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MANAGERIAL DECISION MAKING AND FIRM PERFORMANCE UNDER A RESOURCE-BASED PARADIGM

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A framework is presented that connects managerial decision making to resource building and firm performance. The framework takes a behavioral view of decision making and distinguishes two distinct decision-making processes. First there is the creative conceptualization of new resource configurations that are intended to deliver competitive advantage. Then there is the painstaking development of resources required to implement strategy. We argue that heterogeneity in the resources of rival firms arises from the interplay of these two processes: resource conceptualization and resource development. Heterogeneity spawns performance differences that can be explained ex ante from characteristics of managerial decision-making processes. We illustrate the approach in a simulated decision-making environment representing a highly competitive and dynamically complex industry. Results from repeated simulation experiments conducted with executive and MBA students show vast differences in performance among firms, even when they started with identical resource positions. In a departure from traditional resource-based literature, we explain how these differences stem from path dependent accumulation of resources and spontaneous variety in the way rivals conceptualize resources. Copyright © 2010 John Wiley & Sons, Ltd.

INTRODUCTION

The resource-based literature offers a number of explanations about the conditions under which competitive advantage arises—such as unique resources or the capabilities to build them. But these explanations do not describe the decision-making process that managers follow to develop their resources (Priem and Butler, 2001). Instead, resource-based strategy researchers have embedded decision-making processes into the concepts of dynamic capabilities (Teece, Pisano, and Shuen, 1997; Eisenhardt and Martin, 2000) and dynamic managerial capabilities (Adner and Helfat, 2003; Helfat *et al*., 2007), which are the capabilities with which managers build, integrate, and reconfigure organizational resources and competencies (Teece, 2007) as factors, but not as detailed processes, responsible for competitive advantage.

Without a description of the decision-making processes for developing resources, it is difficult to pinpoint the origins of heterogeneity in firm performance (Foss, 1997; Priem and Butler, 2001) and for practitioners to implement resource-based strategies. So, although resource-based theory explains *ex post* performance, it is less useful *ex ante* for managers seeking to build competitive advantage (Amit and Schoemaker, 1993; Teece *et al*., 1997). Closer investigation of managerial processes will help find the origins of competitive

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advantage (Cockburn, Henderson, and Stern, 2000) and enhance our understanding of 'how' and 'why' some firms perform better than others. Measuring managerial capabilities at more microlevels within a firm is a promising way to provide the firm with guidelines on where and how to improve its capabilities (Ethiraj *et al.*, 2005; Thomke and Kuemmerle, 2002).

Our research question is whether (and how) decision-making processes for managing resources, as a microlevel analysis of managerial capabilities, lead to heterogeneous distribution of resources and subsequent performance differences. This question attempts to extend resource-based literature because the focus of our paper is on decision-making processes acting on homogeneous initial resources that are easily available, which is not the traditional assumption in the resource-based view. To explore this research question, we employ a behavioral simulation experiment that distinguishes two stages of decision making: resource conceptualization and development of resources in a dynamically complex and highly competitive industry with homogeneous resources.

The paper is structured in three parts. First, we describe in more detail the process of managerial decision making for developing resources and its theoretical background. Then we present the results of a study of managerial decision making using behavioral simulation (Morecroft, 1985; Sterman, 1987; Bromiley, 2005; Gist, Hopper, and Daniels, 1998). We believe that behavioral simulation is an appropriate research method to observe the effects of microlevel mechanisms for resource management and to isolate them from organizational and exogenous factors. Specifically, we focus on the resource configuration and development processes tempered by the effect of dynamic complexity. We finish with some implications for strategy research and practice.

THE PROCESS OF MANAGERIAL DECISION MAKING UNDER A RESOURCE-BASED PARADIGM

The implementation of resource-based strategies: expectations or luck

The returns of strategies and firm performance can be highly heterogeneous due to either differences in expectations about the value of the resources available for implementing a strategy (Barney, 1986), or intrinsic characteristics of the resource endowments (Peteraf, 1993). Different expectations about the value of strategies may reflect uncertainty in the competitive environment facing firms or misunderstanding of the processes underlying the strategy (Barney, 1986). Optimistic expectations may lead firms to overestimate a strategy's return potential and pay more for the resource than its value when employed to implement strategy, thereby incurring economic losses. Pessimistic expectations may lead firms to underestimate potential return and, thus, not invest in certain resources that are capable of yielding better returns. Misunderstanding of the processes underlying strategy is likely to result in poor performance. But sometimes such misunderstanding may lead firms to unexpectedly high returns from the good fortune of possessing strategic resources whose anticipated future value was not identified.

Given the serendipity of expectations and resource endowments, Barney (1986, 1991) suggests greater managerial analysis for more accurate insights into the future value of resource-based strategies. However, bounded rationality prevents perfect foresight and may lead managers to entirely different insights and results even when using similar analysis frameworks (Gavetti and Levinthal, 2004). Thus, behavioral characteristics of decision making (reflecting bounded rationality) should be seen as a vital source of heterogeneous performance complementary to unique resources and applicable to a wide range of situations that involve the management of easily obtained and tradeable resources (Alvarez and Busenitz, 2001). This behavioral aspect of the resource-based view is the focus of our paper. In particular we examine how *boundedly rational managers make decisions about resource-based strategies and the effects on firm performance.* For this purpose, we decompose the process of managerial decision making underpinning resource-based strategy in two stages. First is the conceptualization of resources for implementing strategy. Second is the management and development over time of those resources amid dynamic complexity. We now develop these ideas in more depth as the basis for our framework to connect managerial decision making and the resource-based view.

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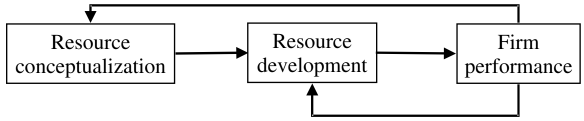

Figure 1. Managerial decision making process under a resource-based paradigm

Resource conceptualization

Firms wishing to obtain above-normal returns must have better foresight than rivals. Differences in expectations about which particular resources to build is a managerial process that we call 'resource conceptualization,' as shown in Figure 1. The initial stage in our framework is to conceptualize the set of resources. This process may create economic rent because managers with heterogeneous resource selection skills discern valuable resources much sooner than, or different than, competitors and thereby acquire such resources at lower cost (Makadok, 2001). To investigate foresight and creativity in resource conceptualization requires research on information and cognition. This broad topic includes the information collected by managers to inform strategy formulation, the cognitive processes they use to filter that information when choosing which resources to acquire (Adner and Helfat, 2003; Bettis and Prahalad, 1995), the skill with which they apply these selection techniques, and their ability to correctly attribute the impact of new resource configurations on firm performance. Foresight[1] in strategy formulation is one aspect of managerial decision making considered key in Barney (1986, 1991), which we assess in this paper.

Resource conceptualization is viewed as a managerial cognitive process (Schwenk, 1984, 1988; Walsh, 1995). Cognition determines the subset of resources perceived to be strategically valuable through attributions about their future effect on firm performance—a forward-looking choice selection (Gavetti and Levinthal, 2000). In this process of narrowing down the relevant resource set, managerial cognition embodies managerial beliefs and mental models that serve as a basis for decision making (Adner and Helfat, 2003). Managers' limited field of vision and value system shape selective perceptions forming the basis for managerial decisions (Adner and Helfat, 2003). Another way to think about selective perceptions is in terms of managers' dominant logic as an information filter or a funnel that selects data deemed relevant to be incorporated into the strategy about the sources of competitive advantage (Bettis and Prahalad, 1995). The development of these perceived to be strategically relevant resources will usually be purposively controlled over time because they will receive managerial attention and managers will attribute the performance of the firm to them. In other words, managers will enact their sources of competitive advantage by selecting a set of resources (from those available to the firm) that they believe are responsible for achieving their vision of the business (Weick, 1979). However, there is no assurance *a priori* that managers' selection of resources is correct. However, if the selection proves to be effective, then managers' investment in building them up will transform them into resources that are costly to imitate due to time compression diseconomies or complex interdependencies (Dierickx and Cool, 1989; Black and Boal, 1994).

Given the complexity of managing a system of interconnected resources and limited rationality, managerial mental representations or knowledge structures of the resource system are not a direct imprint of reality but a result of complex selection, sorting, manipulation, and conversion processes shaped by experience and existing knowledge (Cyert and March, 1992; Lippman and Rumelt, 1982; Mahoney and Pandian, 1992; Walsh, 1995; Mahoney, 1995; Miller and Shamsie, 1996; Eden and Spender, 1998; Senge, 1999; King and Zeithaml, 2001; Moliterno and Wiersema, 2007). In other words, mental models about the complexity existing in the firm and the industry affect what managers see, and two managers with different experience and knowledge

[1] The natural alternative is that firms implement plans with little foresight, then based on market feedback recognize the sources of their advantages ('what works') retrospectively, and finally further develop and exploit what are now proven sources of strength. This view is also known as emergent or evolutionary and stands in contrast to the 'design' approach (Mintzberg, Ahlstrand, and Lampel, 1998; Gavetti and Levinthal, 2000; Gavetti, Levinthal, and Rivkin, 2005; Farjoun 2008). We appreciate this comment from one of our reviewers. Further discussion can be found later in the section 'Closing the feedback loop: issues affecting the relationship between managerial resource management decisions and firm performance.'

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can observe the same industry, or even the same firm, and conceptualize not only the resource system differently but also suggest different relevant resources to achieve competitive advantage.

Resource development

Even though prior expectations about the value of a new strategy may prove to be correct, the uncertainties of implementation must also be overcome as firms acquire resources from strategic factor markets or build them through asset stock accumulation. The implementation of strategies through resource accumulation is a process we call 'resource development,' as shown in Figure 1. This second stage in our framework recognizes behavioral decision-making biases as impediments to the imitability of firms' resources (Amit and Schoemaker, 1993). In contrast to resource conceptualization, resource development affects economic profit only after the acquisition of resources. Confounding effects such as asset interconnectedness and time diseconomies (Dierickx and Cool, 1989) can generate dynamic complexity and make it exceedingly difficult for managers to establish a clear relationship between resources and firm performance. Indeed, Zollo and Winter (2002) suggest that understanding the causal linkages between the management of resources and performance outcomes is at the core of the development of dynamic capabilities. In other words, managers cannot develop resources to influence firm performance until they form appropriate judgments about: (1) the levels of key resources inside and outside their firm; and (2) the causal relationships between these resources and firm performance (Morecroft, 2002). Causal clarity in strategy implementation is a second aspect of managerial decision making we assess in this paper.

Resource development encompasses investment decisions (unplanned or problem-solving decisions) and operating polices (routines) that guide asset stock accumulation. Operating policies, as well as managerial choices and investment decisions, facilitate the accumulation of some resources and capabilities and the decay of others. The result of diverse managerial actions is different rates of accumulation among the resources comprising the firm, which will lead to distinctive firm performance. However, it is not easy to achieve coordination among resource-building policies due to confounding effects such as asset interconnectedness and asset erosion (Dierickx and Cool, 1989; Morecroft, 1985). Thus, appropriate expansion of an existing resource may depend not only on the level of that resource but also on the level of other resources (Thomke and Kuemmerle, 2002).

In this characterization of managerial decision making—either investment decisions or operating policies—under a resource-based paradigm, the processes driving the accumulation of resources are corrective actions intended to close observed gaps between the desired level of the strategically relevant resources and the actual level of these resources. Resource development is represented as purposive adjustment of resources (asset stocks) through goal-seeking information feedback, as described in the system dynamics literature (Sterman, 2000; Morecroft, 2002, 2007), with time constraints derived from resource conditions (Bogner, Mahoney, and Thomas, 1998). The adjustment process is shaped by resource conceptualization and the goal-setting process. People generally search for solutions that are 'good enough' to satisfy their goals (Bromiley, 2005). Goals are determined by the best judgment of managers about the desired amount of a resource given the strategy they intend to implement. Desired resource levels are linked to the process of implementing the strategy in the firm and the level of complexity of managers' conceptualization of the system of resources. In complex multi-resource systems, goal-setting processes are very important to ensure that resources are properly coordinated (Porter, 1996). However, it is probable that different managers interpret this complexity differently and, therefore, they will select diverse goals for a similar resource. As a result, different managers will generate heterogeneity in the level of even similar resources.

CLOSING THE FEEDBACK LOOP: ISSUES AFFECTING THE RELATIONSHIP BETWEEN FIRM PERFORMANCE AND MANAGERIAL RESOURCE MANAGEMENT DECISIONS

The decision-making process proposed is complete when information about firm performance feeds back to modify or reinforces the initial

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conceptualization of the relevant resources for implementing the strategy, as shown in Figure 1. While resource conceptualization naturally precedes resource development,[2] the overall management of resources is evolving and dynamic as firms adapt to environmental contingencies (Simon, Hitt, and Ireland, 2007) and market results, where changes in the resource are stimulated by the lack of achievement of goals (Mahoney, 2005) and are directed toward finding a solution to performance problems by replacing the initial set of resources. On strategic issues, managers must draw conclusions and make commitments based on insufficient, unclear, or conflicting information about the results obtained from their investments (King, 2007). The inevitable blurring of judgment in this situation may prevent managers learning from the results of their decisions and thus hinder the development of their capability to manage resources (King, 2007). The following subsections identify the factors behind such uncertainties and blind spots in more detail.

Internal causal ambiguity

Causal ambiguity is a concept that describes the degree to which decision makers understand the relationships between resource-building actions and firm performance (King, 2007). Causal ambiguity is a cognitive and strategic construct described in many studies (Lippman and Rumelt, 1982; Dierickx and Cool 1989; King and Zeithaml, 2001; Zollo and Winter, 2002; King, 2007) that relate to dynamic complexity in systems of resources. Dynamic complexity exists due to delays between actions and performance responses (Rahmandad, 2008). In the system dynamics literature, the lack of understanding of causal ambiguity has been identified as 'misperceptions of feedback' (Sterman, 1989a, 1989b). This research suggests that decision makers systematically misperceive dynamic environments that include multiple interacting feedback processes and nonlinearities (Diehl and Sterman, 1995; Sterman, 2000). Simulation experiments show that it takes only a few such interactions to exceed decision makers' cognitive limits. Therefore, different people make sense of this complexity in different ways, so causal ambiguity levels typically differ between decision makers and between competitors in an industry (Reed and DeFillippi, 1990), leading to heterogeneous adjustment processes of resource systems. Nonlinear cause-effect relationships existing between internal resources also reduce the coordination between different areas of the organization, decreasing firm performance (King and Zeithaml, 2001; Morecroft, 1985; Amit and Schoemaker, 1993).

External causal ambiguity

Complexity due to the interactions between the forces that shape industry evolution is a common feature in any industry (Gavetti *et al*., 2005; Farjoun, 2008). Environmental contingencies stem from competitive rivalry—how competitors react to strategic actions (Ferrier and Lee, 2002). Chen (1996) suggests that resource similarity determines the degree of competitive rivalry. However behavioral antecedents such as awareness of interfirm relationships and action implications, motivation to act, and capability of taking action, are also important because these antecedents condition managers' responses to competitors' actions. It is also important to recognize that markets and resources are themselves subjective interpretations of reality (Abrahamson and Fombrun, 1994; Fombrum and Zajac, 1987; Porac and Thomas, 1994; Reger and Huff, 1993). Thus, managerial understanding of resource similarity (as a perception of mimicry in the strategic endowments of rival firms) is relevant to resource building since it is the means to identify whether or not firms are following similar strategies (Chen, 1996). While interfirm causal ambiguity raises the barriers to competitive imitation (Lippman and Rumelt, 1982; Barney, 1986, 1991; Dierickx and Cool, 1989; Reed and DeFillippi, 1990), it also makes it difficult to understand the effect of competitors on performance. Therefore, the possibilities of learning from competitive interactions are reduced, increasing competitive rivalry (Porter, 1980).

[2] Managers have different methods to identify the initial set of resources in novel contexts: analogical reasoning (Gavetti *et al*., 2005); strategy as constructing logic (Farjoun, 2008), local incrementalism or experimental strategy (Mintzberg, 1978), and mental experimentation (Farjoun, 2008). In all these methods, the role of managerial cognition is fundamental to explain the resources chosen initially for implementing the strategy. Once the strategy is being implemented, the role of complexity becomes predominant as it reduces the effectiveness of learning from the initial decisions. This section focuses on the latter situation.

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The effect of ambiguity on improving decision making

Decision makers' learning processes are very important in the interconnection between firm performance and resource conceptualization, as shown in Figure 1. Farjoun (2008) suggests that the emergent view of strategy (Mintzberg, 1978), which is based on a process of trial, feedback, and evaluation, does not leverage managerial cognition. If firms follow this process, firm performance will be based on good fortune or luck since competitive advantage will arise by chance (Barney, 1986). However, if managers consciously try to conceive a set of relevant resources and monitor them, it will not be easy to learn about the best set of resource for two reasons. First, if too many resources are changed simultaneously, the ability to understand the results of the strategy is attenuated (Teece *et al*., 1997); and second, if delays between investment decisions and resulting performance exist, managers may attribute the results of the firm to diverse sources not related to the resources they are building. The ability to ascertain cause-effect relationships is confounded due to diversity in interdependence relationships and temporal distance (King, 2007). Therefore, the attribution of the success of strategies may be based on the wrong set of resources perpetuating the inimitability of existing strategies and the erroneous attribution of performance to certain resources.

In other words, managers' perceptions about firm performance and the difficulty of establishing the results of their actions perpetuate the belief that the chosen resources are appropriate and should therefore be further developed over time even though they are not valuable; or managers may discard valuable, rare and nonimitable resources due to incorrect attributions. Therefore, the strategic relevance of a resource is mostly based on the subjective interpretation of resources that influence actual firm performance (Audia and Greve, 2006; Baum *et al*., 2005; Bromiley, 1991; Greve, 1998, 2003a, 2003b; Singh, 1986) rather than on intrinsic characteristics of the resources themselves.

RESEARCH METHODOLOGY

In this section, we present a simulation study to illuminate our framework. The methodology employed follows a behavioral approach (Bromiley, 2005) to test the theoretical model underpinning managerial decision making under the resource-based view of the firm (Barney, 1991). We aim to shed light on the underlying mechanisms by which resources are built and deployed. Through the use of a behavioral simulated decision-making environment (Hough and White, 2003; Gist *et al*., 1998), we are able to examine how managers make decisions about resource building within an ambiguous and dynamically complex resource system.

We should emphasize that our approach deliberately excludes many traditional resource-based sources of superior performance. For example, there are no unique combinations of resources or economies of scale, and the product is undifferentiated. Instead we isolate the effect of the decision-making process to test the following proposition of central importance to the resource-based literature:

Can decision-making processes alone explain why a firm outperforms rivals, without the need to deploy unique resources?

To isolate the effect of decision making on performance, our experimental design involves five key simplifying assumptions:

- First, we restrict the decision-making process to building one resource in the firm.
- Second, this single resource is homogeneous and easily available to all rival firms.
- Third, we know the sources of causal ambiguity facing subjects since we know the interrelationships in the model. We are therefore able to investigate the effect of causal ambiguity on the resource configuration processes.
- Fourth, the simulated firms are strongly interconnected through a single shared resource. So we can reliably establish the degree of dynamic complexity and its effect on resource management processes.
- Fifth, we test the same industry setting repeatedly with different subjects. Therefore, we can infer generalized patterns in resource-building decisions across a number of different subjects.

We acknowledge that this design does not capture some important concepts in the behavioral literature (Bromiley, 2005) such as learning (as subjects participate only once) and innovation (since subjects cannot change the single resource available). Therefore, the feedback process in our framework, between firm performance and resource conceptualization, is not being tested.

Experiment description

For our experiment, we used a popular fisheries simulator called Fish Banks, Ltd. (Meadows, Fiddaman, and Shannon, 2001). The objective is to maximize asset value by the end of the game, where asset value is defined as the salvage value of the fishing fleet plus the accumulated bank balance, which is determined by yearly operating profits from fishing.

There is one tangible and homogeneous resource to be managed by rival firms (the fishing fleet) and the performance of the entire industry is strongly determined by one external dynamically complex and uncertain factor (the fish population), which is shared by all fishing firms. The number of fish in the sea depends on the balance between the reproduction rate and teams' fishing effort (which determines the catch). The reproduction rate is a nonlinear function of fish density. For simplicity and clarity, demand is assumed equal to the catch and price remains constant throughout the game.

The productivity of the only homogeneous resource, the fishing fleet, is subject to causal ambiguity. The catch per ship depends nonlinearly on fish population and is also influenced by random variations in the weather. Teams can buy ships at a fixed price from the shipyard or they can sell to/buy from other teams in private negotiations. There is no productivity difference between teams: all ships catch the same amount of fish.

Additionally, all teams received the same briefing about the performance of firms and causal relations in the game. However, competitors' intentions and strategies were not known, which contributed to interfirm ambiguity. Thus, although the performance of each team depended on the size of its fleet, this simple correlation does not capture the full causal complexity. In addition, it is important to recognize the interconnectedness between resources in a competitive environment.

The simulation was programmed to last a maximum of 10 periods. However, games lasted six periods on average because, in most experiments, the stock of fish in the ocean was depleted by then. All teams participated until the end of the game. Figure 2 summarizes typical dynamic behavior from the game and shows a sudden and rapid collapse of the fish stock following a long period of successful growth in the harvest rate (or catch) and the number of ships.

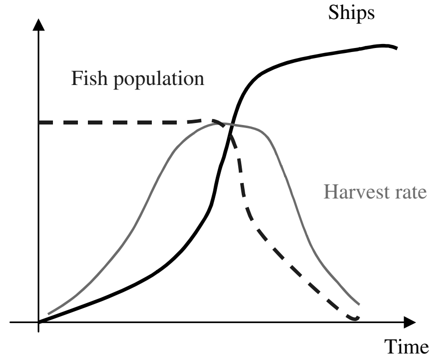

Figure 2. Industry performance in the fishing industry simulation game

Subjects

The Fish Banks experiment involved the participation of approximately 300 students from three different universities taking postgraduate courses in business. We played the simulation game only once in each course, obtaining results from 53 teams. Each team had between five and six people distributed among 10 experiments and totaling more than 320 decisions. The members of each team were self-selected without any specific input from the researchers. Because no team played the simulation game more than once, learning processes could not be inferred that could result in differentials in performance due to learning. We did not measure differences in students' skills related to competitive strategy analysis since they were all well advanced in their programs and each experiment was played with people from the same course.

Teams' decision-making processes during simulation

We can split the decision-making processes of teams according to the two stages of our framework:

1. **Resource configuration.** In order to understand the industry and the diverse causal relationships in this simulated industry, all teams received the same briefing information at the beginning of the game, such as performance measures,

factors affecting productivity, and fleet expansion options. The amount of briefing information was enough to understand the underlying interrelationships between resources. Different management teams may adopt different resource configuration decisions to implement their strategies. Some teams may decide to invest less in ships because they want to balance their resources with the size of the fish population independently of other teams' fleet size decisions. Other teams may invest more in ships than competing teams because they want to dominate the volume of fish captured. Therefore, teams faced a very difficult task environment for discerning the best strategy. We allowed members of teams to discuss their strategies among themselves before making their first decision and requested them to fill out a form stating their strategy at the start of the game. This planning task was very important in shaping subsequent resource development decisions since teams discuss their assumptions about the simulation and possible configurations of resources to implement their strategies and achieve the best performance. The intended strategy therefore depends on each team's cognitive skills to interpret the causal relationships existing in the game, including competitors' likely strategies.

2. **Resource development.** Once teams' members agreed upon their intended strategy, teams made two basic decisions per period: fleet expansion/reduction and fleet allocation. These two decisions parallel basic concepts in the resource-based literature: changes in fleet size correspond to resource accumulation (Dierickx and Cool, 1989), and fleet allocation between two fishing areas where the fish population is located, corresponds to resource allocation to a task (Teece *et al*., 1997; Adner and Helfat, 2003). Since teams shared the fish population, their resource development decisions were strongly interconnected. Therefore, the interpretation of the resulting performance of the fish fleet allocation implies another source of heterogeneity across teams in the usage of the same resource.

The combination of resource configuration activities (as determined by the intended strategy and the presumed best balance of fleet size, competitors' fleet size, and fish population) and resource development (fleet size adjustment and fleet size deployment) affected each team's final performance in this simulated environment.

RESULTS

Firm performance

The performance of the teams is captured by the variable 'total assets.' Total assets are the sum of the bank account balance and the salvage value of the team's fleet (number of ships multiplied by a fixed salvage value per ship). The final value of total assets is the outcome of two related processes: the number (and salvage value) of ships reflects each team's management of the internal resource, while the final level of the bank account captures the effect of the team's ability to manage the allocation of the fleet effectively among the two fisheries (see Appendix 1 for the results of the experiments).

Figure 3 displays the distribution of the teams' performance in terms of fleet size and total industry fleet using standardized data (Keller, 2005). The X-axis represents the fleet size—the accumulated resource at the firm (or team) level. We can observe that most teams are located within one standard deviation (16.82 ships) of the mean (23.08). While this distribution suggests some similarity of fleet size, we have to recognize that the range includes teams with as few as six ships and others with as many as 40 ships. However, the performance for most firms within one standard deviation is positive. The Y-axis reflects the size of the total industry fleet—the accumulated resource at the industry level. We can observe a wide dispersion between industries. Even though most industries are located within one standard deviation, some average 80 ships in total while others have more than 140 ships in total.

Each bubble represents the performance (total assets) for each team. Clear bubbles correspond to teams that obtained negative performance and dark bubbles to teams that obtained positive performance. The size of the bubble indicates the value of total assets at the end of the game. The top right cluster, Quadrant I, contains 14 teams that accumulate a large amount of resources at both the firm and industry level. These teams display poor performance (final average assets of −\$6,434 with a relatively low standard deviation of \$10,366,

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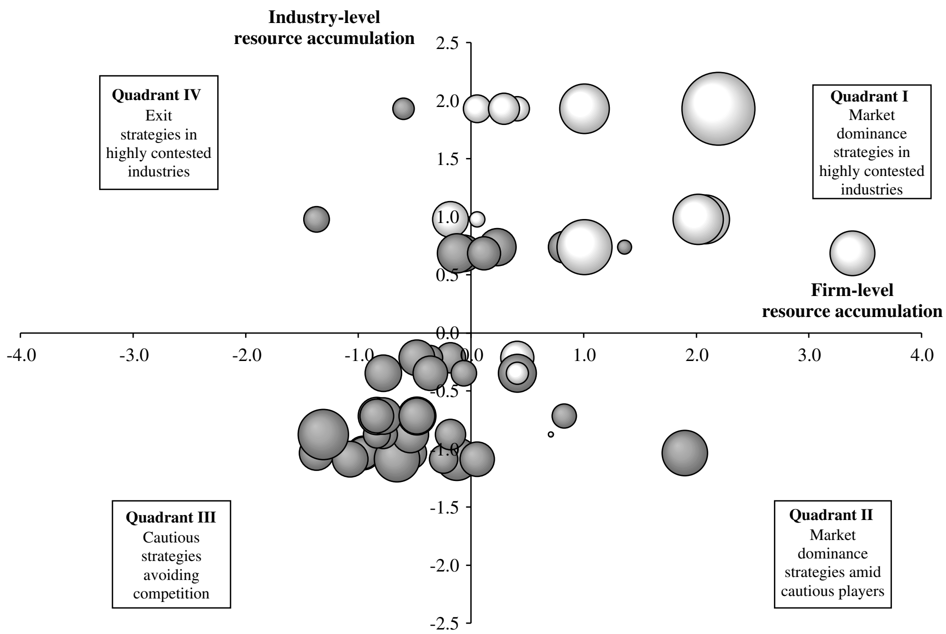

Figure 3. Results from 53 teams participating in the behavioral simulated decision making environment

1.5 times higher than mean). The bottom right cluster, Quadrant II, contains just seven teams that accumulate a large amount of resources in industries with low resource accumulation levels. These teams display mostly positive performance but highly heterogeneous (final average assets of \$2,978 with a standard deviation of \$6,213, more than twice the mean). The bottom left cluster, Quadrant III, contains 26 teams that accumulate a low level of resources in industries with low resource accumulation levels. All teams in this quadrant achieved positive and homogeneous performance (final average assets of \$6,543 with a standard deviation of \$2,602, 0.4 times the average value). Finally, Quadrant IV contains teams that accumulate a low amount of resources at the firm level in industries with high resource accumulation levels. Interestingly, only six teams followed this strategy. They abandoned their resource position in the face of strong competition, which allowed them to obtain better performance (final average assets of \$2,622) than rivals. However, performance was quite variable (standard deviation of \$5,610, more than twice the mean) depending on their exit timing.

Even with identical initial resources (average fleet size=five ships and average total assets=\$2,100), access to similar information and analytical skills, and subject to the same system of resources, different teams neither followed a homogeneous strategy nor achieved an identical performance. Bear in mind, we obtained these contrasting strategies and performances in a relatively simple resource system. Some teams with similar final fleet size achieved polar opposite performances. For example, one of the lowest and one of the highest performing teams (in terms of total assets) both acquired around 60 ships. Other teams obtained similar performance with huge differences in resources, for example, total assets of approximately \$10,000 for teams that had acquired 10, 20, and 55 ships, respectively (see Appendix 1 for a list of results). Even two teams in the same experiment with the same number of ships achieved a 15 percentage difference in performance. The results confirm the difficulty of unequivocally assessing performance from the level of resources even in a simplified simulation game with homogeneous resources. In the following subsections, we analyze the decision-making processes that were followed.

Resource conceptualization

We used qualitative data sources to capture the differences between teams in the first stage of our framework. We asked each team to write its strategy at the beginning of the simulation and

Table 1. Resource configuration logic employed by teams related to strategy

Teams	Resource configuration	Firm performance
Quadrant I	Aggressive teams managed their fleet based on initial expectations of an aggressive competitive environment and inevitable collapse of fish stocks. Their comments illustrated very well their expectations, e.g., 'plenty of fish, aggressive stance'; 'our strategy is to build a huge fleet immediately, pillage the fishery quickly.' They tried proactively to achieve and sustain a preplanned market share by expanding the fleet almost instantaneously before observing the actions of competing teams. So they built their fleet to preempt rival teams without awaiting any outcome information.	Highly negative due to similarities in strategies in the experiments.
Quadrant II	Similar initial expectations as teams in Quadrant I. Their comments illustrated very well their expectations, e.g., 'payback in 2 years, buy boats early'; 'high risk, high return.' They tried proactively to achieve and sustain a preplanned market share, but they did not face strong competitors for market dominance.	Mostly positive due to conservative strategies from competing teams in the experiments.
Quadrant III	Teams believed that positive performance could only be achieved by avoiding head-on competition for contested resources, thereby reducing imitability. They were mostly reactive to the development of other teams' fleet. Some of their comments were: 'we need a long-term view,' 'Too many ships will deplete the ocean as one of the teams was very aggressive' or 'expand continuously and monitor other teams deployment.'	Mostly positive due to conservative strategies in the experiment.
Quadrant IV	They abandoned their positions in highly contested industries (they shared the same industry as teams in Quadrant I), but the timing of the disinvestments was crucial in their performance. Some comments were 'People were biased to market share, to be dominant.'	Mixed due to the timing in disinvesting.

we grouped them according to the location of the teams in each quadrant. Table 1 summarizes the main observed characteristics of each team's resource conceptualization process.

Resource development

To test the second stage of our proposed framework, we analyze the average decision-making processes of the teams in each quadrant. The decision rules in simulation models of human behavior describe decision-making behavior as it is and not as it should optimally be (Sterman, 1987). Therefore, it is difficult to discover and represent the decision rules of actors since they are free to adopt any heuristic and change it over time (Sterman, 1989a, 1989b). Two particular characteristics of the experiment allow us to concentrate on the teams' fleet adjustment decision-making processes. First, teams can manage only one resource to determine their performance. Second, the set of information related to the outcome of their decisions is controlled so we can infer what information is employed in their decision-making processes.

We use a linear decision model to identify differences between the teams' decision rules in terms of the information cues used (Priem and Harrison, 1994; Sterman, 1989b). A team's decision-making process is portrayed as a simple linear weighting of the information available to arrive at a decision on fleet adjustment in terms of the number of ships to be ordered or sold in each period. The relative weights given to each piece of information allow us to infer differences in causal understanding, which are related to the stage of resource conceptualization, between the teams located in each quadrant. Linear decision rules are not intended as a literal statement of how decisions were made. Rather they are considered to be an acceptable simplification and a good representation of managerial intuition employed in decision making (Hogarth and Makridakis, 1981; Remus, 1978; Bowman, 1963). The judgmental decision to adjust fleet size

Table 2. Information used in teams' decision making process related to fleet expansion

Parameter	Quadrant **I**	Quadrant **II**	Quadrant **III**	Quadrant **IV**
Intercept	**13.7619**	**9.2951**	**1.9863**	**6.5448**
Actual fleet (t)	−0.1371	−0.0953	−0.0573	0.1056
Total industry fleet (t-1)	−0.0509	−0.0554	−0.0130	**−0.0639**
Fish sales (t-1)	0.0004	0.0001	**0.0004**	0.0004
Bank account (t)	−0.0001	0.0002	−0.0001	−0.0001
n	73	48	174	29
R^2	0.21	0.15	0.17	0.42
R^2adj.	0.16	0.07	0.15	0.32

Coefficients in bold are significant at 0.01

takes the form:

$$Ships\ ordered\ or\ sold\ (t) = \beta_0 + \beta_1\ x_1 + \beta_2\ x_2 + \beta_3\ x_3 + \beta_4\ x_4.$$

Here x_1 represents an individual team's fleet size this year before adjustment, x_2 is the total industry fleet observed, x_3 is the reported fish sales in the previous period, and x_4 is the balance of the team's bank account at the beginning of the year. The value assigned to each β_i reflects the importance of the information cue in the decision to adjust the fleet. We determined the weights by a regression analysis of teams' fleet adjustment decisions during the game (see Appendix 2 for the summary statistics). We interpret the constant term to be an initial expectation—or goal—for an appropriate fleet size, used as an anchor to inform decision making at the start of the game before any outcome information is available. We assume that a team's subsequent decision-making process follows an anchor and adjustment heuristic (Tversky and Kahneman, 1974; Sterman, 1989a). Anchor and adjustment heuristics are good representations of decision rules since they represent a decision maker's intention to maintain certain resources at a target level and compensate this target from environmental signals. The results of the ordinary least squares estimates are shown in Table 2. We followed the process employed by Rajagopalan and Datta (1996). Durbin-Watson statistics were greater than 1.75 in all quadrants except Quadrant II data, indicating that autocorrelation was not a problem for most of the quadrants. When the residuals were plotted against ships ordered, the analysis indicated absence of heteroskedasticity.

The coefficients showed that the teams in Quadrant I used no information from the environment to manage their fleets during the game. The only significant coefficient in their model is the constant term, which is the highest among all teams. The huge intercept, in comparison with the rest of the teams, implies that these teams had an initial strong propensity to develop big fleets, and they did not adjust their fleets as the game evolved. These teams were dynamically risk takers since they wanted to achieve their desired resource levels in a short period of time, independently of the actions of other teams or information provided.

Teams in Quadrant II also followed a preemptive strategy but they faced competitors that feared a collapse in the fish population since the total resource accumulation at the industry level is lower than for teams in Quadrant I. Their most significant coefficient was the constant term, but it was smaller than teams in Quadrant I. Most of these teams obtained a positive performance during the simulation.

Teams in Quadrant III grew their fleet cautiously, paying attention to the evolution of the fish sales as a proxy for understanding the interconnectedness between their resource level and fish population. Quadrant III teams had the smallest constant term compared to the constant term of other quadrants. The low constant term might reflect the intention of these reactive teams to follow a cautious process to adjust their fleet size by observing the evolution of the fleet's productivity through their fish sales (albeit imperfectly due to random effects and nonlinearity). These teams seemed to manage the expansion of their fleet understanding the effect of their decisions on the system of interconnected resources.

Teams in Quadrant IV tried proactively to avoid losses due to an anticipated collapse of the fish population. As competing teams expanded their fleet, these proactive teams anticipated decline of fish population through the reduction of fish sales and reduced their fleet size (the negative coefficient for the variable 'total industry fleet' is the highest among the three groups of teams and significant). These teams somehow visualized the likely dynamics of the system of resources and acted on their expectations about the collapse of the fishery by reducing their fleets as competing teams expanded very fast. These teams clearly did not follow the pattern shown in Figure 2.

DISCUSSION

To illustrate the process of decision making under a resource-based paradigm and obtain patterns in resource-building processes, we conducted a simulation experiment in which 53 teams of executive and MBA students ran imaginary rival firms facing the same competitive problem with the same initial set of resources. The results of the experiment showed that teams followed different decision-making processes leading to heterogeneous resources and performance, even when subjects had to acquire only one tangible resource and all teams were given access to identical information sources. However, the results also showed that the conceptualization of strategically relevant resources did not always differ in competing firms and was a reason for poor performance in some firms, especially when there are no intrinsically heterogeneous resources (an outcome consistent with the theoretical foundations of the resource-based view).

The distribution of teams' behavior shows two interesting and distinct logics in competitive strategy. On the one hand, some management teams believed that superior profitability could only be achieved by market dominance in a short period of time—a proactive stance and mostly endogenously generated by emphasizing internal strengths (Barney, 1991). They tried to achieve asset mass efficiencies and create scarcity in the system of resources. On the other hand, some management teams believed that positive performance could only be achieved by avoiding competition for resources and observing other teams' behavior—a reactive stance and mostly exogenously generated. These teams tried to address the opportunities and threats in the environment through their resource levels (Barney, 1991). They purposefully reduced imitability as they realized there were interconnections among homogeneous resources.

The results support the importance of managerial foresight and resource management as a source of superior performance (Barney, 1986; Dierickx and Cool, 1989). While all students were equipped with similar analytical tools to determine the best strategy, differences in cognitive capability to understand the complexity in the resource system were determinants of better performance in the same experiment. Those teams that foresaw the future value of a resource configuration obtained the highest performance by creating heterogeneous resource positions in their experiments. Thus, heterogeneity in resources can be identified *ex ante* by analyzing decision-making processes in terms of intended strategies (as proxies for resource conceptualization processes), and differences in information sources employed to build resources due to managerial understanding of the dynamic complexity existing in the system of resources (as proxies for resource management processes).

Research implications

The experimental method used in this paper shows how behavioral simulation models (particularly those that plausibly portray firms as resource accumulation systems) can be used for synthetic longitudinal studies of resource building and competitive advantage among rival firms, which addresses one of the shortcomings in resource-based research (King, 2007; Hough and White, 2003). Cognitive and behavioral differences, when investigated with modeling and simulation, can help explain and anticipate performance differences between competing firms. This behavioral view of resource-based strategy recognizes that what a firm does often comes from complex behavioral processes (Bromiley, 2005). The results obtained from the simulator clearly show the implications of bounded rationality, as sometimes performance is far from optimal. However, other simulations can be used to examine firm performance and industry competitive dynamics under more conventional conditions of rivalry and increasing number of resources with diverse levels of heterogeneity and imitability, a context closer to the traditional resource-based literature.

We observed that a good understanding of the dynamics of the system of resources may enable

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better performance of the firm even in situations that require resource disinvestments. However, a question remains: 'how can we measure managers' understanding of the complexity existing in their business?' Two complementary streams of research arise in the literature on strategic cognition: cognitive processes and cognitive structures (Hodgkinson *et al*., 1999). Cognitive process researchers aim to understand biases and heuristics employed by managers (Tversky and Kaneman, 1974). Cognitive structure researchers develop mapping techniques that seek to capture the structure and content of actors' strategic thought—in terms of beliefs about cause-and-effect relationships. For example, Kunc and Morecroft (2009) propose the use of resource maps as a tool to portray cognitive structures related to resource-based environments, and Gary *et al*. (2008) suggest additional methodologies that employ dynamic simulation to unravel cognitive aspects of managerial decision making. Despite some limitations, cognitive structures can be very important for understanding the possible effects of decision making on performance in systems of interconnected resources. But more multidisciplinary and multimethodology research is also necessary.

Practical implications

Our results reveal the importance of resource-building decision patterns on firm performance, as summarized in Figure 4. Resource-based theory suggests that unique resources are the source of superior performance. In other words, resources that are not highly contested at the industry level—because they are either rare or managers have different expectations of their value—can generate positive performance (Barney, 1986, 1991). Therefore, positive and high performance is associated with creating heterogeneity in accumulated resource positions relative to rivals. Since firms compete mostly in finite environments, an excess of players in an industry segment may imply low performance due to strong rivalry for finite resources. Firms can avoid such finite environments through differentiation: by entering new segments and exploiting similar resources or by renewing the existing resources through innovation. When differentiation is difficult, firms will be better off cooperating and simply recognizing that all rivals are using the same resources.[3] Or, firms can identify idiosyncratic resources to sustain their competitive position as the VRIO (value, rarity, imitability, and organization) criteria (Barney, 2001) suggest.

However, it is very difficult for the situations represented in Figure 4 to occur when there are incentives to maximize market dominance, when limitations on understanding competitors' actions may imply erroneous assumptions about their behavior, or when confounding effects such as asset interconnectedness make it exceedingly difficult for managers to establish a clear relationship between the investment in certain resources and the resulting firm performance. Indeed understanding the causal linkages between the management of resources and performance outcomes is at the core of the development of dynamic capabilities; especially when there may be nonlinear relationships between the amounts of resources accumulated at firm and industry levels and their effect on performance. Hence, management decisions to control the system of resources are a fundamental variable to achieve competitive advantage since they determine the configuration of the strategically relevant resources in dynamically complex environments.

Limitations

Our paper has some limitations. Our teams played the game only once. In practice the development

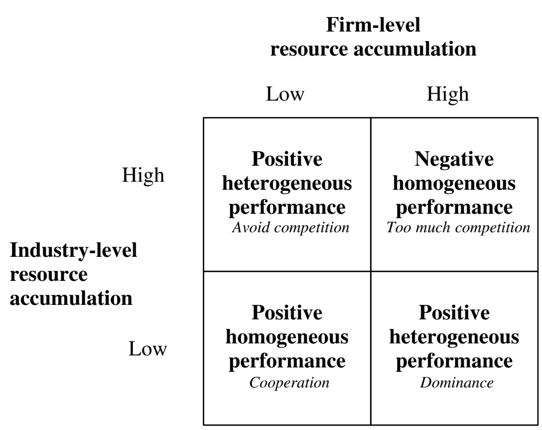

Figure 4. Contextual evaluation of resource accumulation levels

[3] Cooperation will emerge only when managers recognize the consequences of their behavior for the entire system (Axelrod, 1984).

of a new capability proceeds through an iterative process, where 'online' trials of techniques alternate with additional search for alternatives, and teams reflect on what they have learned from the trials (Helfat and Peteraf, 2003). Unfortunately, in a single game we could not infer whether teams develop a capability to manage their firms efficiently in this specific environment through learning and imitation processes. In this experimental design, initial differences in the human capital and cognition of team members mainly affected the abilities of teams to perform well during the game (Adner and Helfat, 2003). Learning and imitation, key processes in behavioral theory (Bromiley, 2005), may reduce initial heterogeneous capabilities in terms of team cognition leading to homogeneous decision-making processes, which highlights the importance of intrinsically heterogeneous resources to achieve heterogeneous performance.

A second limitation lies in our attempt to test different views of the system of resources.[4] In this experiment, we varied decision makers in order to identify heterogeneous patterns of decision-making processes in a similar context. However, the context employed in the experiment was simple since there was only one resource that could be purposefully managed by the subjects. Thus, the lack of diversity in the context did not provide conclusive evidence of diverse decision processes driving resource management. Experiments that systematically vary attributes of the decision context (such as causal ambiguity and availability of strategic options through an increased set of resources available) could provide more information about the implications of decision processes and strategies in resource systems.

CONCLUSIONS

Dynamic managerial capabilities to identify and reconfigure resources are fundamental to the performance of firms (Adner and Helfat, 2003; Teece *et al*., 1997). The realm of dynamic capabilities is fundamentally based on evolutionary economics with its focus on change rather than static equilibrium (Helfat *et al*., 2007). Resource-based theory explains very well *ex post* performance, but it seems to be less useful *ex ante* for managers seeking to build competitive advantage (Amit and Schoemaker, 1993). Closer investigation of managerial processes can help find opportunities for practitioners to implement resource-based strategies.

We have presented a view of managerial decision-making processes under a resource-based paradigm. These processes involve the creative conceptualization of strategically relevant resources and resource management policies to build those resources. Firm performance stems from the resulting set of strategic resources, but is also contingent on the actions of rivals. In this paper, we focus on one situation: managerial decision making of homogeneous resources that can lead to heterogeneous performance. Therefore, this paper extends the resource-based view of the firm literature by showing that decision-making processes for managing resources (resource conceptualization and resource configuration) can lead to a heterogeneous distribution of resources and subsequent performance differences, even though the initial resources are homogeneous and easily available.[5] We believe that more research on managerial decision making under diverse contexts and types of resources can provide a solid base for a comprehensive behavioral theory of the resource-based view of the firm.

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[4] We appreciate this comment suggested by one of our reviewers.

[5] We appreciate this comment suggested by the associate editor.

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APPENDIX 1 - TEAM PERFORMANCE AT THE END OF THE GAME

Experiment	Team	Total assets	Firms' fleet size	Total industry fleet
1	1	−29,240	60	195
	2	−3,170	30	195
	3	−13,440	40	195
	4	2,610	13	195
	5	−4,170	24	195
	6	−5,280	28	195
2	7	11,550	55	83
	8	5,970	14	83
	9	6,560	7	83
	10	5,710	7	83
	11	6,790	0	83
3	12	7,120	5	81
	13	11,620	12	81
	14	10,180	21	81
	15	6,660	24	81
	16	4,440	19	81
4	17	−1,260	24	159
	18	−12,965	58	159
	19	−7,010	20	159
	20	−13,830	57	159
	21	450	0	159
	22	3,655	0	159
5	23	5,210	20	89
	24	7,450	14	89
	25	4,510	10	89
	26	4,160	9	89
	27	−120	35	89
	28	14,090	1	89
6	29	5,580	37	150
	30	7,780	27	150
	31	1,150	46	150
	32	−16,650	40	150
7	33	2,935	16	114
	34	5,265	20	114
	35	−5,830	30	114
	36	3,430	17	114
	37	2,535	16	114
	38	7,220	15	114
8	39	7,440	22	148
	40	8,590	21	148
	41	6,190	25	148
	42	−10,780	80	148
9	43	7,750	9	95
	44	3,260	37	95
	45	8,120	15	95
	46	7,480	10	95
	47	6,350	9	95
	48	7,230	15	95
10	49	6,671	17	109
	50	8,010	30	109
	51	−2,680	30	109
	52	7,580	10	109
	53	3,756	22	109

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	Total assets (t)	Actual fleet (t)	Total industry fleet (t)
Mean	2,200.60	23.08	122.06
Standard deviation	8,198.11	16.82	37.77
Minimum	−29,240.00	0	81
Maximum	14,090.00	80	195
Count	53.00	53	53

Pearson correlation matrix

	Total assets (t)	Actual fleet (t)	Total industry fleet (t)
Total Assets(t)	1		
Actual Fleet (t)	−0.65	1	
Total industry fleet (t)	−0.65	0.41	1

APPENDIX 2 - TEAMS' DECISIONS

	Ships ordered (t)	Actual fleet (t)	Total industry fleet (t-1)	Fish sales (t-1)	Bank account (t)
Mean	3.00	14.88	79.43	3,431.98	1,028.02
Standard deviation	6.36	13.05	44.90	3,182.06	4,933.06
Count	324	324	324	324.00	324.00

Pearson correlation matrix

	Ships ordered (t)	Actual fleet (t)	Total industry fleet (t-1)	Fish sales (t-1)	Bank account (t)
Ships ordered (t)	1				
Actual fleet (t)	−0.07	1			
Total industry fleet (t-1)	−0.22	0.63	1		
Fish sales (t-1)	0.15	0.49	0.09	1	
Bank account (t)	−0.01	−0.68	−0.40	−0.18	1