investment decisions, however the usual elements of these definitions are:
(i) a large financial outlay,
(ii) a revenue stream over a number of future periods,
(iii) an element of risk and uncertainty in predicting revenue, and
(iv) the decision is concerning "the purchase or expansion of equipment or production facilities, or other expenditures which directly impact upon the organization's ability to meet its strategic and operating objectives" (Northcott, 1992).

In the classic capital investment decision, the Net Present Value (NPV) method (Bierman and Smidt, 1992), five groups of assumptions are required. The first assumptions are concerning two project boundaries: a geographical or market space boundary and future time horizon. The second assumptions are concerned with expected revenue, which is broadly determined by assuming a price and level of sales per unit of market space and time. The third set of assumptions are the production, distribution and advertising and selling costs, both fixed and variable, spread through space and time to the boundary assumptions. The fourth set of assumptions concern the cost of monetary funds, literally the risk free cost of funds plus the funding cost to cover risk. The fifth assumption concerns the discount rate applied to future revenue and costs that allows a valuation of these amounts at the present time: the decision time. The fourth and fifth set of assumptions are required to evaluate the benefit versus cost of the investment by returning all revenue and cost amounts to a 'net present value', so that a 'pay-back period' and 'project rate of return' can be given. Typically for well established businesses firms will aim for a rate of return of 25% per annum or more; while for investments in new risky ventures rates of return approaching 200-500% or more are required.

The weaknesses of the NPV method are well documented in the capital investment literature. However, the weaknesses have been partially addressed by the 'Real Options' method of calculating the benefits and costs. The Real Options method enhances the investment decision process by accounting for past and current investment in conjunction with potential future investments. Current thinking is to combine NPV and Real Options methods in assessing capital investment decisions (van Putten and MacMillan, 2004). The weaknesses of the NPV method are reasonably aligned to the four elements of capital investment enumerated by Northcott (1992) (above).

A first issue is that capital investment decisions with large financial outlays, once undertaken, are largely irreversible (Arrow and Fisher, 1974; Pindyck, 1988; Pindyck, 1991). This follows from the heterogeneity of business resources and activities. Rarely can a resource be sold to another firm for its full value. Similarly for activities there is a high degree to which the investment is irreversible. Activities are essentially based on resources and employees; and employees are often highly specialized with detailed education, training and tacit knowledge. In a NPV framework these investments are treated as sunk costs and so are not relevant to the investment decision. However, in a real options method the disinvestment of reversing a strategy is accounted in the investment decision, effectively leading to a momentum to continue the current strategy.

Equally, any capital investment decision which reduces flexibility should be deferred as long as possible and when under consideration should be tested more carefully (Dixit and Pindyck, 1995).

The opportunity to invest in a new market is an option: a right which can be deferred. However, choosing an investment also constrains other possibilities. More specifically, choosing a strategy with minimal possibility for flexibility has greater opportunity cost. Strategies with less possibility for flexibility also commit the firm to follow through at greater cost as the strategy unfolds to environmental shocks. Where capital investments are highly specific the certainty of that future strategic path becomes greater and managers of other firms can rely on this in making decisions.

The second issue is aligned to the uncertainty of revenue and expense streams. In conjunction with the irreversible nature of capital decisions, uncertainty means that there may also be benefits to delaying a capital investment (Corrado, Holly, and Turner, 2002). When revenue and expense streams are uncertain there is a financial incentive to remain on the current strategic course and effectively delay a change of strategy.

The greater is uncertainty, the higher is the benefit to defer investment. Deferring means continuing the current strategy and not changing course until more information is available (Corrado, Holly, and Turner, 2002). During recessions uncertainty increases and strategy changes are minimized, although as asset prices change differentially new options become available.

Under the real option method the greater is uncertainty and the more options that managers have to be flexible with regard to production, the greater is the stability and momentum of the current strategy (Hinrichs, Mußhoff, and Odening, 2008). Likewise, greater information costs mean that an investment is more likely to be deferred (Bellalah, 2001). High levels of environmental uncertainty and high information costs for reducing uncertainty, like the issue of irreversibility, mean that firms investment strategies and strategic direction have a high momentum, effectively making certain aspects of the future highly likely.

The benefits of deferment are evident in the real options decision to maintain a strategy in the face of continuing losses: closing a plant also has costs and realizing those costs in the present period may not be suitable for many reasons (Asplund, 2000). Similarly entering a new market has costs, and so firms will defer the decision to enter a market. The real options method places a greater distance between the capital investment decisions of entering and leaving a market than does a NPV approach (Isik et al., 2003), effectively ensuring greater certainty for managers considering the future of their market space.

The third issue relates to how capital investment decisions for strategic and operational matters are made. Capital investment decisions, especially large strategic ones, are not taken at a point in time; rather strategic investment and disinvestment decisions are taken over periods of time, often in incremental steps. Capital investment decisions are part of a managerial process spread through time, they are not a now-or-never matter, they can be deferred, they can also be undertaken in planned parts as a progression according to changes in the environment. For example the real option method provides investment scenarios for when and how a firm might enter a market relative to other firms (Kong and Kwok, 2007) and even suggests how a manager might reduce irreversible costs when facing a disinvestment scenario (Magis and Sbuelz, 2006). Each of these examples points to active managerial involvement over time in capital investment decisions, but noteworthy is the way decisions are always at a point in time.

The NPV and Real Option method require that continuous x-axis time is divided into episodes and the investment decision is either taken or not in the present period. Under the NPV method the decision is made relative to future benefits and costs, while with the Real Option method the decision is made relative to past and future benefits and costs. Effectively time is removed as a variable by bringing all monetary values to the present and so strategic issues are decided in a relatively static manner, or at best in an incremental way.

The relationship and network framework offers the opportunity to approach strategy in a more dynamic way, especially when the concept of a more assured future is brought to bear from capital investment theory. In the next section we introduce a network perspective of firms making capital investments and indicate some issues requiring more specific approaches if we are to make comments for managers.

3. Network Context and a Partially Assured Future

In this section we describe the nature of a future part of the network as a changed extension of the present. We achieve this by applying three sets of concepts: (i) the Activity, Resource, Actor framework (Håkansson and Snehota, 1995), (ii) the five central elements of interaction from Ford and Håkansson (2006), and (iii) the concept of a partially assured future based on the need for firms with large capital investments to continue their strategy regardless of environmental buffeting.

The network approach to understanding industrial organization relies on the connections between firms (Håkansson, 1982; Håkansson and Snehota, 1995). The resource ties and activity links connect firms within business relationships. These connections allow a firm to make full use of their resources and activity sets so as to achieve self-interest ends through collective economic interaction (Medlin, 2006).

Interaction, in a network of firms, refers to the give and take of information (ie communication) and passing of service/manufacturing resources from one firm to another as embedded product. These interactions occur through time and they are always future focused (Medlin, 2004). This future focus is one element that shapes network logic.

The interactions between the firms in a network can be characterized according to five elements: time, interdependence, jointness, relativity and subjectivity (Ford and Håkansson, 2006). For example, to achieve their firm-interests managers organize 'joint' action, through 'time', and so create different types of 'interdependency' according to the characteristics of the business relationship and the network (cf Möller, Rajala, and Svahn, 2005). The business relationship also creates a form of 'relativity' between the two firms and their positions within the wider network. The position of the firm in the network remains a 'subjective' matter, with all firms in a relative position to each other.

In a theoretical sense the network of firms has no boundary as it extends into the past and future, but practically and subjectively for a group of firms only parts of the past count and some parts of the future are more important. This shows that time, as an element of interaction (Ford and Håkansson, 2006), differentiates the firm network. In fact each of the five elements of business interaction differentiates the network. The degree of interdependence between firms differentiates the network, with some firms more interdependent in a cooperative manner, some independent and some competitively interdependent; and these interdependencies vary over time. Equally the relativity, subjectivity and types of joint action also differentiate the network.

We use the term 'net' to differentiate a specific part of the network. A net has spatial and temporal boundaries imposed according to a manager or researcher's purpose.

The ability of managers to differentiate the firm network is important. The shrinking of the network to a specific net allows managers to undertake problem solving, interaction and future planning. In effect the imposed boundaries of a net allow for different views and means of projecting parts of the network into the future. For example, where a boundary is imposed around an industry one obtains a different perspective of the future compared to a boundary around a number of industries (eg television industry versus convergence of the communication and entertainment industries).

As the managers of the firms in the network undertake interaction now, for a future purpose, they prepare the future resource ties and activity links in each business relationship. This future focus of the interactions partially shapes the logic of the network. Capital investment decisions are taken which are irreversible. Some decisions are very long term (eg oil refinery plant). These long-term capital investments require purchases from supplying firms. For these project supply firms the future is assured until project completion.

Other firms are continuing suppliers of raw materials and products, for embedding in the product/s of the long-term investment firm. For these firms the period of assured future is potentially as long as the life of the assets, although practically the period of certainty will be prescribed by contract lengths. Another consideration is the final demand for products. Variations in consumption of these final products has flow back affects on the output required from the plant. These variations in demand can change the degree to which supplier firms are assured of their future.

The ways in which resources and activities from one firm are set into combinations with those from other firms varies in multiple ways, but the length of assured future is reasonably given by investment life-spans and the irreversible nature of capital investments.

Importantly, there is a dynamic stability about the future network, where the 'shadow' of past decisions is projected into the future, providing some certainty. We use the term 'net momentum' for the assurance of the future given by capital investments to a specific part of the network. Net momentum is further secured where there are expensive start-up costs for a capital investment and large project-ending costs. Net momentum is also greater when there is higher uncertainty concerning the future, making change more risky and expensive. Further, net momentum is greater when there is a larger cost to obtain information to reduce uncertainty, and when investment is in resources and activities which are highly specific.

One can see that when firms secure elements of the future, they also obtain a 'shadow' over the present (Axelrod, 1984). The ability to secure the future leads to greater influence over present interactions, and that effectively leads to greater security about a firm's future position in the network. The shadow of the future is another important element that partially shapes network logic.

The shadow of the future influences the strategic and tactical decisions of other firms in the network. This is especially the case for firms who are connected as suppliers and customers of firms that make large investment commitments into the future, but also for competing firms and their suppliers. Firms who can assure aspects of the future build a type of 'environmental power' (Gaski, 1984; Tedeschi and Bonoma, 1972) that provides influence through the network over the present and future interactions of many other firms. This environmental power forecloses certain types of competition and so provides further security for a firm's strategy. In effect network connections, both through close and competitive relationships, reinforces the irreversibility of a firm making a major capital investment. Environmental power, through firm connections, reinforces net momentum.

Necessarily net momentum is a relative matter, as change and events evidencing change flow through parts of the network at different rates. Different industries experience change at varying rates, so for example the knowledge basis of internet commerce allows for fast changes in technology at relatively low cost. Reversibility of capital investment decisions can be high, start-up and project-ending costs can be low and so there is increased risk for change. Under these situations net momentum is reduced.

However, net momentum and in particular the resource ties and activity links between firms are apparent to managers and provide means to project the network into the future in a differentiated

manner. Two questions now arise. How far into the future is it possible to project a net of firms? What are the means to project the future net of firms?

Value nets offer a specific way to formalize boundary setting with the network. In the next section we elaborate the value net concept as it applies to three different forms of sub-nets, differentiated in time.

4. Value Nets

Lack of boundary presents an interesting problem for managers wanting to apply the network concept. One solution is to 'bound' the network according to the value net of interest to the firm. This requires inclusion of firms with an embedded interest in the final product, as it passes to consumers. The needs of a specific customer or group of customers are the focus of a value net (Möller and Svahn, 2003; Parolini, 1999). When a manager bounds a network on the basis of the co-creating customer the scope of the managerial problem is narrowed and reasonable solutions can be envisaged.

While managers can scope a specific 'value net' to make investment decisions, theory development requires a wider breadth than a single value net. We apply here the conception of different types of value nets (Moller and Rajala, 2007). Analytically and empirically a number of different types of value nets can be identified (Möller, Rajala, and Svahn, 2005; Möller and Svahn, 2003; Möller and Svahn, 2009). Möller and Rajala (2007) provide a schema of three types of nets: current business, business renewal and emerging business nets (see figure 1). These nets vary according to the level of determination, with current business nets being highly determined and emerging business nets having low relative levels of determination.

Figure 1: Business Net Classification Framework
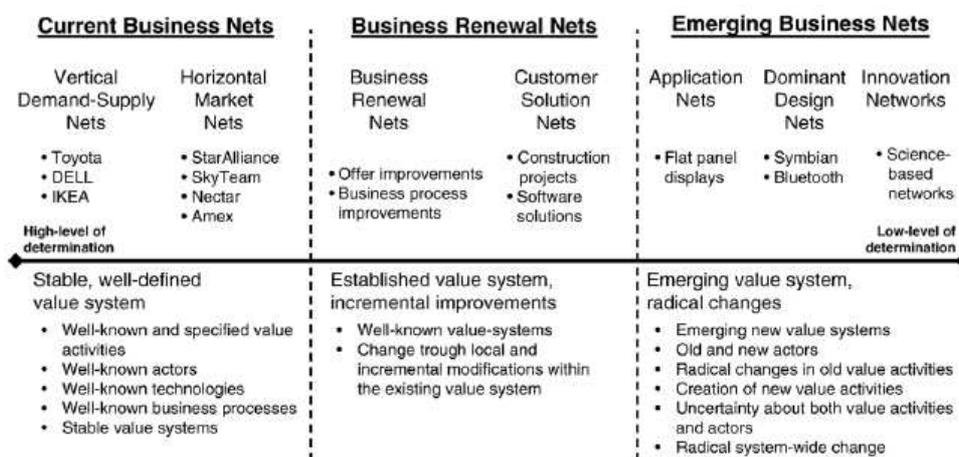
(Source: Möller and Rajala 2007)

In the next section we elaborate the role of capital investment in creating net momentum in current business nets. Given their stability these nets allow elaboration of the future net through examining capital investment. We do not discuss the remaining nets, rather we leave them for future research.

5. Managerial Capital Investment Decisions in Current Business Nets

Current business nets have considerable net momentum, in part following from the high level of determination of these nets. Managers have considerable knowledge and experience concerning the value systems, actors, technologies and business processes within these nets (Moller and Rajala,

2007). The future of these nets is relatively asssured and available for managerial analysis according to resource and activity asset audits. Each resource is built on capital investment decisions with relatively well known life-spans and payback periods. The result is that current business nets have relatively high levels of net momentum.

Within the current business nets will be some firms whose investment in resources is long-term. These firms have taken a strategic stand at some point in the past and have made long-term investments, with pay-back periods for different resources extending from 7 or 8 years to 10 or 15 years or longer. This blend of long-term investments will be matched by control over specific business activities and maintenance of high quality employees to operate the business processes required to extract value from the net.

Important in the positioning of long-term capital investments within a net, is the responsibility of managers to take a strategic stand. At a point in time the managers must make a decision that effectively reduces the firms future flexibility and forces many future investment choices to follow and support that strategic decision. The taking of a stand means being certain that the future is assured and so an investment can achieve payback and profits for future growth.

In taking a stand the managers of firms with long-term investments project forward a part of the network for their firm and the firms' business relationships. In this elongated time-view of the network the firms with long-term investments are central actors. Net time centrality is defined by resource connections between firms, with the connections weighted by the remaining investment period at a specific point in time. The firms are central in the sense that other firms rely on this forward projection of the network in making their own investment decisions.

In figure 2 are shown the investment life-spans for a range of major investments by five firms in a value net. Firm C, with five major investment projects, is an example of a central firm. The centrality is relative to the time dimension, not the position or connections in the network. In this example, firm C is central as it projects the network forward to the greatest degree. Firm C is also shown to have two supplying firms (ie A with one project, B with three projects) and two customer firms (ie E with one project, D with two projects), but this has nothing to do with centrality in a net momentum sense.

Figure 2: Net Time Centrality - Network Projection using Capital Investment Lifespan
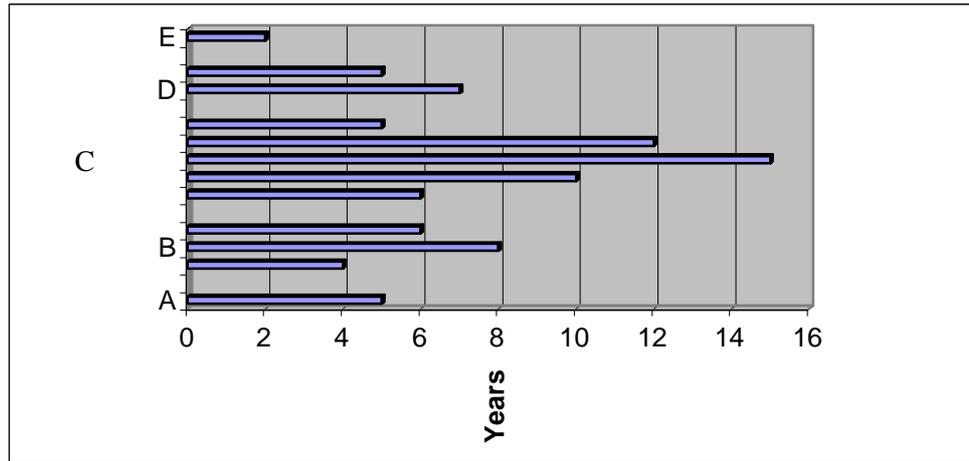
Once the initial strategic investments are made the process of enlarging the scope of the future takes time and is undertaken through a series of investments, each built on the experience of the past and each investment being matched to the strategically important resources of the firm. Thus, central firms of current business nets have taken many years to build up their portfolio of resources and activities to operate their business systems, with each new capital investment decision designed to support their future position in the net, that is their strategic position. Important here is how each decision is part of an incremental and adjusting plan that can be stalled for a period and parts can even be reversed, but overall resources and activities are put in place to ensure a secure investment through some degree of control within the future net.

The central firms will maintain their net position by regulating their supply conditions, they will also attempt to influence demand conditions, but in all cases it is their irreversible investment decisions that assures the elements of the future.

The central firms will also maintain their net position by regulating their associated investments and strategic direction changes. This management of capital investments will be in conjunction with relationship partners; suppliers and customers. Each of these related firms match their resource investments with the central firms, either according to contract length or the depth of their business relationship with a central firm. The distinctions between the central and non-central firms in the net follows from the length of capital investment life into the future. Non-central firms will have capital investments whose shadow extends to a lesser degree into the future.

Necessarily there is an interdependence between the firms in the future net. However, firms that project the net further forward in time can gain greater leverage over the present (cf Axelrod 1984), provided they are supported adequately by other firms. Thus, the role of central firms, in a net momentum sense, is another important element of network logic.

Our discussion now moves to the ways interdependence is created in the future net through resource ties and activity links. Essentially, the ties and links are constructed and supported through interdependent capital investment decisions. When central firms take an investment decision, and make a stand concerning the future net, they provide assurance of the future to suppliers and customers. These firms can now undertake investment for longer periods, and in so doing they support the forward projection of the net by the central firms. As a result, over time the central firms can also be empowered to take even longer term investment decisions.

Only if threatened by a competitor, or drastic environmental changes, will the central firms reverse a major investment decision and move to new technologies, value systems and business processes (eg

the US car industry with the world financial crisis). The central firms effectively offer an assurance of the future simply to ensure their own existence, and that assurance is based on continuing customer demand.

6. Future Research

The role of capital investment in assuring the future of a net deserves further research. This is especially so given the shadow of the future on the present (Axelrod, 1984). Empirical case study research of different value nets, based on an audit of the expected life of capital investments along with resource ties will layout the time extension of the net. Use of historical data for different time points would allow examination of a sequence of future nets, so providing a dynamic perspective on net change. This resource structured view can also be elaborated by qualitative understandings of managers about their investment decisions, and how they are undertaken based on interdependencies between firms.

Dependency has been considered a relative matter at a point in time, and has been measured only by a manager's perceptions of dependency (cf Zhou, Zhuang, and Yip, 2007). Interdependency is recognized as a more useful concept (Ford and Håkansson, 2006; Hallén and Sandstrom, 1991; Lusch and Brown, 1996). However, interdependency varies through time as a result of changes within the firm, relationship and/or network (Ford and Håkansson, 2006), so a more long-term examination is required. The variations in expected life of capital investments across business relationships, and so through the net, should provide an understanding about the nature of interdependency in a dynamic sense.

The audit and mapping of capital investments across a range of nets also offers a way of mapping networks and then examining stability and change in the network. Larger capital investments are less able to be reversed and so the nets where long-term and large resource commitments are made should exhibit greater stability. However, necessarily there must also be some change. The nature of the change and pace of change should exhibit distinctly different patterns according to the character of tied resource investments. The change should be apparent in current relationship interactions in different ways, as present interaction is constrained by the 'shadow' of the future according to the various capital investment ties between firms.

The mapping of capital investments and their connections provides a highly sophisticated tool to researchers interested in 'network pictures' (cf Henneberg, Mouzas, and Naudé, 2006; Mouzas, Henneberg, and Naudé, 2008). With capital investment mapping, including resource ties, it is possible to map networks reasonably objectively across many managers. Mapping capital investments offers a way to partially overcome the inherent subjectivity apparent in current operationalization of the network picture methodology. The analytical methods of real options should allow the inclusion of relative measures of connection stability for each resource tie and activity link within network maps. Further, these maps can be forward projected to provide an new analytical tool for understanding strategy in the network context.

There is the potential to include strategy more formally in network research, when capital investment is considered to shape the future net. The nature of resource ties as made evident by a resource audit that includes investment horizons such as life-span and payback periods should allow new conceptualizations of competitive strategy. For example, one can consider resources tied into competitive groupings and look at their forward projections to compare relative future net positions. There will be variations between intended strategy and projected strategy in a resource tie perspective, depending on the nature of the boundary assumptions.

The importance of economic development in all corners of the globe suggests that considerable future research needs to be undertaken to understand the different dynamics of new industry growth. Combining the network and capital investment frameworks offers considerable research opportunities. The role of capital investment in forming 'emergent nets' will particularly interesting. Old actors are likely to provide capital investments and so project the net into the future. This offers considerable security to new actors. However, one can also imagine that some emergent nets might be composed of different types of capital investment more equally projecting the net forward, so providing a type of cooperative security. These nets may exist inside the shadow of the future provided by other firms, or governments who provide future assurance through regulatory frameworks. This form of influence between nets offers a potential area of future research.

The study of real options until now has been within the finance discipline. This has lead to a mostly static conceptualisation of capital investment decisions. The network framework offers research methods for examining capital investments in a more dynamic way. Within a network framework, where time is conceptualised as episodes and interdependencies are noted, real options research can be extended by applying dynamic modelling and simulation techniques. Real option research can also be extended by inclusion of the resources in partner firms within the calculations informing the capital investment decision.

Each of these areas of research offers means to further our understanding of network logic.

7. Managerial Implications

The managerial implications of combining capital investment and network perspectives are not yet entirely clear. This paper makes only an initial descriptive and partly theoretical foray into the research area. However, there are a number of potential managerial implications.

First, the inclusion of capital investments by closely related firms should be considered when real options techniques are applied to investment decisions. How this is to be undertaken remains an open question. However, from a network perspective recognizing the importance of partner firms in strategic decisions is an obvious addition to the real option method.

Second, conducting an audit of the life of capital investment in all associated firms and mapping out the resource structure projected forward offers managers a number of opportunities. This method of examining firm connection should provide managers with a new understanding of interdependencies and so future strategic options. More precisely the timing of strategic moves should become more clear.

Another benefit of auditing the life of capital investments through a network lens is the opportunity to understand competitor and partner commitments to their respective strategies. When evidence exists of new capital investments, competitive and strategic insight can be gained. Equally, a lack of new investment is also useful evidence. There are many potential reasons for stalling investment, so other information is required, but lack of capital investment is an important indicator of competitor and partner firm strategic intention.

The future is unknown in absolute terms to managers, but almost all managerial thought and action is focused on creating a profitable firm future. In this paper we have shown how networks and capital investment decisions can provide new theoretical and practical methods to help managers with their main concern.

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