

STRATEGIC ACTION AND EXECUTIVE BEHAVIOR:
AN AGENT-BASED SIMULATION

by

BRIAN W. KULIK

A dissertation submitted in partial fulfillment of
the requirements for the degree of

DOCTOR OF PHILOSOPHY

WASHINGTON STATE UNIVERSITY
Graduate Programs in Business Administration

DECEMBER 2006

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the dissertation of BRIAN W. KULIK find it satisfactory and recommend that it be accepted.

Chair

ACKNOWLEDGEMENT

Many thanks are due first to my parents, from whom I learned the value of disciplined work among many, many other things. Thanks of course to my dissertation committee; this work is difficult and compartmentalized; thanks for supporting me and sticking with me through all of the material. Also, thanks very much to Ron Holliday and Joan Dismang, who toiled day after day on daily tasks while I spent day after day obsessed with the completion of this project. This demonstrates that ignorance is not always bliss. I would not have finished this project had it not been for the above individuals.

I would also like to thank the Graduate School at WSU and for their support for six long years of study. Also, many thanks go out to my MS committee in statistics at WSU (Marc Evans, Rich Alldredge, and Hao Zhang); many of the methods, including simulation and the use of S-Plus as well as categorical analysis, were learned and developed from courses taken by these committee members.

Last but not least, I'd like to thank my wunderdog Kiwi – our many walks in between many study and writing sessions kept this material fresh and new.

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Abstract

By BRIAN W. KULIK, Ph. D.
Washington State University
December 2006

Chair: John B. Cullen

Despite its importance, the relationship between an organization and its environment is difficult to study through real-world, empirical analysis because of the ambiguities and complexities involved. This work advances our understanding of how organizations interact with their environments by modeling expected environmental complexities in an multiple agent-based computer simulation. Integrating principles derived from organization theory and computational organization theory, an agent-based simulation rule set is developed, and then extended to the study issues of diversification and CEO compensation, two unresolved areas in strategic management. With regard to diversification, results obtained through various ANOVA tests, difference tests, and multiple regressions found generally that a related diversification strategy was positively associated with profitability, while unrelated diversification was consistently found to be unprofitable, but was related to greater longevity. Furthermore, diversification was found to be a more prevalent strategy in harsher environments, and there

appeared to be a tendency for the most profitable agents to choose a very conservative, related strategy under high-harshness conditions, and a moderate, related strategy under low-harshness conditions. CEO pay results using regression indicated that pay through agency interacts positively with pay through stakeholder performance, while a series of histograms for agents in different environmental extremes indicated that profit-seeking agents moved away from a high-stakeholder proportion and toward a more moderate proportion. Conversely, it was apparently profitable to incorporate a higher proportion of fit-based pay when conditions faced by the agent are more difficult. The implications of the results are discussed in light of the extant literature on diversification and corporate governance.

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CHAPTER 1. INTRODUCTION

The careful interaction between an organization and its environment could mean the difference between the success and failure of a firm. Generally, high-performing firms are thought to have established a proper and efficient interaction with their environments, while low-performing firms are thought to result from environmental misfit. Despite the importance of the environment to organizations, the relationship is difficult to study by analysis of organizations to any degree of precision because of the complexities involved. Specifically, it has been difficult for the literature on organizations and their environments to progress beyond basic, simple prescriptions for managers, such as establishing department-level fit between environmental uncertainty and departmental flexibility, and the idea that organizations enact their environments. When the idea of environmental contingency is considered in the context of two strategic management issues, diversification and executive compensation, environmental contingencies have been hinted at, but real-world studies are still inconclusive with even more basic questions, such as whether related or unrelated diversification is generally the more profitable strategy, or whether an agency-based executive compensation helps or hurts a firm's profitability. The reason, whether in organization theory (OT) or strategic management, may be because of the complexity and the causal ambiguity that prevails in the real world with regard to these fields of study. In particular, no relevant studies control for environmental conditions. In this dissertation, I intend to advance our understanding of how organizations interact with their environments in general, and in the context of diversification and executive compensation, by modeling environmental complexities in a computer simulation. First, drawing on and integrating current theory and research in organization theory and computational organization theory, I develop a rule-based multiple-agent computer simulation of firm behavior for multiple

environmental conditions. Using this simulation as a baseline and varying levels of environmental uncertainty and munificence, I extend the simulation twice to first incorporate corporate diversification strategies, and then to model executive compensation.

This study is expected to contribute to extant theory in several fields in the following ways. First, with the baseline simulation results, it extends contingency theory at the organizational level of analysis by identifying predictors of profitability and longevity in different environmental extremes; second, it advances computational organization theory (COT) by combining OT perspectives into a single, necessarily complex simulation model, while also demonstrating the simulation's usefulness toward the fields of OT and strategic management; third, it contributes to research on diversification in both answering a number of basic outstanding questions that has heretofore seen conflicting results in real-world analyses, and it adds to the field a contingency theory of diversification; fourth, it contributes to the field of corporate governance by developing a contingency theory of executive compensation. The central purpose of this work, however, is to offer an extension of contingency theory itself: contingency theory states that there is no best way of organizing (Lawrence & Lorsh, 1967); this work claims that there are also no best ways of diversifying or compensating an organization's executives.

This dissertation is organized as follows. First, I discuss perspectives in the literature on organization-environment interaction with an emphasis on concluding principles and their limitations. Second, I review the literatures on diversification and executive behavior and determine how a computer simulation's strengths might fit with weaknesses in each field's extant empirical and theoretical research. Third, I review the literature in computational organizational theory to determine what specific set of tools might be applied to the design of the

simulation model. Fourth, I integrate the tenets of the bodies of organization-environment interaction and the modern tools used in simulating organizations, to develop three sets of algorithms: baseline, diversification extension, and executive compensation. Fifth, methodology is described and results are analysed. Finally, I discuss the results while developing a series of hypotheses, and conclude with some final remarks as to the significance of this study and its future direction.

CHAPTER 2. LITRATURE, PART I: ORGANIZATIONS AND THEIR ENVIRONMENTS

At a minimum, any reasonable multi-agent simulation of organizations must be constructed from how we know organizations to act and function at the organizational level of analysis. In this section, I explore the wealth of literature in organization theory (OT) to answer the question, “What does OT have to say about computational organization theory?” and more specifically, “What does OT have to say about the simulation of organizations in their environments?” The literature review in this section, summarized in Tables I and IV, provides surprisingly narrow direction toward how the simulation of organizations might be carried out. Basically, the OT (and some strategic management) literature argues for the representation of organizations as autonomous agents which move and otherwise make decisions based on a scan of nearby organizations on a resource landscape. Rather than build a simulation model based on one or several organizational theories, the literature suggests that organizations, being unavoidably complex, are better simulated using a large number of complementary organization theories. Therefore, the results of this section provide a basis and rationale for a complex simulation of organizations for the purpose of hypothesis generation.

The literature reviews to follow are not complete; rather they have been filtered from a larger set of literature. The literature removed from the discussions below were not overlooked, but intentionally eliminated for reasons of irrelevance toward the construction of a baseline simulation. For example, Hannan & Freeman (1977) was removed from discussion because, while important to the development of the evolutionary perspective on organizations, it was not until Aldrich (1979), who applied a reform-Darwinist approach, that strategic choice was taken into account, and it is Aldrich’s approach that I apply to the computer modeling of organizations

and their environments; Koberg (1987) was rejected for its sub-organizational level of analysis applied such as structure and personnel choices, whereas below, I apply a top-management decision perspective as per Figure 1(b); Molden & Higgins (2004) and similar literature was overlooked because, while it looked at perceived environmental uncertainty, it was considered at only the individual, or dyadic, level of analysis, and may represent a different (and irrelevant) theoretical field altogether; Baum & Oliver (1996) was selected out of the discussion below because it addressed the issue of organizational founding, an issue that is avoided in the simulation developed here for methodological reasons (all organizations are “founded” at program initialization); finally, a number of articles were selected out of the discussion below because they would be more suited toward an extension of the basic, or “baseline” simulation developed here, which only considers the production and sale of a commoditized product that is “manufactured” on the supply of a single resource. Thus, I have focused on the body of literature that has something unavoidably fundamental to say about the environments facing firms, and the firm’s responsive behavior.

Historical Perspective: Prior to 1950

In this section, I proceed more or less chronologically in order to gain an historical perspective of theoretical development in OT. To begin, it may be interesting to observe the initial ignorance of organization-environment interaction in OT. Management research turned to the issue of how organizations interact with their environments only after the scientific management era of the early 20th century, perhaps beginning with Barnard’s (1938) definition of the organization as a coordination of activities, while individuals “stand outside all organizations and have multiple relationships with them” (Barnard, 1938, p. 100). Barnard (1938, p. 98)

understood that “all organizations ... are partial systems, being parts of larger systems, and can only be regarded as in isolation within special limits.” However, as Scott (1995) noted,

“Barnard ... did not attempt to follow up these insights systematically. This pursuit, in my view, has been the most important feature in modern contemporary theory. Attaining a better understanding of the vital role environments play in creating and shaping organizational structures and activities has dominated the agenda of organization theorists since the early 1960s” (p. 44).

Why had such a “systematic approach” been overlooked prior to Barnard (1938)? Perhaps during the era of industrialization, management theorists and practitioners such as Taylor (1911), Ford (Bak, 2003), and the Gilbreths (Wren, 1994; Gilbreth & Gilbreth, 1917) could assume a general condition of environmental munificence, as most manufacturers could more or less casually sell all that they could produce: the more efficient they became, the more they could sell. For example, Frederick Taylor (1911) noted that it was fallacious to think of the shoe industry as having a limited market; the more efficient the shoe manufacturing process could be made (with, for example, the introduction of machinery to the manufacturing process), the lower the subsequent sales price per shoe, and the more shoes could be sold at a lower price, such that “demand for shoes has so increased that there are relatively more men working in the shoe industry now than ever before” (p. 5). Consultants such as Taylor (1911) and manufacturers such as Ford (Bak, 2003) concentrated on improving the efficiency of internal processes while the environment remained more or less munificent, given that manufacturers made something that markets were interested in buying in the first place. However, with the end of World War I in the early 1920s, specific, isolated examples of organizational adaptation to environmental conditions began to emerge as the United States switched its economy from war-time to peace-

time. It was during this period that Chandler (1962) noted one of the first examples of an organization responding to scarcity in the environment: DuPont's executives were eager to keep gunpowder factories running after the end of World War I, so they diversified into products with peacetime demand (chemicals and dyes). At this critical point in the history of American industry, DuPont's executives "discovered" the multidivisional form (M-form) of organizational structure as a means of coping with a diversified set of products. Thus, diversification was the result of responding to changing demands in the environment – scarcity in one part of the environment (wartime products) and relative and increasing munificence in another (peacetime products). Through extensive case study of other companies such as General Motors and Jersey Standard, Chandler (1962) developed a common profile of a firm's lifecycle: First, a firm starts small and is run by its founder, often an "industrial imperialist" who is more concerned with prestige and personal profit than operational efficiency and who often closely controls the firm's decision-making; second, the firm grows large despite its inherent inefficiencies; third, the firm faces a crisis of a shortfall in (environmental) demand or increasing (internal) inefficiency to the point of loss rather than profit; fourth, the firm's founder is unable to fix the organization's problem and departs; fifth, the remaining or newly hired executives, intent on increasing the firm's efficiency in response to the growing threat of bankruptcy, develop a strategy of product diversification to increase revenue and decrease risk of existing low-demand products; finally, the executives reorganize the firm into an M-form (with a central headquarters and semi-autonomous product divisions) to cope with the increased organizational complexity and the need for division managers to take responsibility over their respective divisions. Chandler (1962) summarized this corporate growth model as "structure follows strategy," which clearly involves an element of environmental adaptation (decreasing demand for current product

offerings) as a catalyst for the growth model shortly after the firm's founder leaves (step 4). Thus, Chandler saw organization-environment fit as an essential function of the professional executive that was found absent in the entrepreneur and industrial imperialist.

Bounded Rationality

Simon (1945) saw the specialization of work activities within organizations as a consequence of bounded rationality. In his view, the enormous complexity of understanding the environment within an organization is divided into pieces that are, at the lowest level in an organizational hierarchy, within an individual's cognitive limits of analysis, through a procedural planning process Simon called "constructing the psychological environment of decision" (p. 107). The organization then integrates these separate analyses of individuals upward through the organizational hierarchy in a way that maintains bounded rationality. Thus, at higher levels of the organizational hierarchy, "only the very general aspects of the situation [i.e. the environment] can be given consideration.... Hence, a fundamental problem of administrative theory is to determine how this plexus of decisions should be constructed" (p. 107). Thus, Simon (1945) shed light as to how the executives at Du Pont in Chandler's (1962) case study reached their decision to diversify and reorganize: it was the result of analysis conducted by individuals at lower parts of the hierarchy (and the staff's executives) and then integrated and simplified into something that Du Pont's executives could work with: the divisional structure to meet their strategy of diversification. Simon's view also provides the first justification for simplification in the simulation of organizations, as the simulation need only create a simplified environment for simplified organizations to interact and operate, since at the executive level in real organizations, such a simplified world are all what the executive sees in any case.

Biological Analogies

About the same time that Simon, Cyert and March were criticizing the extant economics literature as an overly-simplified account of managerial and firm behavior, economists were criticizing the viability of biological analogy to describe industry-wide behavior among sociologists. Thus, the application of biological analogy to organizations emerged well before Hannan & Freeman (1977), but before that seminal work, it had been rejected as more confusing than helpful. For example, Penrose (1952), in her reaction to a widely cited work by Boulding (1950), found the life cycle application to organizations lacking in content and consistency with regard to theoretical construction, and in any case our understanding of biological systems was no better than our understanding of organizations so that one side of the analogy failed to illuminate the other. Furthermore, organizations change and develop through the (relatively) conscious will of its members, while an organism's age is hardly a choice, and conversely there are no known "laws" that govern the behavior of organizations.

A second analogy that Penrose (1952) criticized was "viability analysis" which could more descriptively be labeled as organizational Darwinism, and she specifically addressed the ideas put forth by Weick (1969), who observed that firms attempt to make profits in uncertain environments.

"Hence the expected outcome of any action by a firm can only be viewed as a distribution of possible outcomes, and it is argued that while a firm can select those courses of action that have an optimum distribution of outcomes from its point of view, it makes no sense to say that the firm *maximizes* anything, since it is impossible to maximize a distribution.... To survive, a firm must make positive profits. Hence positive profits can be treated as the criterion of natural

selection – the firms that make profits are selected, or “adopted” by the environment, others are rejected and disappear” (Penrose, 1952, p. 810).

Furthermore, according to Alchain (1950), firms evolve in a common industry or as a “species” by imitating each others’ innovations. Penrose (1952) noted that “with intense competition only firms that succeeded in maximizing profits would survive” (p. 811), and under such conditions traditional marginal analysis and “viability analysis” would yield identical results. Yet Darwin himself observed that organisms must compete intensely, as they tend to both reproduce at a geometric rate and yet maintain constant populations. Thus, the biological Darwinian analogy itself suggests that classical economics analysis is sufficient, and in any case one cannot “assume that men act randomly” (p. 812). More importantly with regard to our topic of focus,

“the authors of the viability approach have given us no hint of what they mean by the environment. It is vaguely referred to as an ‘adoptive mechanism’ but in view of the enormous complexity of the interrelationships of the economy, a prediction of the types of organizations that will survive a given change in the environment ... does not seem to me to be an ‘intellectually more modest and realistic approach” (Penrose, 1952, p. 815).

Thus, Penrose saw environments as too complex and ambiguous to be a useful theoretical construct – an argument that Starbuck (1976) continues a quarter century later.

In Penrose’s (1952) criticism of biological analogies to the firm, she simultaneously underscored the growing popularity of such analogies and the limitations of extending economic theory, which is at first glance concerns the interaction of firms with their environments, toward a theory of firm behavior. The task of many organization theorists from 1952 onward, particularly during the theoretical proliferation period of the 1960’s and 1970’s, has been in part

to first overcome Penrose's criticisms of biological analogies, and then to demonstrate how the analogies more aptly apply to behavior in and of firms, and better describes organization-environment interaction, than do traditional economics models.

Social Context

Peter Blau, in his first edition of *Bureaucracy in Modern Society* (1956), compared the findings of two well-known works in a discussion of what he called "social context" and the "study of interconnections between organizational factors and social change" (Blau, 1956, p. 96). The first study was Selznick's case study of the Tennessee Valley Authority (TVA), in which threats from local (grass-roots) conservative groups was dissipated by the absorption of local conservatives into the TVA leadership structure, enabling the TVA to function effectively even in conservative local areas, but resulting in some rather dysfunctional practices that limited the organization's potential for making a positive difference in the economic development of the Tennessee Valley – the mission of the New Deal and the TVA as a part of the New Deal in the first place. The second study, by Lipsett, Trow and Coleman (1956), described the interaction between a newly elected liberal socialist government's cabinet in Saskatchewan and the cabinet's conservative administrators and deputies, which had been retained from the previous administration. The conservative administrators and deputies continued with many of the conservative policies established by the previous government, often convincing the new cabinet members, for example, that there would be too much protest if this or that policy were discontinued or changed. Thus, the previous conservative administration persisted through the change to a socialist government. In contrasting the two case studies, Blau concluded,

“The fact that government policy was modified in a conservative direction in both cases reveals the power of conservative forces in Canadian and American society. In one case, however, conservative pressure was exerted by bureaucracies and its success indicates their strength, while in the other case, conservative pressures were exerted upon the bureaucracy and their success indicates its weakness” (Blau, 1956, pp. 99-100).”

Thus, Blau hinted at the possibility that, if “organizations” were to replace “bureaucracies” in the above quote (as the work’s third edition in 1986 tended to do), powerful organizations may have an effect on their environments, while weak organizations may be affected by their environments. If extended to for-profit organizations, this proposition of Blau’s could be considered an early form of institutional theory, and suggests that those organizations with high power (say, those exhibiting performance and/or controlling market share) change those organizations with low power, and that the direction of cause and effect in organization-government and organization-society interaction depends on which entity holds more power.

Theoretical Proliferation: 1960s and 1970s

As indicated by Scott (1995) and quoted above, significant theoretical advances were made during this period toward the ways in which environments are expected to interact with organizations. The discussion in this section continues chronologically as it traces the development of eight dominant organizational theories: institutional theory, behavioral decision theory, enactment, strategic management, resource dependence, contingency theory, transaction cost economics, and population ecology. For the purpose of clarity, I have summarized these eight perspectives, with citations from seminal authors and those that will be discussed below, in

Table II. The discussion below avoids specific, detailed discussion of the theoretical development and instead focuses on what each theory has to say about the interaction between organizations and their environments.

A Theory of Institutions

Selznick (1957), writing well before his time, anticipated much of the theoretical development to follow. With regard to environments and organizations, he noted that, much like individuals in groups, organizations take on roles, where “role” was defined as “a way of behaving associated with a defined position in a social system” (p. 82). Thus, organizations find a way to fit into the societies they are embedded in by the activity of role-taking, which is a form of adaptation. If an organization develops a “distinctive competence” (p. 87) in its role, that role may become institutionalized. Thus, “roles are shaped by capability” (p. 88) and provide an organization a way to become a fixture in society – i.e. to institutionalize. Selznick (1957) thus provides a picture of the life cycle of an organization, at least one that eventually institutionalizes: (1) the organization forms around some distinctive competence; (2) the distinctive competence shapes the role taken in its environment (society) by the organization; (3) that role, when performed competently, results in the institutionalization of that organization. In short, any organization adapts and grows in ways constrained, often defined, by its interaction between its internal competence and its external environment. Therefore, the process of role taking, and institutionalization, can be represented in a simulation by an agent that moves around on a competitive landscape until it finds a fit with its internal competencies and with organizations it transacts with. After some time and a number of “moves,” it stops moving when it finds a profitable “fit” and emerges as a sedentary “institution” on a particular part of the landscape.

March and Simon

March and Simon (1958) was later described by the authors (March & Simon, 1993) as a treatise on organizational decision making mostly at the micro and meso levels. They justified the approach they took to the study of organizations in the 1958 edition by explaining that the 1958 edition

“is, for the most part, written from the perspective of understanding how an organization responds to changes in its (exogenous) environment. Studies of the external environment are essential in that view, but they can be carried out without simultaneous attention to studies of decision-making, and vice-versa. A proper division of labor” (Simon and March, 1993, p. 17).

This is an interesting argument, as it states that the study of organizations can be divided up into the study of within organizations and the study of organizations in their environments. While March and Simon (1958) and later Cyert and March (1963) took largely the former approach, this work proposes the latter approach.

Nevertheless, March and Simon (1958) did identify an environmental variable (considered briefly but discarded by Thompson, 1967) that was removed from March and Simon (1993): hostile versus benign environments. This variable is perhaps better described in Cyert and March (1963) as environmental munificence. Cyert & March (1963) noted that firms tend to simplify their environments considerably, as they tend to seek feasibility, rather than (as economists typically assume) optimality of numerous alternatives. Thus, organizational members tend to drastically simplify their environments by ignoring large parts of it on the one hand and applying simplified summaries to parts they pay attention to on the other hand. To handle the problem of cognitive overload from information in the environment, organizations

develop standard operating procedures which entail screening, routing, and filtering rules for environmental information. Consequently, not all individuals receive all information (via routing rules), information that *is* received by organization is simplified (via screening rules), and information received is interpreted with bias by organization members (via filtering rules). The result is that when plans are made in organizations based on such altered information from the environment, their consequence is to “reduce a complex world into a somewhat simpler one” (p. 112). Thus, the organization does not actually adapt to its true environment, but only to an environment that is perceived through routed, screened, and filtered information, and its own experience. The rationale for this perspective of adaptive rationality, rather than the perspective of omniscient rationality as put forth by economists, is that short-run environmental changes (i.e. an unstable environment) must be taken into account when the firm makes a decision, as Cyert & March (1963) recognized that long-run experience interacts with short-run firm behavior.

A second notion that Cyert & March (1963) proposed was the idea of environmental munificence. They theorized that, as an organization’s environmental munificence increases, so does an organization’s “accumulation of resources in excess of demand” (p. 36), and conversely as environmental munificence decreases,

“organizational slack becomes a cushion... [which] permits firms to survive in the face of adversity. Under the pressure of a failure (or impending failure) to meet some set of demands on the coalition, the organization discovers some previously unrecognized opportunities for increasing the total resources available” (p. 38).

This perspective is notably different from economics models of the time, which assumed zero organizational slack. Thus, Cyert & March (1963) introduced two important environmental variables – munificence and uncertainty – in the context of how organizations realistically make

decisions in dealing with these variables. These ideas are central to any simulation of organizations, and since their theory was developed into a computer simulation of their own, I will have much more to say about this important work in later sections. Note also that while Simon (1945), discussed above, provided a rationale for a simplified *organization* in computer modeling, Cyert & March (1963) instead provide a rationale for a simplified *environment*.

Contingency Theories

Burns & Stalker (1961) extended the idea that organizations interact with their environments by categorizing two rational responses that organizations develop toward two different types of environments. In the first type of environment, characterized by stability, individuals within the organization develop a mechanistic management system, characterized by a bureaucratized, functional structure, a focus on the “technical improvement of means,” (p. 119), the precise definition of work tasks, vertical communication rather than horizontal, the assumption of omniscience imputed to the head of the organization, and other individual-level behavior. In the second type of environment, characterized by instability, individuals develop an organic management system as characterized by a network structure of control, the spread of commitment beyond technical concerns, imprecise definition of work tasks, horizontal communication rather than vertical, the absence of the assumption of omniscience imputed to the leader, etc. Furthermore, these two organizational forms represent extreme ends of a continuous scale, and any organization may contain elements of both types. Their point was to emphasize that there is no “one best way” of organizing, but in some situations a mechanistic management system may be appropriate (i.e. for a stable environment). Organization-environment fit was seen as a determinant of the specific level of uncertainty in a specific environment. Burns &

Stalker (1961), and the approach of contingency theory in general, are helpful in the construction of a computer simulation strategy in studying the interaction of firms with their environments. Specifically, different environments can be programmed to systematically vary along dimensions of stability and any other variables that might be identified by subsequent literature. Outcomes would be the observation of differences in the characteristics of successful organizations across the different environments. Thus, much of the discussion of the literature to follow concerns the identification of what those characteristics of organizations, and dimensions of the environment, a computer simulation should contain.

Thompson (1967) and Lawrence & Lorsch (1967) more or less simultaneously proposed a contingency theory wherein sub-organizational elements adapt their structures to cope most efficiently with the level of environmental uncertainty it faces. Thompson (1967) theorized that under conditions of rationality, an organization's technical core, being buffered from the external environment (termed a "task" environment and containing an organization's customers, suppliers, competitors, and regulatory groups), operated under conditions of relative uncertainty, while boundary-spanning segments of the organization (those departments in the organization that interact with and observe the environment) must adjust to the level of uncertainty in the (task) environment in terms of degree of heterogeneity and degree of stability. Using a 2-by-2 contingency table for perhaps the first time in management theory, Thompson (1967) identified four types of task environments: (1) homogenous and stable environments wherein organizations are constrained in action, centralized, and simple in structure; (2) homogeneous and shifting (uncertain) environments wherein organizations are constrained in action, but decentralized with geographic divisions and planned responses to organizational problems; (3) heterogeneous and stable wherein organizations are expected to be centralized and more constrained, but structured

functionally for each homogeneous (core) segment and divisionally otherwise; (4) heterogeneous and uncertain environments wherein organizations are expected to experience more constraints, but be organized functionally with planned responses. Thus, Thompson identified four distinct types of task environments based on two variables: degree of uncertainty and heterogeneity. He concluded that “there is no one right way to structure all complex organizations. Yet the variations are not random” (Thompson, 2003 [1967], p. 74). The structures are, instead, contingent on task environment characteristics. With regard to the application of these ideas to a computer simulation, Thompson’s application of the task environment, rather than the larger environment that includes government and society, toward his hypothesis development suggests that a baseline computer simulation that includes only task environments is sufficient. The more general environment could be added to the baseline simulation as an application area of study.

Lawrence and Lorsch (1967) studied the characteristics of individuals within companies at three different industries. Each industry was chosen for variance across environmental characteristics of uncertainty (consisting of a composite score of three variables: clarity of information, uncertainty of causal relationships, and time span of definitive feedback), and uncertainty was scored in each industry for three types of knowledge: scientific, market, and techno-economic. Each type of knowledge in turn indicated the degree of uncertainty faced by the research, sales, and production departments. The plastics industry, their first environment studied, indicated a high variance in uncertainty across each type of knowledge, with scientific knowledge scoring highest in uncertainty and techno-economic scoring lowest. They observed that, in general for six plastics companies studied, the research departments (applied and fundamental) were less formally structured (flatter hierarchically with work conducted under less formalized procedures) than the production departments. Two other variables, interpersonal

orientation (from relationship-oriented to task-oriented) and time orientation were found to be a function of the nature of the work in each department rather than contingent on environmental uncertainty. With regard to performance, the authors found that those organizations with fewer deviations of fit across environments exhibited higher performance:

“the achievement of a degree of differentiation consistent with the requirements of the environment is related to the organization’s ability to cope effectively with its environment” (Lawrence and Lorsch, 1967, p. 43).

Clearly, “coping effectively” implied more than environmental uncertainty, and the authors assumed that their theoretical predictions with regard to time orientation and interpersonal orientation were accurate even though their own data suggested internal rather than external contingencies as more salient. The authors compared their results obtained from the plastics industry to results from the container and packaged food industries. The container industry was observed to be more certain than the other two industries, with the packaged food industry considered moderately uncertain, although uncertainty scores on the techno-economic dimension were observed to be about the same for all three industries, and market uncertainty higher for the food industry than the plastics industry. However, the plastics industry exhibited the greatest range of uncertainty across market, science, and techno-economic uncertainty, and the container exhibited the shortest range. This implied that the container industry companies’ departments should be less differentiated in terms of formality of structure (and should generally exhibit more formal structures for all departments), companies in the food packaging industry should exhibit moderate differentiation, and plastics companies the most. Upon interpreting their industry data, the authors concluded that “it seems quite apparent from these data that the container environment required less differentiation of organizational parts than either plastics or foods,

while foods required less than plastics,” but in comparing company-level data to environmental conditions, the authors turned to the need for integration of differentiated departments: those companies operating in environments with high range of uncertainty across departments (plastics industry) were observed to require an effective integrating department for high performance, while the converse was observed for companies operating in low-range uncertainty environments (container industry): low-performers were those companies that included a formal integrating unit (unnecessary for more certain environments). The Lawrence and Lorsch (1967) study, while not especially rigorous in its statistical methodology, raised important issues with regard to environmental variables that might be considered when managers decide how their organizations should organize. In particular, their observation that range of uncertainty across types of uncertainty sub-variables matters at least as much as average environmental uncertainty.

Lawrence and Lorsch (1967) and Thompson (1967) were inconsistent in that Thompson (1967) considered an organization’s core as somewhat independent of environmental conditions, while Lawrence and Lorsch (1967) did not distinguish between core and boundary-spanning departments, instead assuming that all organizational divisions interacted with the environment in a different way; also, Lawrence and Lorsch (1967) restricted their considerations to only functionally-organized organizations, while Thompson (1967) considered such a structure to be contingent and therefore variable. However, despite also differing in methodological approach, variable identification, and theoretical development, both works concluded that organizing was contingent on environmental conditions. In terms of variables considered, Thompson took into account environmental heterogeneity (while Lawrence and Lorsch did not) while Lawrence and Lorsch took into account different types of uncertainty and heterogeneity across these different types (while Thompson did not). Taken together, the environment is seen to vary according to

the characteristics of an organization's competitors, suppliers, and customers as well as the range and average uncertainty faced by each basic organizational subgroup. This is an interesting, non-intuitive observation. For example, suppose an organization consists of three sub-departments, as in my proposed computer simulation to follow: purchasing, production, and sales. Two of these, purchasing and sales, interact with the environment. The purchasing department's level of uncertainty depends on the uncertainty of resources, while the sales department's level of uncertainty depends on demand for the firm's products. If the uncertainties each department faces are both high, integration and cross-department coordination will be easier and more efficient because the structures and routines of both departments will be similar: informal, low-height hierarchies that respond organically. Extra efforts to promote coordination would be needlessly costly. However, if one of the departments faces a stable environment while the other faces an uncertain environment, inefficiencies in coordination would result and extra efforts to promote coordination would be well spent. The more costly situation occurs when variance of uncertainty across all environments is high, rather than in a situation where all environmental uncertainties are high. It would be difficult to account for this effect in a baseline simulation, where structural fit is assumed. One approach could be to simply assign a proportionate coordination cost to simulated agents operating in environments of varying uncertainty.

Enactment

Karl Weick (1969) took a unique, bottom-up process-based approach to the activity of "organizing" in which successful, or environmentally "selected," organizations enact their environments, select out certain information from that environment, and retain the experience for future organizing action, enactment, and selection. Enaction was seen as more than mere

perception of environmental conditions: “We have purposely labeled the organizational equivalent of variation *enactment* to emphasize that managers construct, rearrange, single out, and demolish many ‘objective’ features of their surroundings” (Weick, 1969, p. 64). The idea of enactment implies that a key environmental variable that must be considered is the organization itself, especially if the organization is large in size. In terms of Thompson’s task environment, then, Weick implies that (simulated) organizations somehow change their customers, suppliers, and competitors before and during the process of trying to understand them, and this effort to change and then scan other organizations in the environment is a function of characteristics of the organization and its leadership.

Further Work on Environmental Variables

Expanding on Thompson (1967) and Lawrence and Lorsch (1967), among others, Hickson, Hinings, Lee, Schneck, & Pennings (1971) developed a useful contingency theory of intraorganizational power. Defining power as “the determination of the behavior of one social unity by another” (Hickson, Hinings et al., 1971, p. 215), the authors predicted that those organizational sub-units that are most capable of coping with the most environmental uncertainty will have the most power. When combined with Lawrence and Lorsch’s (1967) observation that different subunits can face differential levels of uncertainty, (Hickson et al., 1971) imply that any distributed resources, such as financial budgets, will be distributed first to the subunit with the most power, which is the subunit which copes with the most uncertainty (assuming that the subunit’s work is critical and nonsubstitutable in the first place). Power asymmetry could be simulated by allowing the resource needs of the subgroup facing the highest level of uncertainty to be met first.

Duncan (1972) studied 22 decision units in 3 organizations in order to identify dimensions of the environment that have an impact on decision-making in these units. Through structured interviews, Duncan (1972) identified 5 components of the external environment: customers, suppliers, competitors, socio-politics, and technology. Duncan then identified two independent scales based on the work of previous authors (Terreberry, 1968; Thompson, 1967; Emery & Trist, 1965): simple-complex (few versus many factors and decision components in the decision unit's environment), and static-dynamic (extent to which environmental factors stay the same versus differ per time period). Developing a contingency table based on these two scales, Duncan then created a progression of the level of uncertainty from low to high: simple-static (least uncertain), complex-static, simple-dynamic, and complex-dynamic (most uncertain), and empirically verified three distinct environments (there was no significant difference between complex-static and simple-dynamic environments). An important aspect of this work was the use of perceived uncertainty. Due to bounded rationality on the function of environmental scanning, "actual" uncertainty may include factors that had been ignored by the organization's members, while "enacted" uncertainty (Weick, 1969) may not be measurable, or relevant, in a cross-sectional study such as Duncan's. For example, Duncan (1972) observed through analysis of variance (ANOVA) results that about 70% of the variance across environmental uncertainties was due to variance across the static-dynamic dimension, while only 30% of the variance was due to the complex-simple dimension; an inquiry into enactment would have asked how much of each dimension had first been enacted – did the organization members understand the static-dynamic dimension as more important and then impute this importance on their perception of the environment? To a certain extent, this additional depth added by the idea of an enactment process is irrelevant with regard to decision-making in organizations, as it is perception of the

environment, independent of the perception's origin, that contributes to the decision of an organizational member. Stated more directly, it is the *perception* of environmental uncertainty, not enactment or actual environmental uncertainty *per se*, that is an important measure in decision making in organizations, and it is this dimension that must be modeled by any computer simulation that involves organizational decision making.

A further question that Duncan (1972) answers, at least in part, is: Can an organization's members be modeled in a simulation by the actions and decisions of one agent? If perception of environmental uncertainty across individuals in the same organization is observed to be heterogeneous, then a computer simulation involving one agent to represent an organization might constitute an oversimplification. However, Duncan found that perception of uncertainty among an organization's members to be remarkably homogenous, suggesting that an organization's perception of uncertainty can indeed be modeled by the perception of a single, simulated agent.

Staw and Sz wajkowski (1975) noted that, while much attention had to date been paid to environmental uncertainty, such as with Duncan (1972) above, comparatively little consideration had been paid to environmental munificence. Furthermore, extensive theoretical, but no empirical, work had been done toward the ability of organizations to control or change their environments. In an effort to fill these research gaps, Staw and Sz wajkowski (1975) studied the strength of correlation between environmental manipulation, in the form of the commission of illegal acts, and environmental munificence. They found that the degree of environmental munificence was negatively correlated with the commission of illegal acts in a sample of *Fortune* 500 firms. The idea that corruption may be connected to environmental variables is an important potential extension to the baseline simulation being developed here and will be considered later;

with regard to the baseline simulation, it is important to note here the possibility that decreased environmental munificence may increase an organization's effort to obtain resources, and *vice-versa*. The extent of the alignment of resource procurement effort with environmental conditions may in part be a determinant of environmental selection, retention, and performance. In a scarce environment, one might say that only the enthusiastic foragers survive, while in a munificent environment, the enthusiastic forager may expend too much energy to be among the most profitable. Furthermore, a scarce environment suggests that survival may be an important measure of firm success, while a highly munificent environment, in which nearly all organizations survive, suggests that organization performance becomes an important measure of firm success.

Transaction Cost Economics

In a reconciliation of sorts between economics and organization theory, Williamson (1975) drew upon both fields in the development of his theory of transaction cost economics (TCE). Armed with the assumptions of environmental uncertainty, small-numbers bargaining (suppliers from the perspective of a buyer are small in number, and once a contract is reached with one of them, the buyer is disinclined to break this relationship because of both the sunk costs involved and the absence of a large number of alternatives), and bounded rationality (which allows for opportunistic behavior between buyers and suppliers), Williamson (1975) argued that market failure exists (when the economist's classical market system is not achieved). Sarcasm notwithstanding, Perrow (1986) perhaps best described the basics of this theory most succinctly:

“Well, that's serious.... What is to be done about it? Williamson and capitalists have a solution: integrate forward or backward. That is, you can buy out the

person you sell to (or set up your own organization in competition with your customer), called ‘integrating forward’; or you can buy out your supplier (or build your own source of supply), called ‘integrating backward’.... If the supplier is part of your firm, you can control her. That eliminates the leverage she had as one of a handful of suppliers that you had to depend on. She won’t dare lie about labor problems or raw-material problems because you can check the books (controlling opportunism)” (Perrow, 1986, p. 238).

Once opportunism is controlled, costs are reduced and the enlarged organization is more efficient when the supplier is internalized. Thus, market efficiency is maintained whenever market failure exists after firms engage in vertical integration. In this way, a large organization may be more efficient than if it were replaced by numerous smaller organizations. However, small organizations still exist when spot contracts are efficient – i.e. when opportunism does not emerge to a significant extent because of numerous suppliers or if environmental uncertainty is low. Thus, Williamson (1975) combined organization theory assumptions and economics theory to create a “theory of the firm” which explains why and when both large and small firms exist, and how organizations act when the environmental conditions of market efficiency are less than ideal. With regard to how organizations interact with environments, TCE ties increases in environmental uncertainty to decreases in organizational efficiency, at least under conditions of bounded rationality and small numbers of buyers/suppliers. In order establish a reasonably accurate computer model of organizations in their environments, then, Williamson’s (1975) TCE prescribes that conditions of bounded rationality, small numbers, environmental uncertainty, and the ability for computer-modeled agents to integrate forward and backward must exist simultaneously. In a computer simulation of agents in environments of varying uncertainty

where vertical integration is not allowed, TCE would predict that, in environments which favor large, integrated organizations (yet simulation rules disallow integration to occur), the agents will operate substantially more inefficiently than their counterparts operating in more stable environments.

Natural Selection and Resource Dependence

Aldrich & Pfeffer (1976) set out to compare the perspectives of the natural selection model with those of resource dependence (Pfeffer, 1972). Since much more will be said below about both of these models, it is important here to note the conclusions reached by Aldrich & Pfeffer (1976). The authors noted that, while the resource dependence model focused more on “the criteria by which decisions are made” (Aldrich & Pfeffer, 1976, p. 84), the natural selection model focused more on the decisions themselves:

“The stages of variation, selection, and retention constitute a general [natural selection] model not entirely incompatible with the resource dependence approach. A review of the differences between the two perspectives indicates that an explanation of organizational change must address issues of the level of analysis, sources of variation, selection criteria and mechanisms, and the time frame for analysis that is used” (Aldrich & Pfeffer, 1976, p. 102)

The natural selection model raises issues of heterogeneity and major transformational changes at a higher level of analysis; resource dependence suggests that the idea of planned (rather than merely random) variations be added to the natural selection model and that this model should allow for the possibility of organizations influencing their environments at this level. The authors also called for longitudinal empirical studies to better account for (and validate) the

processes described by both models. Note that this paper was not an integrative work, but a comparative one, in which the authors identified a number of factors necessary for the study of both perspectives, and the possibility that one perspective could contribute to study in the other. It is relevant to the current work in its implication that the analysis of the computer simulation should take place at two parallel but separate levels of analysis. At one (lower) level, the way simulated agents make decisions should be studied, while at another (higher) level of analysis the resulting decisions should be studied in order to observe how the character of the industries, each operating in a different environment, change over time and changing levels of population size.

Boundary Reification

Starbuck (1976) reviewed the extant literature on organizations and environments across the disciplines of sociology, management theory, and economics. He found progress to be limited and the ideas of “organization” as distinct from “environment” to be essentially a reification that was unique to the particular researcher. For example, Starbuck criticized Duncan (1972) for treating the perceived environment in much the same way as the actual environment, yet an understanding (and measure) of both is important in any study; in fact, a study of the actual environment may be more important, as institutionalization pressures act to compress the scale of perception of uncertainty across organizations: “collective socialization processes homogenize perceptions across different organizations” (Starbuck, 1976, p. 1081). Starbuck also demonstrated that an identification of rules as to who which individuals belong inside the organization and which belong outside it depends entirely on the decision rule applied: psychological job investment, social visibility, influence on resource allocation, or system response speed. Since any boundary can be moved by the adoption of a different decision rule, the study of organization-environment interaction has been accompanied with a certain degree of

ambiguity and inconsistency. The definition of where organizational boundaries may actually be up to societal norms rather than a researcher's rules: "Two important contingencies [to boundary definition] are the society's norms about role compartmentalization and about organizations' purposes" (Starbuck, 1976, p. 1076). Because of the difficulties involved in boundary definition, Starbuck (1976) suggested that researchers should "stop thinking of organizations as distinguishable subsets of society, and start thinking of them as hills in a geography of human activities" (Starbuck, 1976, p. 1078).

There are, however, grounds on which to argue that Starbuck (1976) may have been overly pessimistic for a number of reasons. First, if we look at corporations, boundaries of organizations have existed in a legal sense (through a corporation's articles of incorporation that the organization is required to file with a state government) for some time. If Texaco is considering suing Exxon-Mobil over, say, a drilling rights dispute, there is rarely, if ever, any question among lawyers involved as to who is suing whom. Further, Starbuck ignored the definition of organizations arising out of TCE theory: those individuals that are paid by an organization are members of it (and presumably provide work contributing to its goals in exchange), while those individuals not paid by an organization are not members of it; alternatively, organizations that transact with other organizations (rather than with individuals) are *prima facie* evidence of an organizational boundary. Again, a decisional perspective in which organization members are identified as those individuals who make decisions which contribute to an organization's goals (and not the goals of other organizations – see Cyert and March, 1963) results in a similarly-defined boundary. At worst, then, researchers may have to qualify their theories and evidence as contingent on their own definitions of organizational boundaries, and the implication for any computer simulation is that a population of

organizations, and the boundaries between them, must be carefully defined and coincide with identifiable societal norms. Furthermore, any variables defined for study must describe either organization characteristics or environmental characteristics, but not identify a confusing mix of both, in both the simulated environment and in real populations. In sum, the separation of organizations from their environments may in fact be a reification of researchers, but it is also a useful one and parallels legal and societal norms.

Second, Starbuck (1976) contradicted his own ideas about the scale compression of perceived uncertainty later in the same book chapter: “There is a fairly strong case for saying that uncertainty is inevitably a characteristic of a perceiver rather than of a perceived situation” (p. 1087). This phrase implies that uncertainty is a property of the perceivers rather than some institutionalized environment that results in a uniformity of perception, or at least it suggests that perceived uncertainty at the individual-level (or from Duncan’s findings of homogeneity within organizations, at least an organizational-level) is a possibly important characteristic to study in the absence of strong institutional constraints. Later on, Starbuck (1976) notes: “Organizations obviously differ in the attentions they pay to various environmental phenomena ... in the amounts and kinds of perceptual distortions they experience” (p. 1095); and, “an organization’s perceptions are quite heterogeneous” (p. 1098). These statements rather directly contradict his scale compression argument, which would have suggested in the first case that all organizations apply the *same* perceptual distortions due to institutional pressures, and in the second that an organization’s perceptions are instead *homogeneous*. These latter statements actually agree quite well with Duncan’s (1972) findings. Clearly, then, the implication for computer simulation that were obtained from Duncan (1972) remains (one must model perceived uncertainty at the organization level), with perhaps an added caveat that actual environmental uncertainty must

also be modeled. As will be argued below, this dual-observation is a far simpler task for a computer simulation study than for a study of real environments.

Strategic Typology

Miles and Snow (1978) proposed a set of strategies that organizations use to adapt to their environment, and suggested that a mix of “fit” strategies would indicate a “healthy” organization by applying the evolutionary prerequisite for “health” of environmental variation. Noting that “efficient organizations establish mechanisms that complement their market strategy” (p. 3) and that “organizations act to create their environments” (p. 5), Miles and Snow (1978) identified four market strategies: defenders (managers have a narrow market focus and tend to concentrate their efforts on developing efficiencies), prospectors (always search for market opportunities, and in so doing tend to create change and uncertainty in their environments), analyzers (managers operate through formalized structures and processes; the organization occupies two product-market domains, one in a stable environment and the other in an unstable environment, and closely follows innovations of competitors in the unstable environment), and reactors (managers are unable to respond to perceived environmental uncertainties, and therefore their organizations lack a consistent strategy-structure relationship while managers make changes only when forced by the environment). The authors stated that this typology was superior to those that preceded it (Ansoff, 1965) because “we believe that our formulation specifies relationships among strategy, structure, and process to the point where entire organizations can be portrayed as integrated wholes in dynamic interaction with their environments” (Miles & Snow, 1978, p. 30). In other words, Miles and Snow’s (1978) model is oriented around the idea of organization-environment interaction. These findings (which were

extracted from observations of numerous case studies) have several significant implications for any computer simulation of organizations. First, Miles and Snow (1978) imply that firms make decisions based on a profile of characteristics. Modeling these four profiles could be problematic in a baseline simulation, as it requires, for example, the modeling of the development of internal processes (defenders) and allowance for diversification in the baseline model (to accommodate the analyzer's strategy). Furthermore, the ideas that organizations react to their environments rather than fully understand it (as reactors do) and search for market opportunities (as prospectors do) are, according to other authors, activities that organization theorists describe as characteristic of all organizations. In any case, as the authors noted that their typology was probably not collectively exhaustive, it might be more interesting to create a set of randomly generated decision characteristics and then attempt to derive a typology of profiles among those successful organizations. This simulation-derived typology could be compared to Miles and Snow's (1978) typology, possibly resulting in types of organizations that Miles and Snow had overlooked. In any case, their proposition that "healthy" environments are ones in which a wide variety of strategic profiles exist across organizations could be investigated, and their idea that a firm's strategy could be based on a profile of characteristics provides a modeling framework.

Resource Dependence

In their effort to explain "how organizations manage to survive" (p. 2), Pfeffer and Salancik (1978) emphasized the problems organizations face in acquiring resources (rather than problems of merely using them once obtained, as earlier authors had focused on) as a central motivation for characteristic organizational behaviors. Their argument was that, if organizations

find that they are dependent on resources that are both scarce and important to the organization's survival, organization members work to manage this dependence and achieve resource stability. "For some organizations, stability is a more important dimension of its operation than either profitability or growth" (p. 47). Thus, Pfeffer and Salancik (1978) added resource dependence as a reason for integrating vertically, in addition to reasons of efficiency (Williamson, 1975) and growth (Chandler, 1962). Pfeffer and Salancik (1978) explored a number of strategies that organizations use to manage their dependencies. Organizations can avoid the dependence by controlling the rules of trade informally, legal or illegal means such as by collusion, merger, vertical integration, related, or unrelated diversification. Alternatively, organizations could change their strategies by altering their environment or by adapting to the environment to achieve a better fit. Finally, organizations could attempt to avoid resource dependence by antitrust suits and cooptation. At issue for Pfeffer and Salancik was whether resource dependence constrained the discretion of the organizations' managers: managers prefer their own discretion in making decisions about their organizations, so their management of resource dependence was directed toward this goal; otherwise, organizations would change, adapt and fit (i.e., they would institutionalize) to the requirements of external control.

Pfeffer and Salancik (1978) also had much to say about the environment. With regard to environmental variables, they summarized the contributions from the fields of organization theory, economics, and political science into 6 environmental variables that are causally connected, with environmental uncertainty as an outcome variable. Concentration, munificence and interconnectedness (an environment's structural characteristics) were indicated as input variables, while conflict and interdependence (which describe the extent of relationships between actors) were shown as mediators. Furthermore, the resulting uncertainty must be directly related

to an organization's effectiveness for it to have any predictive power. The implications for any simulation are significant. While uncertainty can be modeled into a simulation by means such as variance of available resources, demands, and munificence, the total level of uncertainty is also a function of the concentration and interconnectedness of the simulated agents. For example, if munificence, demand, and resource variance is held constant throughout a simulation, and the agents are allowed to be selected out of a simulated landscape without being allowed to reenter, the inevitable loss in concentration of agents will lead to reduced conflict and *lower* total uncertainty. Thus, concentration (and interconnectedness), while not controlled in the simulation I propose below, must be monitored so that any numeric measure of uncertainty is adjusted for changes in concentration and interdependence. If one were to simulate two environments where one is intended to be *relatively* more uncertain than the other, merely increasing the variance of munificence, resources, and demands in one environment compared to the other will be necessary but insufficient to create differences in uncertainty between the environments. One must also show that, at the end of the simulation, the decreased concentration and increased interconnectedness in the "higher variance" environment does not reduce the total uncertainty to be on par with the "lower variance" environment.

When taken in total, one gets the impression from Pfeffer and Salancik (1978) that organizations are constantly looking back into the past in order to make choices in the present – back through the supply chain to decide what dependencies should be managed, back through the past in order to predict a future environment, back at the organization's own actions to determine organizational meaning (Weick's enactment), and back at the organization's failures to determine present-time defense mechanisms. Certainly, many of these characteristics of an organization's behavior can and should be accounted for in any simulated environment.

Furthermore, Pfeffer and Salancik (1978) point out that managerial choice, rather than being considered as either an undeniable fact (Child, 1972) or an illusion (Blau, 1986), is instead a variable that depends on management's effectiveness at managing their organizations' resources. According to Pfeffer and Salancik (1978), managers prefer resource independence, and work toward that goal, because the more independent, or loosely coupled with its environment, an organization is, the better chances it has for long-term survival.

Aldrich's Application of Reform Darwinism

Aldrich (1979) anticipated the period of integration of theory by presenting ideas such as open systems, contingency theory, population ecology, and strategic choice side by side. Aldrich avoided Penrose's criticisms, discussed above, by drawing the biological analogy in the context of reform Darwinism instead of the conservative version. Reform Darwinism acknowledges that "selection need not be accidental" (Aldrich, 1979, p. 33), and this perspective allowed Aldrich to construct an evolutionary model that involves (constrained) choice. The limits to strategic choice (barriers to entry, limited influence on its environment, and limited perception of reality) were assumed to allow firms sufficient variation; as long as there is sufficient variation across firms in any environment, selection and retention will occur when birth and death rates in the environment are sufficiently high. For the population ecology model to operate in any environment, it must meet all three conditions of variation, selection, and retention. This model works well for small organizations that compete against each other, but large organizations lack at least the condition of intra-industry variation; these large organizations must be carefully managed so that the three conditions are met *within* the organization in order for it to continue to adapt to environmental conditions. Thus, innovation by large organizations is assumed to be

carried out by the deliberately infused, now-internal mechanisms of variation, selection, and retention. Institutionalization, then, becomes a point of equilibrium for large organizations that are not run internally in a way similar to an ecological system (called “planned variation” and included management’s strategy and choice; Aldrich, 1979, p. 39). Such a planned variation style of management would certainly allow managers to adopt all that is feasible rather than searching for the optimal (Cyert & March, 1963) and could be applied in at least three ways – at the individual, corporate, and organizational levels of analysis. The application of population ecology within large organizations has not been met with much success, however. For example, at the individual level of analysis, Kulik (2005) noted that Ken Lay set up just such a system of internal human resource management at Enron, by laying off the lowest 15% on performance reviews every 6 months (a high mortality rate) and by hiring mostly new graduates as opposed to industry professionals (a high rate of variation; thereby meeting Campbell’s (1969) two conditions for environmental selection) from which emerged not the highly adaptable system of employees as Aldrich might have predicted, but a strong, damaging culture that promoted and rewarded corruption. At the corporate level, this strategy of creating conditions for selection might be applied to unrelated diversification, wherein managers could acquire companies that are different from its current divisions (high variation) where and when feasible and then wait to see if any synergies were formed with existing divisions; if not, the acquired company could be spun off (high mortality). Whereas Aldrich would have predicted that an unrelated diversifier would perform better than a related diversifier, Rumelt (1974, discussed at length below) noted that related diversifiers performed better than unrelated diversifiers. Thus, there is no strong argument for the continuance of the population ecology model after the organization has grown large. In a simulated environment in which firms are allowed to diversify unrelatedly, Aldrich’s

prediction could be tested against other diversification strategies, but the incorporation of Aldrich's (1979) large-organization application of population ecology is not clearly justified.

With regard to a description of the environment, Aldrich (1979) identified 5 basic dimensions of the environment: capacity, homogeneity-heterogeneity, stability-instability, concentration-dispersion, domain consensus-dissensus (the extent to which an organization's claim to a domain of the environment is recognized by other environment members); he also identified a "higher-order" dimension (a result of the other 5): turbulence. If Aldrich's capacity and turbulence can be regarded as the same as Salancik and Pfeffer's (1978) munificence and uncertainty, respectively, then Aldrich (1979) offers only domain consensus-dissensus to our list of environmental variables, which can be taken into account in a simulation with regard to whether any agent can occupy the same spot on a (resource) landscape as another agent, but it need not be an active dimension, and was in any case dropped by Dess & Beard (1984) in their empirical analysis of Aldrich's dimensions. However, Aldrich (1979) also discussed the difference between what he called fine-grained and coarse-grained environments, with fine-grained environments being "that the environment changed to many short-term conditions over the lifetime of organizations" (p. 114) and only long-term changes occurring in coarse-grained environments. Aldrich (1979, p. 115) speculated that only "specialists" (i.e., single business units) would survive in fine-grained environments, while generalists (i.e., unrelated diversifiers) would be able to survive, albeit inefficiently, only in coarse-grained environments, and particularly those environments that are also unstable and heterogeneous. This coarse/fine grain idea offers yet another parameter for simulation: the resetting frequency of a random arrangement of the resource landscape, particularly when the simulation is applied to the study of diversification.

Conclusions

The proliferation of theory during this period has resulted in a more specific characterization of how firms might behave within their environments. By 1979, despite some of the integrative work of Aldrich (1979), one can delineate a number of independent ideas, identified in Table II. Ideas about the environment within each perspective, however, varied little. Environments were seen as entities that organizations should understand, fit to, and attempt to change, and those that did so effectively were generally considered to survive longer and perform better. For example, the idea of “fit” cannot be relegated to just population ecology, as resource dependence suggests that organizations change their outputs according to the availability of inputs, and contingency theory suggests that the high-performing firm fit internal structures to external environmental conditions. Neither can the manipulation of environments by organizations be considered the realm of Weick’s (1969) enactment, as resource dependence suggests that organizations manage and manipulate at least the critical, scarce resources in their environments, and Aldrich (1979) admitted that organizations are only limited to the extent that they can control their environments, an admission that Weick would certainly agree with. The only “differences” in perspectives with regard to how the environment should be treated during this period seem to have been the amassing of insight into what the environment is and how it should be studied. Thus, Pfeffer & Salancik (1978) noted that Thompson (1967) need not have limited his discussion to the task environment, as many higher-level societal effects may also hold as predicted at the task-environment level; Staw and Sz wajkowski (1975) added munificence to uncertainty as an environmental consideration; and Aldrich (1979) added that resources in environments may be reconfigured periodically by, for example, changes in customers’ demands, and this reset-frequency of resources adds to environmental uncertainty.

The general consistency, yet increasing complexity, of perspectives on environments and how organizations interact with them suggests that the theories developed to this point may be integrated or combined in some way to more parsimoniously reflect the complexity of organization-environment interaction. The decade of the 1980's provides a number of important efforts at integration.

Theoretical Integration: 1980s

Complexity of Organizations

Schoonhoven (1981) advanced the complexity idea when, after testing contingency ideas of Galbraith (1973) between (technological, or workflow) uncertainty and structure (standardization, centralization, and professionalization), she uncovered nonmonotonic and interactive effects in a hospital operating room setting. For example, she found for lower-uncertainty organizational subunits, decentralization had a negative effect on effectiveness, while for high-uncertainty subunits, decentralization had a positive effect on effectiveness – but at a decreasing rate. While her work considered only internal measures of uncertainty, with no regard to environmental conditions, it suggested that there might be much work left with regard to an accurate description as to how organizations interact with their environments, and this behavior may be messy and curvilinear. Such behavior may not be predictable *a priori* by extant theories, yet it might be difficult to modify current theory with sufficiently accurate predictive power. Either theories must be integrated, as the remainder of the decade attempted to do, or a different method of hypothesis generation must be developed that accommodates complexity sufficiently, such as computational methods, as discussed in a subsequent section.

Charles Perrow (1986) argued along similar lines of complexity in the third edition to his 1972 criticism of theories of organization (in the third edition, he discussed more theories, but his main points remained unchanged). After finding fault with decision-making theory (organizations need not be “products of technology and a structure adapted to it”, p. 156), institutional theory (it overlooks that environments may adapt to organizations, and has been applied mostly to the study of weak and trivial organizations), population ecology (what does

one do when the preconditions of variation, selection, and retention are not met, and if met, how, specifically, is selection determined and who does the determining?), agency theory (it is more deterministic and causally unambiguous than reality), TCE (the definition of what is a transaction cost is too flexible to test empirically), Perrow proposed that the power of groups and the state be accommodated for in current theories, but in any case, theories are necessary simplifications of much more complex phenomena. However, measures could be taken toward prevention of oversimplification of any organizational theory. He warned against the assumption of efficiency of production as the only driving force behind decision making, and especially those theories that do not take into account the beneficiary of a move toward efficiency. He also warned against “unspecified ‘environments’” that may mask deeper phenomena. If one theory cannot fully account for how organizations behave, then neither can a reasonably realistic simulation model rely on one or a few theories of organization; otherwise, generalization would be problematic. Even with the incorporation of numerous theories into a simulation model, however, the theory that it produces is only as extensive as the theory it incorporates: A simulation incorporating decision making (organizations as tools, according to Perrow) can only be applied to the development of theory on decision making, such as the one proposed by Cyert & March (1963). Nevertheless, a simulation model that accommodates all of the organizational theories, and also heeds Perrow’s warnings) may be limited more in the theories that have not yet been conceived than in incomplete coverage. Indeed, such a simulation model, if possible, may be the only answer we currently have to Perrow’s (1986) and Schoonhoven’s (1981) oversimplicity criticisms of current theory.

Industrial-Organization Economics and Michael Porter

Drawing from concepts in industrial-organization economics and marketing, Porter (1980) attempted to integrate extant theories on firm behavior by way of competition toward high performance in an industry as an overarching objective. His work is somewhat of a retraction from previous advancements to a certain extent, as he assumed rationality toward a profit-maximization goal with the consideration of only industry-level parameters. On the other hand, it can be said that this particular rational approach was a way to reduce the boundedness of one's rationality, and it certainly marked the beginning of many studies, and the field of strategic management, involving a similar approach. Porter (1980) saw industries as consisting of groups of organizations along industry-specific relevant critical dimensions (cost position, product quality, technology, leverage, vertical integration, service, etc.). Thus, organizations could be "mapped," as if on a landscape, along an industry's two most important dimensions. Once mapped, an organization's strategists could target itself within a high-profitability strategic group (or at least to begin to overcome barriers to entry to the group), or find an unoccupied area on the strategic landscape (a niche) to inhabit that could be relatively free from the potentially detrimental reactions of competitors (i.e., neighbors on the landscape). Porter's theory was able to accommodate transaction cost economics, resource dependence (since "resources" could be identified as a critical dimension for any industry), and contingency theory at least in terms of strategy formulation (strategies are based on a fit between study of one's industry and the organization's strengths) and uncertainty (which serves as an entry barrier if high), although organizational structure was a downstream issue that was beyond the scope of his work. Porter did, however largely ignore tenets put forth by enactment, institutional theory, and population ecology, and he saw his work as more of a practical toolbox for strategists than a theoretical

contribution. Still, the idea that organizations can be mapped onto a two-dimensional landscape that organizations move across in order to compete against each other suggests a useful framework for a computer simulation.

The Executive Decision Process

Porter's (1980) "upstream" focus might be best explained by the theory derived from an integration of the structure-environment and technology-environment literature streams (Randolph & Dess, 1984). Randolph and Dess' integrative theory, shown schematically in Figure 1(a), places managerial choices (choice of product/market, technology, and organizational structure) into causal relationships with the task environment and performance. Note, however, that the choice of product/market may be re-named "strategy" that results in a subsequent choice of structure according to Chandler (1962). Thus, a reversal of direction may be in order for the arrows between product/market-technology and product/market-structure. Additionally, since according to, the choice of product/market is the result of an evaluation of the environment by organizational strategists (Porter, 1980; Ansoff, 1965), the causal relationship between product/market choice and environmental conditions should be bi-directional. Porter (1980) more or less assumes that choices of technology and structure are carried out appropriately by middle- and lower-level managers throughout the organizational hierarchy, and that congruence with respect to technology and structure is at least rational, if not relatively straightforward. What matters most, at least at the top management level, is an organization's choice of product/market, as strategy formulation is a function of top management (the practice of emergent strategy aside) and requires strategists to process and reduce uncertainty (Hickson et al., 1971) when uncertainty is at its maximum (according to Figure 1(a) and Randolph & Dess,

1984). Suppose, then, we were to assume congruence of the choices of technology and structure (i.e., that strategy implementation is effective). What minimum process would arise? Figure 1(b) shows a schematic of this reduced model, where the causal link between product/market choice and performance is now bidirectional, where choice of product/market has a direct effect on performance. If Figure 1(a) were to be labeled “contingency theory process,” then Figure 1(b) might be labeled, “strategic management process,” and is similar to more recent models of the strategic management process (Farjoun, 2002). The model in Figure 1(b) can then be applied as a baseline simulation model, with the additions of technology and structure, Figure 1(a), added as an application study of technological and structural congruence.

An important element of Randolph and Dess’ (1984) study was that of the environment, or really, environmental uncertainty, which was explored in a separate paper and integrated much of the previous work on what are the dimensions of the environment (Dess & Beard, 1984). Arguing (as I also noted above) that Aldrich’s (1979) variables encompass virtually all of the dimensions discussed by other authors, Dess and Beard (1984) applied interitem reliability analysis (to eliminate internally inconsistent variables), then exploratory factor analysis to a number of variables predicted by previous literature as significant environmental variables. Three main factors emerged: munificence, complexity, and market dynamism. These factors are summarized in Table III, following the summary found in Randolph and Dess (1984), and significantly factor-loaded variables identified by Dess and Beard (1984). The extensive citations shown in the table demonstrates the comprehensiveness of Dess and Beard’s (1984) investigation, and the variables such as “price-cost margin” and “value added” suggests that resources and demand (an input-output approach) should be considered simultaneously when determining munificence (growth in relevant variables), dynamism (variance around average

growth), and complexity (the density of nearby members). Not only does this approach make parsimonious use of real-world data, it also greatly simplifies the work toward the creation and measurement of simulated environments.

Performance and Effectiveness

Randolph and Dess (1984) included “Organization Performance” in their model after the Parson’s “economic primacy” argument (Parsons, 1956, p. 228), in which financial goals are assumed to be of primary importance in determining an organization’s performance. It remains to be seen as to what a model would look like if effectiveness, or an organization’s survival, were substituted for “performance,” at least at the extremes of high and low performance. Suppose, for example, a for-profit firm forecasts only minimal profits, or even losses, for the foreseeable future; in this case, does it focus on survival instead, knowing that performance will be poor for some time? On the other hand, if a firm’s performance seems to be consistently high, say, because of the acquisition of a prime location for sales; in this case, does the firm turn to other measures of success? It seems that effectiveness, among any number of other factors, may serve as a substitute for profits under certain situations, yet this finer-grained investigation was not addressed by Randolph & Dess (1984), as they were only interested in normative firm behavior.

Perhaps more to the point, what do we really mean when we discuss “fit” (a strong form of contingency theory) and “congruence” (a weaker form that does not involve performance; see Drazin & Van de Ven, 1985) with the environment? Randolph & Dess (1984) certainly would not suggest that a firm should match environmental uncertainty with matching strategies: when industry sales growth decreases, the successful firm’s sales growth should proportionately

decrease; when industry complexity increases, the successful firm should find a place on the competitive landscape that is closer to more of its rivals. However, there is clearly *some* action that a firm takes in response to the level of uncertainty in the environment – perhaps different actions are performed to meet each of the three independent dimensions of environmental uncertainty identified by Dess and Beard (1984) – yet the Dess-Beard-Randolph papers describe only one action: movement across the competitive landscape. Whatever those other actions (to be discussed later) might be, Bourgeois (1985) proposed that the nearer a manager’s perception of uncertainty was to the environment’s true uncertainty, the greater the probability that said manager would make the appropriate decisions and take the appropriate actions toward higher economic performance. Bourgeois (1985) also predicted a positive association between environmental volatility and the *number* of strategic objectives (rather than a match between specific objectives and level of volatility). His uncertainty congruence proposal was empirically verified, but his volatility-number of objectives prediction was not. Thus, we know that “perceptual acuity” (Bourgeois, 1985, p. 565) is important for managers, but we are still begging the question as to what managers do about environmental uncertainty once its level is accurately perceived, and (again assuming effective strategy implementation) how that action is associated with performance.

One action a poor-performing firm might take toward higher performance is a strategic reorientation. “Strategic reorientations are relatively short periods of discontinuous change where strategies, power, structure, and systems are fundamentally transformed towards a new basis of alignment” (Tushman & Romanelli, 1985, p. 173), as directed (mediated) by “executive leadership” who are motivated toward transformation by institutional pressures, environmental requirements, and periods of low performance (and motivated toward mere convergence by

inertial factors). Specifically, strategic reorientations involve the new choice of product, market, technology, or competitive timing. Alternatively, an organization may undergo a more radical re-creation, wherein the organization's core values (choice of customers, competition, technology, and employees) are reconstructed. The idea that long periods of convergence are abruptly interrupted by reorientations and/or recreations (the so-called punctuated equilibrium model) is the result of the integration of ecological, adaptation, and transformational models of organization theory.

The punctuated equilibrium model serves as a useful basis for the simulation of organizations when it is combined with the idea of dominant logic (Bettis & Prahalad, 1995; Prahalad & Bettis, 1986), which is “a mind set or a world view or a conceptualization of the business and the administrative tools to accomplish goals and make decisions in that business” (p. 491), since “top managers ... must possess the ability to revise the dominant logic they [use] to manage” (p. 495). Dominant logic, then, is a formula for success that is more or less shared by top management. An organization might follow a particular dominant logic for some time, but when it encounters difficulty (especially a life-threatening one), might attempt to overcome the difficulty, to survive, by reorganizing (Tushman & Romanelli, 1985) toward a different dominant logic (Prahalad & Bettis, 1986). When encountering smaller-scale difficulties, Prahalad & Bettis (1986) note that organizations may attempt to modify parts of their dominant logic to overcome them, not unlike Tushman & Romanelli's (1985) convergence periods. While Prahalad & Bettis (1986) make no distinction between reorganization and re-creation, this added distinction provides us with four alternatives for top managers, according to the decision hierarchy shown in Figure 2. One could guess what occurs at the extremes, as described above (chose no action when encountering long-term high performance; choose recreation when near

death), yet intermediate situations that call for changes of intermediate degree may be causally ambiguous and difficult to predict with theory *a priori*. Given lack of detail in this regard, one might assign intermediate changes randomly in a computer simulation (as discussed below). This approach would be decidedly evolutionary, but when used in a simulation it does not imply that managers actually act randomly as has been accused of population ecology; rather, it is a way of modeling variation of behavior. Alternatively, the profiles of each simulated organization could be programmed to act consistently in when faced with a certain history of performance, and these profiles could be assigned to each simulated organization at random in initialization phase of the computer program. In this regard, “fit” in the proposed simulation is assumed to be considered as a “profile deviation” (Venkatraman, 1989p. 433), where some profiles are expected to be higher-performing, on average, than others within a particular environment, and those that deviate from some best-performing ideal (or set of ideals) exhibit lower (average) performance.

Upper Echelons

One way that specific types of dominant coalitions might be derived is through upper echelons theory Hambrick and Mason (1984) applied to the distribution of (scarce) resources. Upper echelons theory proposes that a top manager’s decisions are shaped by their career experiences, as well as demographic variables (education, socioeconomic background, etc.). Recently, upper echelons theory has been pursued as an antecedent to corporate diversification (Jensen & Zajac, 2004). Specifically, a functional background in finance was demonstrated to be associated with higher levels of diversification. Similarly, functional background might determine which demands are met first within simulated organizations, since Cyert and March

(1963) observed that one consequence of bounded rationality is that managers make decisions (allocations of resources) sequentially rather than simultaneously. Therefore, simulated CEOs could allocate resources to meet the needs of different departments (say, among 3 departments: buyers, producers, and sellers) according to the CEO's simulated background (randomly assigned at initialization). CEOs with production backgrounds, for example, would be modeled to give the production department all that it needs, and then allocate less-than-requested resources to the buying and selling departments. CEOs with a balanced background might allocate resources on an equally (dis)proportionate basis. This simulation decision rule also fits in with Weick's (1979) enactment (the production-experienced CEO will see the environment through production-tinted lenses), and Perrow's (1986) notion of the asymmetry of power across organizational departments.

Institutional Pressures

A final aspect of Figure 2 that bears further elaboration is the "institutional pressures" evaluation component of the environment. DiMaggio & Powell (1983) noted that there are essentially three sources of institutional pressures that cause organizations to make reorganizations that are similar to each other: coercive, mimetic, and normative isomorphism. Coercive isomorphism might arise from the forced compliance with a new law, from cultural expectations, or from pressure in terms of force, persuasion, or invitation from other organizations in the task environment. Mimetic processes are instead voluntarily executed within organizations as a way to reduce uncertainty. Here, the organization may try to make sense of otherwise ambiguous causal relationships by copying elements of the profile of, say, the most successful organization within its task environment, whether those elements of the high-

performing organization are the cause of its success or not. Normative pressures toward isomorphism stem largely from professional organizations that contain members spanning multiple organizations in a task environment. The first mechanisms of isomorphism (coercive and isomorphic) can be modeled in a simulation by assigning a probability that a profile element of a nearby (coercive) or the highest-performing (isomorphic) will be adopted, per simulation iteration. Profile elements can be chosen at random, while adoption probabilities could be assigned randomly at initialization as an element of each simulated element's profile. For example, if the highest-performing organization at the end of a particular iteration happens to contain a CEO with a production background, nearby and low-performing organizations would tend (with some assigned probability) to also adopt production orientations. Meanwhile, higher-level (societal) pressures and lower level (normative) pressures toward isomorphism could be considered as application areas of study in extensions to the basic model.

Conclusion

Much of the research question we have been pursuing has been answered in the above discussion in that we have developed solid, reasoned guidance toward the setup of an integrated simulation of organizations based on the extant literature. However, since the above guidance was based on little empirical evidence, it remains to investigate and comment on empirical studies and their implications for the simulation under development, as well as commentary on some modern theoretical developments.

Empirical Verification and Modern Theory: 1990s to Present

In this section, I lend legitimacy to and extend further the contributions of each of the fields outlined in Table II. Therefore, this section is organized by each perspective identified in

Table II rather than chronologically as above. However, the views of resource dependence, strategic management, and transaction cost economics are incorporated at various degrees into the other perspectives, so I will not consider these views separately. Also, in this section I tend to move past groundwork toward a baseline simulation and toward the development of numerous specific rules of behavior for simulated agents. The rules developed here will be further developed into algorithms in the subsequent Methods section. The implications for a baseline computer model derived from this section are summarized in Table IV.

Environmental Variables

Before discussing implications in the advancement of each perspective, however, some illumination of advances in the dimensions of the environment should be discussed. A recent article on the territoriality in organizations (Brown, Lawrence, & Robinson, 2005) implied that attention should be paid toward Aldrich's (1979) overlooked dimension of consensus-dissensus. Brown, Lawrence & Robinson (2005) identified the importance of territoriality, defined as "an individual's behavioral expression of his or her feelings of ownership toward a physical or social object... include (Ingram & Silverman, 2002) behaviors for constructing, communicating, maintaining, and restoring territories" (p. 578). They note that among individuals within organizations, the demarcation of personal and group space can aid in increasing organizational commitment at the individual level and reducing conflict at the dyadic level, but also leads to self-focused preoccupation and isolation. It is reasonable to extend this idea to top management levels as well, and therefore toward firm behavior, at times as a basis for competitive interaction (D'Aveni, 1994). Thus, a simulation of organizations should accommodate mechanisms for territoriality. For example, firms that are direct competitors with each other (i.e. are located on

the same location of a competitive landscape) will tend to move away from each other (Porter, 1980), regardless of other conditions. This could cause a simulated agent to be preoccupied with its position relative to others, and move accordingly, rather than moving toward greater quantities of resources on the landscape. After isolating itself and finding itself in a stationary location for some time, a simulated agent should be programmed to set up a territory around itself. Direct competitors subsequently moving into this territory can be charged a “trespassing fee.” An example of this behavior is described in the aerospace industry (Rosetti & Choi, 2005) where suppliers attempted to circumvent original-equipment manufacturers (OEMs) and sell reverse-engineered parts (that had been designed by the OEMs) to end users (airlines) who had previously only transacted with the OEMs. In response, OEMs began patenting their replacement parts, suing suppliers who reverse-engineered them, and charging royalties for supplier-end user transactions. Perhaps due to bounded rationality or enactment, some OEM executives failed to recognize the issue. Said one OEM executive, “ ‘They [referring to parts suppliers] would not dare to [bypass the OEM and sell directly to the aircraft operators]’ ... ‘They are in enough trouble already and I don’t think we have to worry about them’ ” (Rosetti & Choi, 2005, p. 54). These quotes are clearly expressions of territoriality: suppliers would not “dare” and OEMs need not “worry” about suppliers trespassing on the OEMs’ market not for economic reasons (it is certainly economically feasible for suppliers to do so), but for territorial reasons. In this example, territoriality was expressed by OEMs toward members of the environment occupying a different spot on the supply chain; surely, this idea of territoriality can be extended toward firms that are more directly competitive. For example, Porter (1980) noted that firms form strategic groups and erect mobility barriers (costs) to prevent entry of firms outside their strategic group. The territoriality rules in the simulation as outlined above can thus

be considered mobility barriers as agents begin to cluster around munificent areas of the resource landscape (Epstein & Axtell, 1996). In this case, environmental uncertainty in a simulation may be seen to increase in part due to the number of territories set up by simulated agents.

Rosetti & Choi's (2005) anecdotal illustration suggests supply-chain tactics for those agents that cooperate as well as compete. The idea of strategic sourcing predicts that transaction costs will decrease the more the same buyers and sellers transact, but Rosetti & Choi (2005) also illustrate a competing, disruptive, tactic of suppliers that move around a landscape and offer lowest-price supplies to any available buyers. Thus, suppliers can be considered to employ two mutually exclusive types of tactics: (a) start by offering a high price and a long-term relationship with buyers, during which selling price decreases by a per-period amount specified in a contract, or (b) start by offering a lowest price, but increase that price by an incremental amount per-period until the buyer buys elsewhere and then move on to the next buyer. Buyers, in turn, can exhibit two mutually exclusive behaviors as well: (a) survey suppliers and buy from the one with the lowest price, and (b) buy from the same supplier regardless of price. Rosetti and Choi (2005) essentially describe problems in the aerospace industry as OEMs (buyers) of type (a) transacting with suppliers of type (a), but then switching to suppliers of type (b). Those type (a) suppliers then retaliated by selling to end users with type (b) supplier tactics. This type a/b tactic characterization should therefore be incorporated into the profiles of simulated agents.

Some advancement has also been made in the development of the environmental dimension of munificence and how an organization is found to respond to it (organizational slack). Paralleling previous approaches toward environmental uncertainty, Castrogiovanni (1991) proposed that the munificence dimension is multi-level and multi-dimensional. While most studies had to date been done at the task environment level and the aggregation of task

environments, a higher level includes the macro environment, while lower levels include the subenvironment (faced by Lawrence & Lorsch's (19069) organizational "subgroups") and resource pools. Castrogiovanni (1991) argued for more studies to be conducted at lower levels of analysis and noted that the differences in munificence across subgroups might influence internal standard operating procedures and structural characteristics. Should an aggregate munificence score be calculated using an average of all subenvironments since organizations can move high-munificence revenues toward subgroups facing low munificence, or should a minimum of all environments constitute the aggregate score? From the perspective of the computer simulation proposed, since environments are interrelated and located along only one supply chain, I maintain that a minimum munificence score should be measured. For example, if there is great demand but few resources in a simulated environment, demand is simply not met; on the other hand, scarcity in resources (in a high-demand environment) may not lead to an increase in prices for those resources in the simulation because some long-term supply-chain agreements may be maintained at lower prices in some areas of the landscape. Nevertheless, it would be interesting to simulate environments with large differences in munificence across subenvironments, similar to the environmental uncertainty approach, and observe whether prices do, on average, increase as a result of the strategies employed by the buyers and sellers. Alternatively, an extension to the baseline program could be the calculation of a base price across the industry in which agents set sales prices in reaction to the costs of their resources. Given this extension, an averaging score of munificence across the two simulated subenvironments (buying and selling) should be employed.

Castrogiovanni (1991) also identified three dimensions of munificence: capacity ("the upper limit of which industry activity can be maintained beyond the short term", p. 556),

growth/decline (change in capacity), and opportunity/threat. He noted that different authors applied the same labels to different dimensions of munificence. For example, the label “munificence” meant capacity for Singh, House, and Tucker (1986), growth/decline for Dess and Beard (1984), and opportunity/threat for Nottenburg and Fedor (1983). Certainly, these dimensions must be addressed as separate dimensions in a baseline computer simulation of organizations. The first two, capacity and change in capacity over time, can be programmed into the simulation. Opportunity/threat can instead be measured as simulation output, perhaps as the ratio of agent-type (raw materials suppliers, producers, or retailers) revenues to total number of same-type agents. This measure would be similar to the complexity measure of uncertainty (the total number of agents on the landscape), in that the measure depends on the number of agents that have survived, but in opposite directions: given stability in revenue, the more agents that exist on a landscape, the greater the complexity dimension of environmental uncertainty and the lower the opportunity dimension of environmental munificence. Thus, environments represent a tradeoff for organizations: in more munificent environments, more organizations will survive which results in increased complexity; in less munificent environments, less organizations will survive, but those that do will face a less complex environment. It may be that only under intermediate conditions of environmental uncertainty and munificence that organizations exhibit highest performance. Tan & Peng (2004) observed a U-shaped relationship between organizational slack and performance among state-owned enterprises in China’s emerging economy. While these authors applied agency theory to the explanation of the downturn of performance at high levels of slack, an alternative explanation could be that, under conditions of high levels of slack (implying high levels of environmental munificence), a highly complex environment, and consequently high environmental uncertainty, could cause managers to make

more mistakes in their decisions, resulting in lower performance. Thus, it is difficult to separate coping with uncertainty and agency theory explanations in describing Tan & Peng's (2003) U-shaped relationship between slack and performance. A computer simulation can separate the two mechanisms, where the coping mechanism toward increased environmental complexity can be programmed into the baseline model, and the agency behavior of simulated agents added in an extension of the baseline (see below).

Institutional Theory

Institutional theory, the first perspective listed in Table II, has undergone a revival of sorts since 1991, when a conference on the “new institutionalism” helped to simultaneously broaden and specify the institutional approach. The “old” institutionalism had considered a society's cultural influences toward an organization's goal displacement, while the “new” institutionalism focuses on an organization's struggle for legitimacy. Neo-institutionalism, as a process, might be identified as isomorphism–legitimacy–institution, where firms rationally and deliberately conform to some exogenous influence in order to compete with other organizations in its task environment for survival. The first link, isomorphism–legitimacy, was confirmed empirically (Deephouse, 1996) where isomorphism was measured as strategic conformity (in this case, comparing key asset strategies of banks to an industry mean value). Strategic conformity was found to be strongly associated with legitimacy (measured by media coverage), even after controlling for bank age, size, and performance. Rooted in this approach is the assumption (also empirically validated by Deephouse, 1996) that organizations, even for-profit firms, do not succeed by efficiency alone:

“But even among market-driven organizations, productive efficiency may have relatively little to do with survival. Hannan and Freeman (1989) suggest that selection in organizational populations does not necessarily favor the most efficient producers. They argue that a number of strategic factors – market share, product reputation, successful advertising, physical location, patent protection, and their presence of legal threats – may be more consequential. Even the most efficiency-minded organizations rely on socially constructed beliefs such as more is better” (Powell, 1991), p. 187).

The key here for simulation modeling is the is that a simulated agent’s survival “does not necessarily favor the most efficient populations”. What a simulation must do is to reward agents whenever they perform efficiently, whenever they change through isomorphism, and whenever they are able to change other organizations to be more like theirs (based on at least some of the strategic factors mentioned above), as each of these actions increases legitimacy of the focal organization. I suggest that a computer simulation store “legitimacy points” in each agent’s profile, adding points whenever each agent (a) performs among the best in the industry for a sustained period, (b) copies a profile element from the highest performer, or (c) is copied by another agent. At some threshold level of cumulative legitimacy points, an agent becomes an “institution,” with at least the benefit of longer allowable time operating at a loss before being removed from the simulated landscape.

Powell and DiMaggio did not, however, advocate a shift away from the old and toward the new institutionalism:

“we suspect that something has been lost in the shift from the old to the new institutionalism. Although the prime importance of assimilating the cognitive

revolution to sociological theory is undeniable ... the goal must be a sounder multidimensional theory, rather than a one-sidedly cognitive one” (Powell & DiMaggio, 1991, p. 26).

A multidimensional view of legitimacy, the key link in the isomorphism–legitimacy–institution chain, was not systematically addressed, however, until Suchman’s (1995) multidimensional and multilevel typology. Consistent with the above discussion and consequent computer simulation rule, Suchman (1995) described the purposes of institutionalizing as “making sense”, “having value” (p. 575), and “persisting” (p. 592) which, as discussed above, can be modeled in a simulation as market share, performance (profit), and survival. Note, however, that “persisting” according to Suchman’s (1995) depiction is a second-order notion: “individual organizations do enjoy some ability to foster comprehensibility and taken-for-grantedness merely by persisting” (p. 592). Thus, not only do organizations persist by institutionalizing, organizations also institutionalize by persisting. Thus, persistence and legitimacy interact in the real world which presents somewhat of a methodological problem. In a computer simulation, it would be helpful to control conditions such that only one causal direction is allowed. Therefore, for the baseline simulation, I propose allowing deaths, but no births, in the simulated population of agents. Furthermore, I propose that the landscape of simulated agents be overpopulated in such a way that initial death rates will be quite high initially, then will maintain a relatively constant rate for a time, and then stabilize with a relatively low death rate. The useful period of observation would then be the intermediate death rate period. While this experimental control (of sorts) may pose a problem with regard to population ecology (no births) and IO-economics (no barriers to entry needed), it is not unlike a real-world situation in which a new industry emerges with the simultaneous entry of numerous new entrants, with a consequent “shake-out” period. It is a bit

unusual in the real world, however, for that “new industry” to also immediately appear with commodities as products, as this baseline simulation appears to do, but this issue can be addressed by extensions to the baseline model (discussed below). Certainly, the “no births after initialization” rule solves the double-causality problem between legitimacy and persistence, since all “living” simulated organizations are equally persistent at any iteration of the computer program.

Suchman (1995) also attempted to unify old and new institutional approaches by noting two approaches to legitimacy: the strategic approach (employed by the new institutional theorists) and the institutional approach (employed by the “old” institutional theorists). Dissecting both approaches, Suchman derived no less than 3 main types and 12 subtypes of legitimacy. Of interest here is one of the four archetypes of organizations, which is possible since each organization must face the three main types (pragmatic, moral, and cognitive legitimacy) simultaneously: the archetype that describes “predictable, consequentially legitimate organizations engaged in value exchanges” (Suchman, 1996, p. 584), since this archetype describes commodity producers and is consistent with our objective of a baseline simulation model. In this case, legitimacy is sought through exchange (a type of pragmatic legitimacy in which “support for an organizational policy [is] based on that policy’s expected value to a particular set of constituents”, p. 578), consequential (a type of moral legitimacy in which “organizations (Shin & Stulz, 1998) judged by what they accomplish”, p. 580), and predictability (a type of cognitive legitimacy which describes the “comprehensibility of actions”, p. 583). While the simple rules described above may sufficiently model this archetype, the other three archetypes might be applied to the study of extensions to the baseline in studies of institutionalization.

Christine Oliver's work extended institutional theory in the directions of change and deinstitutionalization (Oliver, 1992), and institutional and task environment interrelations (Oliver, 1997a), among other contributions (Oliver, 1997b; Baum & Oliver, 1996); each of the first two contributions cited here have important implications for simulation modeling and will be discussed in turn. Oliver (1992) advanced theoretical discussion on deinstitutionalization, defining it as the erosion or discontinuity of an institutionalized practice, and identifying social, functional, and political pressures likely to promote deinstitutionalization. Examples include increasing internal diversity as a social pressure, a lessening of rewards for conformity as a functional pressure, and shifts in resource dependence as a political pressure. Clearly, when institutional change is considered, isomorphism does not imply that organizations rigidly retain their current institutional practices, but instead that organizations shift from institution to institution over time, with the speed of change related to the strength and effectiveness of deinstitutionalization pressures.

Oliver (1997a) applied the observation of Scott and Meyer (1983) in distinguishing between two environments that exist simultaneously: (1) the "task environment," in which members compete over critical and scarce resources for survival (consistent with RD theory), and (2) the "institutional environment" in which members strive for conformity to gain legitimacy in order to survive. Oliver (1997) observed that studies supporting RD theory tended to be conducted in environments in which competition was high and resources critical but institutional forces were weak, while studies supporting the institutional environment were conducted in environments where institutional forces were high but competition was weak. Oliver (1997) studied the Canadian construction industry, which was characterized as high in both competition and institutional forces. She found more support for the link between resource

relations quality and firm performance than for institutional relations quality-performance.

However, “both types of relations contributed positively to performance when environmental constraints were severe” (Scott & Meyer, 1983, p. 117). This suggests a contingency theory for resource dependence and institutional forces. With regard to a computer simulation, an important environmental variable suggested by Oliver’s work is the rate at which organizations copy each other (i.e., the rate of mimetic isomorphism). Consequently, the probability that an organization copies another per simulation iteration can be manipulated: a high probability models an environment exhibiting high institutional pressures, while a low probability models an environment exhibiting low institutional pressures.

Since Oliver (1997a) measured performance, an efficiency measure, rather than effectiveness (such as the probability of survival) as the dependent variable in study, she was compelled to describe the potential benefits of institutional conformity to a somewhat greater depth than previously. To justify her prediction, and her empirical findings, that institutionalized firms perform better in institutionalized environments, the benefits of institutionalization must outweigh the benefits – a point that is not at all clear from a theoretical standpoint. She noted that, at least for the Canadian construction industry, the cost of institutionalization is a relatively small up-front cost, while the subsequent benefits include “higher consumer demand ... better access to financial and human resources, ... a source for direct funding ..., strategically useful information and contacts ..., lucrative business contracts ..., and influential product endorsements” (Oliver, 1997a, p. 103). In the computer simulation, I propose modeling the first benefit that Oliver highlights, higher consumer demand, by giving agent-to-agent transaction preference to those agents with higher legitimacy (i.e. more legitimacy “points) in their profile. For example, suppose an agent is looking to buy supplies from nearby agents, and in its scanning

finds two agents willing to sell it the supplies needed. It may decide to purchase from the agent with more legitimacy points in its profile. Of course, other agents may prefer to purchase on the basis of (lowest) price, and still others on the basis of transaction-lowering potential over the long term. Thus, we have arrived at three separate decision rules for agents buying supplies; one is legitimacy-based, the second is competition-based, and the third is supply-chain efficiency-based. Oliver's findings could then be tested over a much wider range of environmental variables than had been performed by her or any other researchers to date.

Dacin, Goodstein, and Scott (2002) introduced a special issue of *Academy of Management Journal* on institutional change. This special returned focus on Oliver's (1992) notion of deinstitutionalization, and added *reinstitutionalization*, making institutionalization a life-cycle type process. One major contribution that these authors, and the special issue, corrects a long-standing criticism of institutional theory by including agency and self-interest in the institutional process, as after all, institutions are established in organizations by individuals who no doubt have conflicting goals (Cyert & March, 1963). The implication, illustrated in several qualitative case studies in the special issue (Townley, 2002; Zilber, 2002; Kraatz & Moore, 2002), was that conformance through isomorphism is never complete nor homogeneously implemented so that there may be any number of new institutions waiting in the wings, each perhaps with its own champion or "entrepreneur" (Dacin et al., 2002, p. 47) ready to promote it; Kraatz and Moore (2002, p. 120) referred to this phenomenon as "startling impermanence," even for institutionalized practices that had become taken for granted. Furthermore, Kraatz and Moore (2002) observed that leadership change was a strong influence for institutional change; thus, some of the most effective institutional entrepreneurs are the organization's leaders. Furthermore, the particular types of institutions that new leaders ("immigrant executives", p.

138) establish were found to be largely dependent on their (functional) backgrounds. These findings support the practice of re-generating agent profiles after organizations have performed at a loss for a number of consecutive iterations, as discussed above. What the articles in this special edition also suggest, however, is that when one agent copies a profile from another one, it represents the beginning of the adoption of a different system that is consistent with the copied agent. Thus, any further copying might proceed by copying a different profile element from the *same* highly legitimate agent. De- and re-institutionalization can then be modeled as either sudden or by slowly replacing one profile with another. Furthermore, agents might only copy from legitimate agents with the same background and focus (buying, production, or sales). This rule should promote institutional heterogeneity across industrial populations.

A final contribution to the institutional literature that I will discuss here is

Washington and Zajac's (2005) discussion of an organization's status as a concept distinct from legitimacy and reputation. These authors saw "status" as the enjoyment of certain privileges as determined by social stratification:

"status ... refers to a socially constructed, intersubjectively agreed-upon and accepted ordering or ranking of individuals, groups, organizations, or activities in a social system. Status generates social esteem and special, unearned (i.e., non-merit-based) benefits known as privileges" (Washington & Zajac, 2005, p. 284).

In contrast, legitimacy refers to a "level of social acceptability" (Washington & Zajac, 2005, p. 284), while reputation fits more the "economist's notion of perceived quality" (Washington & Zajac, 2005, p. 282). Washington and Zajac (2005) applied the idea of status to the probability of acceptance into the NCAA post season basketball tournament and found that teams with higher status, and those teams that played the higher-status teams (whether they won or lost) had

a higher probability of selection, after controlling for year-to-year team performance. The implication for a computer simulation is that status should be modeled along with, and independent of, the modeling of legitimacy (reputation, on the other hand, refers to a non-commoditized industry and need only be applied in a relevant extension to the baseline model). Washington and Zajac (2005) noted that status can be gained by two mechanisms: through historical legacy, and the accumulation of positive associations, while they also noted two means in which status can be reduced: through decay in the absence of increasing status, and through the accumulation of negative associations. Thus, status gain and loss is, to a certain extent, contagious: simulated agents who transact with agents of lower status lose status “points” in their profiles (analogous to, but independent from, legitimacy points discussed above) while simulated agents who transact with agents of higher status gain status “points.” The original assignment of status points can be both a function of the resources an agent finds itself on at the beginning of the simulation (and at every subsequent resetting of the landscape) and randomly, to represent the status of the organization’s CEO (for example, a CEO who had graduated from Harvard might bring more status to an organization than a CEO with an education from, say, White Sands Community College, independent of the potential skills each CEO brings to the position). Every time a profile is reset, then, a component of the status in the agent’s profile must also be reset (and a component pertaining to the agent’s history retained).

Conclusions

What benefits of status should be modeled in a computer simulation? Washington and Zajac (2005) noted only the benefit of selection into a prestigious and revenue-enhancing tournament. Rather than affecting the probability of being selected, I propose instead to use the

status variable as a way to give priority to some agents, acting as buyers, to transact with selling agents, over other lower-status buying agents. Consider a situation with three agents, one with resources that each of the other two require to meet their respective demand. The buyer with the higher status is able to buy what it wants from the seller before the buyer with the lower status is allowed to buy. Thus, locally highest-status buyers are able to meet their demands first in a scarce-resource environment, but status levels are changing with every transaction and every move across the simulated landscape. Note that the idea of status serves the important social function in the simulated society of prioritizing the distribution of resources. Without this prioritization, the simulation might be considerably less realistic.

Behavioral Decision Theory

The practitioner journal *Academy of Management Executive* recently published a special issue on executive decision making. This special issue is useful here not for the recommendations given to real-world managers, but because more or less well-known authors have summarized their and others' work in top-tier research literature in a way that can be applied to rules in a computer simulation. The introduction (Ireland & Miller, 2004) and subsequent articles outlined current interests in the field of behavioral decision theory, from which I will discuss three areas that will be of interest to computer simulation. First, the decision speed/search tradeoff under conditions of bounded rationality was discussed in the issue (Nutt, 2004) and is considered an important variable in the decision-making process. Second, strategic flexibility is considered (Shimizu & Hitt, 2004) which somewhat parallels the shift from institutions to institutional change as discussed above, but in the reverse direction (the ability to reverse a poor decision). Third, strategic positioning is discussed in terms of strategic groups

and niching strategy not unlike Porter's (1980) framework, but with the added consideration of competitive dynamics (Ketchen, Snow, & Street, 2004). Fourth, the observation that strategic decision-makers must make complex decisions in uncertain environments has led to interest in research toward the reduction of uncertainty-reducing tactics. For example, options theory (Janney & Dess, 2004) and intuition (Sadler-Smith & Shefy, 2004) are two ways that are discussed in the special issue to cope with complex, ambiguous, and uncertain environmental conditions.

Decision speed represents a real-world tradeoff in managerial decision-making. On the one hand, decisions that are made quickly are done with relatively little information. While they have the advantage of quick action and low initial cost, quick decisions in complex environments are more often wrong (Nutt, 2004; Nutt, 1998) (or in our context, less than optimal) than decisions that take more time and are less comprehensive (Ketchen et al., 2004) in alternative consideration. Nutt (2004) suggests that most decisions are made too quickly and that managers should "invest time and money to identify a range of alternative solutions" (p. 27). This notion of decision speed as a variable is an intriguing addition to a simulation of organizations in different environments. It is assumed that faster decisions must be made in more dynamic environments, while slower decisions can be made in more stable and complex environments, but there is no study confirming this assumption. Furthermore, these assumptions are neither systematic nor comprehensive. For example, should decisions be made faster or slower in an environment that is both complex and dynamic? Thus, it will be useful to study decision-making speed and the number of alternatives considered in an extension of the baseline computer simulation developed here; for the purpose of building the baseline model, it is important to note that Nutt (1998, 2004) considers that different organizations approach decision-making speed

and the consideration of the number of alternatives as a variable at both the individual and firm levels of analysis. Thus, agents in the computer simulation should have such decision characteristics as elements of their profile. For example, a buyer might purchase from a supplier based on the first seller it finds in the environment, wait and compare two candidate sellers, or even compare and choose among three sellers (or more). We have arrived at four applicable stopping rules for the agent's action of environmental search: (1) buy from the first seller found; (2) search until two sellers are found and choose between them based on other elements in the agent's profile (such as choosing the seller with the most status points, the most reputation points, the highest price with supply-chain benefits expected, or the lowest price); (3) search until three sellers are found and choose from among these three as in (2) above; (4) search a pre-set number of spaces in the environment and make a choice among the sellers discovered. Transactions must be assigned sequentially in a computer simulation, and to take into account the expected positive relationship between decision speed and the number of alternatives considered, buyers who consider only one seller, and who search a minimum amount, will complete transactions before all other buyers, even those longer-searchers of higher status (discussed above). Therefore, transactions are sequenced in tiers, with status serving to rank each agent in each tier. To simulate the trade-off, search in each cell of the environment will cost an agent simulated cash that could have been used to buy or transform resources, so that a more extensive search will cost more cash.

Strategic flexibility, the second area of consideration in the *Academy of Management Executive's* special issue, highlights the ability for firms to reverse poor decisions (Shimizu & Hitt, 2004). Firms that do so are expected to achieve competitive advantage. The authors identified barriers to each of three components in the decision-reversal process: attention

(insensitivity to feedback, a complacent mindset, and organizational and psychological inertias), assessment (self-justification and politics), and action (none or too slow, and deference to the status quo). The point here for our purposes is that firms can and do reverse changes that they make, but to different degrees. The discussion of barriers (and how to overcome them) implies that most organizations do not reverse poor changes frequently enough, but it is also plausible that organizations reverse their changes too often, before a complete evaluation of its success or failure. Thus, I propose that change reversion threshold level also be a profile element: if profit/loss drops more than a threshold level after any simulation iteration (or after the average of one, two or three iterations – a profile setting), then change is reverted. In this way, simulation agents will tend to gravitate toward more profitable profiles, but loss in profits may not be caused by the changes *per se*, so that gravitation is somewhat haphazard (as in real organizations). At simulation setup, some organizations will be given a low threshold, and others a higher threshold, perhaps initially in a range defined by a uniform distribution. Successful agents are expected to exhibit a certain average threshold value, but this value is expected to change under different environmental conditions.

Related to strategic flexibility is decisions toward change in the forward direction, the Academy of Management special issue's third area of interest, that of strategic positioning within a given industry setting. The authors (Ketchen et al., 2004) addressed four issues requiring strategic decision: (1) market entry and positioning in new and existing markets, (2) how to respond to a competitive attack, (3) how to pursue market growth, and (4) deciding to compete or cooperate with fellow industry members. The discussion of each issue adds to our computer simulation in various ways. The first and third issues were addressed with the aid of Porter's (1980) competitive landscape, in which companies were plotted on a 2-dimensional landscape of

industry-specific competitive characteristics. The authors suggested that “managers simply classify firms along key competitive dimensions, such as market share, perceived product quality, geographic scope, or level of service provided to customers” (Ketchen, Snow & Street, 2004, p. 34). This idea has changed little from Porter’s (1980) discussion, thus confirming use of an enduring paradigm, that of competitive landscape, for a computer simulation of competing organizations. I only assume here (with opportunity for further extension) that the landscape dimensions are independent of agent characteristics and that mobility across the landscape is achieved with the same relative effort, although movement into other agents’ territories are more costly than other landscape areas, as discussed above. However, Ketchen, Snow & Street’s (2004) second issue, when to respond to a competitor’s attacks, adds depth and variability to the trespassing rule. While they suggest that responding to attacks is better if conducted sooner, this implies that different firms respond to intruding competitors at different rates. Thus, response time and magnitude of attack should be profile variables, with attack magnitude exacted at a cost to the attacking agent. It may be that under certain environmental conditions (e.g. high munificence), slow or no response might result in higher profitability than quick, high-magnitude responses because responses are not without expense which, in a high-munificence environment, may be needless.

The fourth strategic decision considered by Ketchen, Snow and Street (2004), deciding whether to compete or cooperate, followed Brandenburger and Nalebuff (1996) in suggesting that cooperation should be applied to the situation of creating a pie, while competition should be used when dividing it up. Since the baseline simulation creates the proverbial “pie” during program initialization, the decision to cooperate rather than compete may not be a requirement of the baseline simulation. However, a useful extension of the baseline may entail the potential

of collaboration between same-function agents in the creation of a second, alternative resource, or in the movement of agents from a crowded industry into an empty one. In this case, a simulation could be set up with only two industries, and the

An additional implied area of consideration is the decision for non-competition, from which Ketchen, Snow & Street (2004) drew upon the work of Chen and Miller (Chen, 1996; Chen & Miller, 1994) in competitive interaction groups and game theory as discussed by Brandenburger and Nalebuff (1996). In making this decision, the would-be attacker does well to consider the expected speed, probability and magnitude of the potentially attacked firm's retaliation. If each of these values is high, then the decision should be not to attack. In a simulation, this decision could be represented by moving away from the potentially retaliatory firm. As discussed above in the context of IO-economics, since Porter (1980) and now others (Ketchen, Snow & Street, 2004) consider non-competition as a primary consideration for non-competition, some simulated agents might give this consideration as a primary consideration in deciding where on the landscape to move to in the agent's profile. In this case, IO-economic theory drawn from Porter (1980) is explained in more depth by work on decision theory in the areas of competitive interaction, co-opetition, and game theory.

The fourth area of interest in the *Academy of Management Executive's* special issue were some of the tools that managers use to cope with apparently high levels of environmental uncertainty and complexity. Real options theory (Janney & Dess, 2004) analogically parallel financial options and refer to efforts that managers make to reduce future risk. For example, the hiring of interns is a real option: a manager takes an action to hire an employee on a temporary, trial basis for lower-than-average pay; at the end of the period, the manager has the option, but not the obligation, to hire the intern at full pay on a full-time basis. The simulation of a real

option could entail the purchase of an exclusive right to enter a non-territorial, unoccupied area for a specified number of iterations. At each of these iterations, the possessor of the option considers movement onto any part of the specified area; if it decides it should move on a spot. During this time, no other agent will be allowed to enter that area. This tactic may turn out to be profitable under highly dynamic conditions where the resource landscape is frequently and randomly reset, or an agent may reserve a right to occupy a desirable spot before it has the opportunity to actually move to it.

Intuition (Sadler-Smith & Shefy, 2004) is another tool that managers use to improve decision success rate in uncertain and complex environments. Sadler-Smith and Shefy (2004) defined intuition as “a capacity for attaining direct knowledge or understanding without the apparent intrusion of rational thought or logical inference” (p. 77). These authors saw intuition as a complement to rational thought rather than its antithesis, to be used only in extreme circumstances. For example, quick decisions require “cognitive economy” (p. 79), and intuition enables decision makers to take “mental shortcuts” (p. 83) in the course of arriving at a decision. Furthermore, surveys of managers identified intuition as especially important in making strategic decisions (Parikh, 1994), and interviews of executives (Hayashi, 2001) identified intuition as an important skill that distinguishes executives from middle managers. Clearly, any modeling of firm behavior at the organizational level of analysis as identified by Figure 1b must account for intuition.

Sadler-Smith and Shefy (2004) identified two types of intuition. The first type, intuition-as-expertise, is the application of feedback and memory toward the development of experience applied to new, non-routine decisions. This type of intuition can be modeled in at least three ways. First, the agent should keep in its profile a record of the least and most profitable

transaction partners. If there are more than three sellers that the agent must choose from, it will choose the agent with the closest likeness to the profile of the best-seller in its own experience. Second, intuition-as-expertise can be modeled by keeping lists of profile changes that are reverted from due to strategic flexibility (a “blacklist”) and changes that are considered profitable (a “whitelist”). In making future changes, agents are programmed to keep their whitelist changes and avoid changing back to blacklisted items. When a simulated CEO is replaced due to sustained poor performance, the black and white lists are retained in the agent’s profile. Note that this method does not always result in a correct decision, as for example, some whitelisted items may in fact be coincidental with improved performance and could have or should have been blacklisted instead, but neither is intuition always correct (Sadler-smith and Shefy). Like intuition in the real world, the use of blacklists and whitelists are expected to increase decision-making success among agents in the computer simulation. Variance across organizations can be arranged by randomly generating a profile threshold for each agent at initialization, but this threshold can be the same as the one already proposed in the modeling of strategic flexibility as discussed above.

The second type of intuition identified by Sadler-Smith and Shefy (2004), intuition-as-feeling, or “gut feel”, is perhaps the most difficult characteristic of management to model in a computer simulation, and perhaps the foremost argument against computer simulation as a methodology. This somatic type of intuition is described as “bodily senses [which] aid executives’ decision-making quickly and covertly sifting through fine details and providing feelings-based signals for or against a course of action” (Sadler-Smith & Shefy, 2004, p. 84). Thus, intuitive managers can sense slight trends and shifts in the environment through intuition. Toward modeling somatic intuition in agents, I propose that, in a highly complex environment

(with more than three sellers nearby), when determining which direction to move, agents calculate a vector of movement from among known nearby agents, at least for non-harvesting agents (harvesting agents depend on landscape resources for movement). This method replaces moving toward suppliers, and may be most helpful to agents' success when supplying agents are located on both sides of a buying agent. This rule is rational and does not fully capture the realities of somatic intuition, but it does allow for at least some element of sensitivity toward slight trends in the local environment. An analogous real-world example might be that of a restaurant owner deciding on whether to hire a new head chef for her restaurant: Should she hire an inexpensive head chef in order to provide meals at a budget price, or should she hire an expensive, well-trained gourmet chef at a much higher expense, but able to provide meals at much higher quality and potential profit margin? A non-intuitive, rational approach to deciding what type of chef to hire would be to conduct a study of the local population to determine if there is enough of an expendable-income representation to support an additional high-end chef in the local market of expensive restaurants. However, suppose that the population is dense and heterogeneous, making sufficient accuracy of such a study difficult to achieve. In that case, the restaurant owner might rely on her knowledge of the history of the area and sense of recent trends: how have other restaurants made this decision in the (recent) past, and how did they succeed with the choice made? The restaurant owner might be able to derive a feeling from her observation of the trend toward more expensive (or less expensive) head chef hirings in the area, and then quickly make a decision based on this feeling.

Enactment

Weick's (1969) enactment process has received rather consistent attention in theory building throughout the management literature. Recently, Danneels (2003) applied this perspective more explicitly. In this study of clothing retailers, Danneels described the enactment as a mechanism for tightening coupling (or narrowing of attention) with customers: "The paradox is that the same process that enables the firm to develop efficient transactions with its market restricts environmental inquiry and limits available options" (p. 560) which resulted in a "creeping commitment" (p. 569) of a firm to its current customers. Once retailers found a profitable strategy through feedback with its recurrent customers, they found it very difficult to change their product mix, and could do so only incrementally through experimentation in a slightly different product mix. This consideration of enactment suggests three additions to a baseline simulation study. First, agents should be restricted in their movement across the landscape since any movement represents a change in the agent's "product mix." Second, agents should have the option not to move at all across the landscape. Third, the more agents choose not to move across a landscape, the more restricted their movement should become so that, eventually, there is a very low probability of movement and very low range of search; however, a threshold of negative change in profit/loss should create a sense of urgency in changing the "product mix" and the probability should return to being high again. In other words, if a simulated agent finds a profitable spot on the simulated landscape, it will tend to stay there and lower its range of search; if that agent, after many iterations of seeing at least acceptable profits suddenly experiences poorer performance, it becomes mobile again and searches more extensively.

According to Gibson and Birkinshaw (2004) and He & Wong (2004), however, some firms are more ambidextrous (“aligned and efficient in their management in today’s demands, while also adaptive enough to changes in the environment,” Gibson & Birkinshaw, 2004, p. 209) than others. For ambidextrous firms, then, the rate at which they become sedentary is remarkably low, and ambidexterity was found to be empirically associated with firm performance. Thus, ambidexterity should be added as a profile element with a value randomly generated at program initialization. The extent of ambidexterity reflects internal organizational characteristics such as discipline, the use of challenging goals, mutual support between individuals, and a climate of trust (Gibson & Birkinshaw, 2004). Thus, the ambidexterity profile element provides a useful way to model important internal characteristics, as well as a way to validate the baseline simulation, since more ambidextrous agents should be more profitable.

Contingency Theory

When applied to determining the antecedents to competitive advantage, the contingency theory view of organizations stands somewhat in contrast to the strategic management view (Figure 1(b)) in that it sees environmental variables as mediators (as stated by Lawrence & Lorsch, 1967) to the strategic formulation process rather than as interactive moderators. Recently, Aragon-Correa & Sharma (2003) delineated this perspective when, in a natural environmental strategy context, they identified the relationship between the combination of external resources (following resource dependence theory) and internal capabilities (following the resource-based view) with a firm’s competitive advantage as shown (simplified) in Figure 3. This is perhaps a distinct difference between the strategic management perspective and that of contingency theorists: strategic management theorists see the role of the environment as a

parameter to adjust and fit to, while contingency theorists see the environment as constraint, to various degrees, on managerial action. For our purposes, testing the results of the baseline model for significance of Figure 1(b) versus that of Figure 3 allows us to characterize the baseline model at either a contingency-based simulation or a strategic-management oriented simulation, so that extensions of the model are framed appropriately. However, it must be noted here that the contingency framework will be taken as the model for the baseline simulation. Thus, I will set up a number (say, 18) of discrete environments and observe changes between important variables in each environment; a strategic-management perspective would require the generation of a number of different environments (say, 300) that are incrementally different so that each environment setting can be treated as a continuous variable. I expect that the latter design will be too burdensome to simulate to any publishable precision, at least with the use of current computing power; since the former design is groundbreaking in any case, I will pursue the former design now for the current study. Still, even with 18 environments, the strategic management perspective (Figure 1(b)) might be tested, albeit crudely.

Hough and White conducted two interesting contingency studies that contribute to our baseline simulation model. In their first study (Hough & White, 2003), the authors used behavioral (as opposed to computer) simulation at the decision level of analysis to confirm their hypothesis that high levels of environmental dynamism will mediate the relationship between the extent that rationality was applied in making the decision and decision-making quality such that in low levels of dynamism, there will be a nonsignificant relationship, while in a highly dynamic environment, there will be a strong and positive relationship. Actually, Hough and White (2003) claimed that environmental dynamism would *moderate* the rationality-decision quality relationship, but then they analyzed the variable as a *mediator*; this switch of language perhaps

confirms my observation above that strategic management theorists see the environment as moderators, while contingency theorists see the environment as mediators, as these contingency theorists probably felt compelled to change to the word, moderator in order to have this research note accepted by *Strategic Management Journal*. In any case, this study contributes to our baseline study in that it gives use a means to validate the incorporation of intuition by testing the quality of decision under intuition versus intuition under more rational processes. Hough and White (2003) also noted that pervasiveness (i.e. the extensiveness of environmental scanning) was associated with a reduction in decision quality in dynamic environments, but was positively related to decision quality in moderately dynamic and stable environments. The authors speculated that a cause of the negative relationship in dynamic environments might be due to the discovery of contradictory information upon more extensive scanning, which required time to resolve, subsequently reducing decision speed. In support of intuition (although this factor was not measures), the authors stated, “the frequent opportunities provided by the rapid pace of the dynamic environment may diminish the need to ensure that each decision is fully rational” (p. 486). In our baseline model, as discussed above, three relationships can be tested at the decision level for a number of different environmental conditions: rationality-decision quality, intuition-decision quality, pervasiveness-decision quality. Perhaps following Cyert and March’s (1963) methodology, one could consider decision quality (measures as subsequent profit/loss) as an independent variable and intuition, rationality and pervasiveness as independent variables in a least-squares hierarchical regression model, and comparing the coefficient of determination (R^2), or the contribution to the explanation of agent performance, for each variable in each environment. Confirming Hough and White’s (2003) results in this way might lend validity to the baseline model.

In their second study, Hough and White (2004) addressed the relationship between scanning actions, termed “pervasiveness” in the previous study, and environmental dynamism, with pervasiveness as the dependent variable. They discovered a different shape in the relationship between these two dimensions depending on the manager’s position in the managerial hierarchy: vice presidents and product developers exhibited an inverted u-shape (i.e., maximum pervasiveness at moderate levels of environmental dynamism), sales & marketing managers exhibited a u-shape (*minimum* pervasiveness at moderate levels of environmental dynamism), and manufacturing managers exhibited a linear, positive relationship. For our purposes, as we are attempting to model executive decisions with our computer simulation, we could test for model validity by discovering whether a u-shape between pervasiveness and dynamism is achieved. However, this study had nothing to say about either decision quality or background of the vice presidents studied. As discussed above, our simulation model takes background into account, in part in an effort to model the background of the decision-maker/CEO, and in part to model the heterogeneity of power across production, sales, and purchasing departments. It will be interesting to see whether the simulation’s results parallel either the vice president’s inverted u-shape, or whether profile background for each agent identifies different shapes, as in this study. Interestingly, this second study included sensing/intuiting as an independent variable, with the slope coefficient (with pervasiveness as the dependent variable) found to be significant and positive in a regression model. Therefore, not only should sensing/intuiting increase with increasing environmental dynamism as implied by the first study, but it should also increase with increasing pervasiveness of scanning, as shown (but not discussed) by the second study. The first observation is expected to be a characteristic of the simulation model’s output, while the second observation is part of the computer model’s

input, already stated, which enables agents to switch to an intuitive method of decision making (in terms of determining if and where to move across the resource landscape) when a threshold number of agents are identified as a result of scanning.

Population Ecology

In their introduction to a special issue on what they termed organizational ecology, Amburgey and Rao (1996) summarized progress in population ecology to that point, including Singh (1990) and Baum & Singh (1994), which both moved population ecology toward institutional theory and organization-level change, and both attempted to broaden the field beyond the ecological paradigm and toward an evolutionary one. Baum and Singh comment that

“the emerging ecological view is that organizational evolution can be best studied by examining how social and environmental conditions and interactions within and among populations influence the rates at which existing organizations and organizational forms are created, the rates at which existing organizations and organizational forms die out, and the rates at which organizations change forms”
(Baum & Singh, 1994, p. 4).

It would seem that this perspective is perhaps at a higher level of analysis, the level of the population, than we are interested in for our baseline computer model. However, sections of the volume (Baum & Singh 1994) departed from previous work by explicitly studying ecological processes and outcomes at different levels of analysis (Amburgey & Rao, 1996). In addition, commentaries by some seminal authors in this volume serve as a check of our model as it exists. We begin with two commentaries in Baum & Singh (1994), and then turn to empirical and

simulation studies in Baum & Singh (1994) and in the *Academy of Management Journal*'s special issue in 1996.

March (1994) observed that the view of organizational evolution is changing from an historical outcome perspective (i.e. a mechanism that explains some present state) to a process that produces history: "Much of contemporary interest in evolution is in describing the mechanisms that generate a path of history. These include reproduction, learning, choice, imitation, and competition" (March, 1994, p. 40). Perrow's (1986) criticism that only God can be attributed to any progress of evolution toward an improvement of organization-environment fit has been addressed by replacing "'God's will' or the 'unity of nature'" with "the will of individual humans" (p. 40). It is this contemporary perspective that allows for the methodology of computer simulation, where evolutionary phenomena are demonstrated through the observation of "the will of individually simulated agents." In fact, a number of studies found in this field are the closest, methodologically, to this present work (Lomi & Larsen, 2000a; Bruderer & Singh, 1996; Mezias & Lant, 1994), and presently serves to justify the current approach altogether. With regard to the mechanisms of interest to ecological researchers, their approach seems to cross with that of the institutional theorists: While institutional theory is moving away from inefficiencies (Selznick's goal displacement) as a result of institutional forces and toward rational and efficiency-creating institutional effects, March (1994) noted that the study of organizational evolution (ecology) is turning toward the study of *inefficiencies* in the process. This poses a problem in the model developed in this work, since we are attempting to develop a contingency theory, and we are employing, in part, evolutionary mechanisms to arrive at a useful, near-optimal set of organizations exhibiting high (and low) levels of organization-environment fit, or at least exhibiting high (and low) levels of performance. However, these

inefficiency-creating mechanisms must also be allowed to occur in the computer simulation because they are inseparable from the general evolutionary process. Thus, there must be elements in our simulation model that both accommodate and overcome March's (1994) list of evolutionary inefficiencies. March's first mechanism describes *long-term lags* in matching. This mechanism acknowledges that it takes a population a long time to converge on a fit that is anything approximating optimality, if it converges at all. The solution here is simply to simulate many iterations until stability is achieved. For example, Bruderer and Singh's (1996) simulation required 1,750 iterations before their genetic algorithm (discussed below) uncovered a viable organizational form; certainly this number of iterations is nearly trivial in terms of their model's computation time. March's second mechanism, *multiple equilibria*, takes into account that local conditions may be different from global conditions, so that more than one profile might exhibit high performance in a common environment. This mechanism is taken into account methodologically by conducting statistical analyses on the top performers in each environment (say, the top 10%) rather than the single top performer, and comparing them to the lowest performers. The third mechanism that March identifies is *path dependency*: evolutionary histories may take populations into nonoptimal directions from points in time that are dependent on prior environmental conditions, and sometimes, unusual events that permanently alter the population structure. The current model development intends to address this potential inefficient mechanism by generating a number of runs of the simulation and then summarizing central tendencies (or top and low performers) with statistical summaries. Fifth, the processes of *diffusion through networks* of interacting organizations tends to create outcomes that are isolated. Thus, evolutionary processes are in part dependent on network properties (network tie density, structural holes, etc.). These effects are expected to be present in the current simulation, but their

effects are not expected to be strong since network chains only contain three connecting segments (harvesters, processors, and retailers). Thus, the network in the simulation is somewhat less complicated than in reality, which should resist dominance of network effects. It is, however, reasonable to generalize the results of this study to populations of organizations involving more complicated networks if one assumes that, in general, network effects do not serve to isolate any segments of the population. In that case, the study of isolating network effects can be left for future study.

A sixth mechanism described by March is *mutual adaptation*. This mechanism describes evolution between the organization and its environment: organizations learn to exploit certain segments of the environment, but that exploitation results in a change in that segment, making further exploitation difficult (for example, firms move into a desirable market in such droves as to make the market no longer desirable). “These forms of mutual adaptation are likely to lead to stable outcomes that are not uniquely predicted by the internal environment” (p. 43). The solution here is to simulate a large number of organizations so that errant agents do not significantly affect statistical trends. We assume here that this is an acceptable level of noise in our data given that we will apply statistical analyses on many simulated agents.

The seventh and eighth mechanisms described by March (1994) are *multiple ecologies* and *nested adaptations*, respectively. Multiple ecologies (that is, the acknowledgement that real organizations exist simultaneously in multiple populations and as such few, if any, observed fits are near-optimal) are taken into account in a simulation by controlling the number of populations that any simulated organization gains membership to. In the case of the simulation of unrelated diversification (discussed below as a model extension), simulated organizations can be studied at different levels of analysis – at the level of the strategic unit, the environment (when related

diversification is also allowed) and the aggregate organization. Nested adaptations acknowledges that different parts of organizations adapt differently to different environments at different, cumulative levels of analysis. Thus, individuals (organization members) each adapt in their own way, as does each strategic unit, organization, and population, in an interactive chain of influence. Analogous to the minimization of network effects through interaction chain simplification, this mechanism is mitigated through simplification of the organization in that each agent includes one head decision maker (represented by the agent's profile) that receives requests for resources from three internal influences (purchasers, processors, and sellers). Nesting is still allowed to occur, but in this simplified form, multilevel analysis techniques can competently separate levels effects.

Two distinctions are implied by the above discussion of March's (1994) mechanisms of inefficiency. First, the current model is developed to reasonably account for organizational phenomena on its way to developing extensions toward contributions in a wide range of fields in management theory; the current study is not for now, however, particularly interested in organizational ecology/evolution itself, as this is left for a potential model extension study. Usher and Evans (1996) demonstrated empirically that both mechanisms of transformation and environmental selection/replacement typically exist to varying degrees, depending on the relative success of the organizational form adopted (more successful forms were arrived at by transformation; less successful forms were dominated by selection/replacement). Thus, any reasonable general simulation of organizations, such as the one developed here, must account for both processes. This suggests that, when consistently poor-performing agents re-generate profiles in an effort to survive, about half should retain their black/whitelists (to simulate

transformation), while half should discard the black/whitelists altogether and begin with a completely random regeneration of its profile (to simulate ecological replacement).

The second distinction is that none of the real-world or simulation studies considered here simultaneously accounts for and mitigates all of the inefficiency mechanisms described by March (1994). For example, Usher and Evans (1996) and ignored any possible network and nesting effects, Bruderer and Singh (1996) failed to accounted for nesting but not networks, and Lomi and Larsen (1996) avoided the possibility of multiple equilibria by keeping to one set of evolutionary rules. It may be that the model being developed here is more generalizable with regard to the study of ecology/evolution, but with regard to the first distinction, the present model is certainly more generalizable to applications other than the study of ecology/evolution. The tradeoff in the current study is computation time. As Lomi and Larsen (1996) note:

“We are not aware of any work that has implemented such a model [that includes for multiple sets of evolutionary rules], possibly because – if the number of possible combinations is left unconstrained – the computational burden quickly becomes prohibitive” (p. 1316).

It is possible, however, that multiple equilibria can be allowed for, yet computational burden kept reasonable, with the semi-controlled expansion of evolutionary rules. By this I mean that selection (organizational death) and replacement (in this case, of a failing agent’s profile) can occur by a controlled number of simple possibilities such as after a number of periods of poor performance proportional to the extent of access to further financial resources, as discussed below, and the variable number of iterations with poor performance before profile elements are replaced. Thus, the present model employs a closed set of rules with unpredictable outcomes, at

the expense of longer computation times. Furthermore, computing speed has increased some 50 times since 1996, so the extra “computational burden” may not be evident at all.

The second commentary I will discuss involves the mechanisms of survival subsequent to sudden shifts in the competitive landscape (Levinthal, 1994). An organization may find itself a top performer with ready access to scarce resources and heavy demand for its products at one moment, but in a Schumpeterian environment experience a sudden shift whereby resources suddenly cannot be acquired in desirable quantity, and demand for its product has diminished. How might such an organization survive in the altered competitive landscape? One way might be survival through longer poor-performance periods until the organization is able to transform its competitive position, which can be achieved through increased access to financial resources. Pfeffer & Salancik (1978) suggested, for example, that access to financial resources might be gained through external financial network ties of members of an organization’s board of directors. Simulated agents could exhibit variance in financial resource access by allowing for differing periods of time (simulation iterations) before organizational death in each agent’s profile. Agents could gain access to financial resources in proportion to its increase in status as the simulation proceeds. Thus, each iteration of the simulation would need to include an adjustment of allowable iterations before death after each agent’s status is considered for adjustment. A second factor for nonevolutionary survival/selection identified by Levinthal (1994) is social capital, but I expect this factor to be taken into account by both status and legitimacy, at least in terms of the task environment.

Yet another mechanism identified by Levinthal (1994) is learning capacity: some organizations have more of a capacity for learning different routines and producing different products (when demand shifts) than others. Learning is modeled in our simulation by the

maintenance of profile items that are blacklisted (avoided) and whitelisted (retained). Capacity for learning might be modeled by each agent's profile being able to accommodate a variant number of black/whitelist items, with each item entered and erased in FILO (first in, last out) order. Thus, agents with long lists have longer memories, but are less capable of forgetting what they have learned after environmental discontinuities are experienced. Some intermediate level is expected to exhibit optimal learning "capacity," but the specific value is expected to increase upon increasing rates of landscape resets (a property of the simulated environment).

In a combination of ecology and institutionalization, Mezias & Lant (1994) applied computer simulation to the study of the density dependence of the proportion surviving firms that had been founded by copying existing forms (the process of mimetic isomorphism) as opposed to those formed randomly (the process of ecological variation) under various environmental conditions. Thus, the authors relaxed the long-standing assumption in ecological studies that organizations act, or can be modeled to act, randomly in uncertain environments (after Hannan & Freeman, 1984). The proportion of mimetic firms were found to increase with increasing munificence, a u-shape with increasing environmental (in)stability, and u-shaped with increasing magnitude of environmental change. The significance of this work is that it confirms the coexistence of simultaneous institutional pressures (of the mimetic type) with ecological effects, analogous to Usher & Evans' (1996) findings of the coexistence of organizational transformation with selection/replacement, and Bruderer and Singh's (1996) findings supporting accelerated evolutionary change with the coexistence of organizational learning. This observation shores up the argument for an integrated approach in this work: institutional effects, learning, ecological mechanisms, and an organization's purposive choice are all simultaneously coexistent, and realism in a computational model increases when they are all included as elements of the model.

Conclusions

This first segment of my survey of the literature is perhaps the most important and critical, as such a review has not been conducted previously. We have developed all of the major components of a computer simulation as directed by the field of organization theory and, to a lesser extent, strategic management. In so doing, we have justified the use of a landscape-type, agent-based configuration where agents make decisions on work, interaction and competition based on their profiles which evolve in a kind of punctuated equilibrium according to institutional pressures and experiential learning. We have also developed a rather detailed account of an agent's profile, as summarized in Table V. This profile, environmental variables as indicated in Tables III and IV, and the baseline simulation framework as summarized in Tables II and IV, will be carried forward to the development of a set of simulation algorithms. The objective here was to maximize theoretical integration and the number of simulation guidelines without regard to any consideration of complexity or possibility of convergence (i.e., the ability of a computer simulation run to reach its end) in a subsequent simulation model. The next section reviews useful tools in the computational organizational theory literature that increases simulation simplicity and the possibility of convergence so that both complexity (this section) and simplicity (next section) might be parsimoniously integrated into a set of algorithms, and finally, a validatable, programmable code. Extensions of the simulation could then be applied toward the study of salient issues in strategic management and organization theory literature.

CHAPTER 3. LITERATURE, PART II: BASELINE MODEL EXTENSIONS

In this section, literature reviews are conducted of three proposed extensions to the baseline model outlined in Part I. The approach here, as discussed further in the Methods section below, is to study an issue in strategic management (or organization theory) through a specific model extension rather than through the baseline model itself. A similar approach was taken by Prietula (2000), in which a baseline code, named “TrustMe,” was developed and run twice (once for independent agents, and once for dependent, interacting agents), and then extended to include conditions such as a turbulent environment and deceptive behavior, with each new condition constituting a new simulation run. Also, at the Center for Computational Analysis of Social and Organizational Systems (CASOS), Kathleen Carley maintains baseline models ORGAHEAD (extended in Carley, 2000 toward the study of different learning styles), a tool for examining organizational adaptation, CONSTRUCT-TM, a computational model of the co-evolution of people and social Networks (a slightly different baseline model, CONSTRUCT-O, was extended to study learning, memory, and organizational structure among decision-making groups of agents in Carley & Hill, 2000), and DyNet, a computational model for network destabilization, among others; each named computational model constitutes a baseline upon which specific issues of complex systems are studied through end-user defined baseline model extensions. In the current study, the baseline model, constructed from OT guidelines, is extended to address issues in strategic management: diversification, agency-stewardship balance, and ethics and entrepreneurship. My objective is to develop a contingency theory of sorts by substituting “structure” in classical contingency theory with organizational characteristics such as diversification and CEO behavior through an output analysis of three separate extensions of the baseline model. Of course, these are not the only possible extensions, as a

number of other simulation model extensions toward the study of other issues such as have been discussed in Part I; those issues, and others, are left for future work; the current work focuses on the three issues that are discussed below because of the frustration in the literature of the current body of empirical work (diversification), relevance to and advancement in this author's published research which might not be otherwise possible (agency-stewardship balance), contribution to an emerging field of literature (entrepreneurship and ethics), and in general, each issue may be modeled as complex processes based on simple rule sets. The remainder of Part II discusses diversification, agency-stewardship, and entrepreneurial ethics with the goal of developing simulation guidelines and research questions that will be addressed by each of the three baseline simulation model extensions. In the literature review of each extension, as in Part I above, guidelines for computer simulation are established. These guidelines are summarized in Tables VI and XII, for diversification and CEO behavior, respectively.

Diversification

The Early Paradigm: Limits to Economies of Scale

Diversification is a cornerstone issue in strategic management (Palich, Cardinal Laura B., & Miller, 2000; Chatterjee & Wernerfelt, 1991). While population ecology models (Hannan & Freeman, 1977; Aldrich, 1979) have de-emphasized the role of the managerial decision, the executive decision with regard to whether and how to diversify stands as an obvious exception to this view (Bowman & Helfat, 2001), and according to Ansoff's (1965) exposition of one large company's (Lockheed's) corporate management process, diversification constitutes a key decision step. In the early paradigm literature, the important issue of diversification across

nearly a century is traced in terms of public policy, the optimal degree of diversification, and the connection of diversification with performance.

With regard to public policy, the early paradigm debate centered around the issue of who benefits from diversification, and whether it was a benefit to society. Examples of greed and avarice of the leaders of large monopolies could easily be found, but examples of conscientious managers' pursuit of efficiency through diversification could also be found; the point of contention seems to have been which example served as the rule and which the exception, and thus on which "rule" to base federal legislation. From the latter 1800's to the 1950's, diversification-to-monopolize was seen as the rule. A telling example of this point of view was recounted by Louis Brandeis (Brandeis, 1911; five years before Brandeis was appointed a U.S. Supreme Court judge) during his testimony to the United States Senate's Committee on Interstate Commerce. At that time, the U.S. Senate committee was considering the necessity of the La Follette bill, which would have served to supplement the Sherman Antitrust Act of 1890. This moment in history allowed the senators to reflect on the corporate strategy of diversification, the effectiveness of the Sherman Act, and whether the idea of the act had been consistent with Congress' intentions. Brandeis testified that large, diversified firms could be split up into two groups – those that failed and those that were a success. For those companies that failed, they all apparently shared in common that they "lacked the ability to control prices" (Brandeis, 1911, p. 1148), while the successful companies were able to become successful only at the expense of society by controlling prices through monopoly. In either case, consumers suffered from large, diversified companies through the deteriorating quality of products sold, and in the worsening conditions of the companies' employees. Brandeis placed the blame squarely on those individuals at the corporate apex, referring to corporate executives of large firms as

practicing “irresponsible absentee landlordism” and having “a certain degree of wealth without responsibility” (Brandeis, 1911, p. 1156). The senators were apparently perplexed as to how to prevent monopolies from occurring, and considered whether corporate size limits should be re-imposed, as evidenced by the following exchange between Senator Newlands and Mr. Brandeis:

“Senator Newlands: Mr. Brandeis, what limit would you place upon the size of corporations?”

Mr. Brandeis: I should not think that we are in a position to-day to fix a limit, stated in millions of dollars, but I think we are in a position, after the last 20 years, to state two things: In the first place, that a corporation may well be too large to be the instrument of production and of distribution, and in the second place, whether it has exceeded the point of greatest economic efficiency or not, it may be too large to be tolerated among the people who desire to be free....

Senator Newlands: Do you think it would be in the power of the United States Government, by act of Congress, to limit the size of state corporations...?

Mr. Brandeis: I do not suppose it would be constitutional in one sense to limit their size, but I suppose Congress would possess the constitutional power to confine the privilege of interstate commerce to corporations of a particular character.

...

Senator Newlands: ... Now what standard would you phrase it?

Mr. Brandeis: I do not think that I am able at this time to state the exact provision which I should make.... I am very clear that the maximum limit could

not be properly fixed in dollars, because what would be just enough for one business would be far too much for many others.

Senator Newlands: Then, if it is not fixed in dollars, would it not be necessary to fix it in respect to the area of the operations, the proportion of the business, or of the industry which the corporation would be likely to absorb?

Mr. Brandeis: There is embodied some such suggestion in the La Follette bill.... The La Follette bill provides that where there is found to be a combination in restraint of trade, if the combination controls 40 per cent or more of the market, that creates a presumption of unreasonableness” (Brandeis, 1911, pp. 1174-1175).

With this exchange, the Senate Interstate Commerce Committee was directed by Mr. Brandeis away from limiting the size of corporations and toward limiting their market power. Meanwhile, it was left up to corporate managers to determine what might be the most efficient size for their corporations, as growth was unlimited if the firm could expand into multiple markets (leaving economies of scope unregulated) with no less than a 40% presence in each market. At the same time, Arthur Dewing was concurrent with Mr. Brandeis’ view in his scholarly publications. One early article, which investigated the expansion and subsequent failure of the United States Leather Company (Dewing, 1911), found U.S. Leather to be “notably free from fraud or deceit” (p. 104); its failure was neither the result of corruption nor keen competition, but rather, “inadequate business foresight and managerial power” (p. 103). Thus, exactly concurrent with Mr. Brandeis’ testimony above, large corporations must (above some idiosyncratic size threshold) be either successful monopolies or abject failures.

Dewing later followed up his anecdotal evidence with statistical evidence (Dewing, 1921). In this study, he measured firm performance by three standards: (1) the net profit of the merged corporation should be greater than the sum of the profits reported by the companies just before the merger; (2) the net profit should be near the expectations of the merger's proponents, and (3) the merged firm's average net earnings should continue to increase over a long period, say, ten years. Choosing 35 industrial mergers at random, Dewing found that "the aggregate earnings of the separate competing establishments prior to consolidation were seven-tenths of the earnings estimated to follow consolidation" (Dewing, 1921, p. 90) and that "the earnings before the consolidation were nearly a fifth greater (18%) than the earnings of the first year after consolidation" (Dewing, 1921, p. 90.). "Nor were the sustained earnings an improvement, for the earnings before the consolidation were between a fifth and a sixth greater than the average for the ten years following the consolidation" (Dewing, 1921, p. 91). Thus, presumably well-meaning large mergers became too large to succeed.

While the observations of Dewing and Brandeis were concurrent, their explanations diverged somewhat. Concurrent with Dewing's (1911) study of the United States Leather Company, where he found fault with the company's management, Brandeis applied a bounded-rationality-type rationale long before Simon (1945) applied the idea explicitly toward managerial decision making. According to Brandeis,

"Anyone who critically analyzes a business learns this: That success or failure of an enterprise depends usually upon one man; upon the quality of one's judgment, and above all things, his capacity to see what is needed and his capacity to direct others.... Now, while organization has made it possible for the individual man to accomplish infinitely more than he could before, ... there is a limit to what one

man can [know] well.... When, therefore, you increase your business to a very great extent, and the multitude of problems increase with its growth, you will find, in the first place, that the man at the head has a diminishing knowledge of the facts and, in the second place, a diminishing opportunity of exercising a careful judgment upon them” (Senate Committee on Interstate Commerce, 1911, p. 1147).

Thus, organizations can become too large for any individual to comprehend. Beyond this point in corporate size, the organization’s leader makes less-informed decisions, which inevitably leads to mistakes and failure.

In contrast to Brandeis’ explanation, however, Dewing (1917) developed his Law of Balanced Return, in which he stated that “there is a point of maximum productivity as the quantity of labor and of capital is increased, but that this point varies in position according to the relative proportions of capital and labor represented in the final product” (Dewing, 1917, p. 766). Below this “point of maximum productivity” (by which he meant maximum efficiency), when a company increases in size, it can realize economies of scale; after the “maximum point” is reached, for any further increase in company size, diseconomies will be realized. Furthermore, the maximum point was contingent upon the human intensity of the final product. If many machines (what Dewing termed “capital”) can be used to manufacture the product(s), then firms can grow large; however, if many people are used in proportion to machinery, the maximum efficiency point in corporate size is relatively small. Thus, large corporations have, on average, failed miserably (Dewing, 1921) because they have surpassed the size at which the maximum of efficiency might be realized (Dewing, 1917). Thus, a paradigm (Kuhn, 1996), or at least a predominance of understanding, had likely been established among early diversification

researchers in which the view of large companies was largely a negative one, the result of either a harmful monopoly or a managerial mistake believed to be caused by either diseconomies of scale, bounded rationality of executives, or both.

A Paradigm Shift

According to my review of the literature, it was not until 1935 that empirical evidence contradicting this paradigm allowed for an alternative interpretation of empirical data. Livermore (1935) challenged Dewing's "the trust turned out ill" (p. 68) hypothesis with a sample of his own, wherein "the successful concerns in the whole group form slightly over one-half of the total.... The percentage is far higher than students of the merger period and its results have previously indicated" (p. 76). Furthermore, the merged companies studied were generally more profitable and more stable in their profits than industrial firms in general. With regard to success through patent rights and monopoly, "less than 15 percent of the whole group can be said to owe success to these twin causes" (Livermore, 1935, p. 88). To the contrary, Livermore (1935, p. 88) cited managerial discretion as the cause of success: "Instead of being hampered by internal managerial problems, a majority have displayed unusual resourcefulness and flexibility in meeting problems of management." Livermore's study represents the beginning of a paradigm shift toward the perspective that large corporations made through merger may in fact be beneficial to society, owners, and management, as long as the merged organization's managers are sufficiently resourceful. In fact, the different results in Livermore's study compared to that of Dewing's may have been the result of a fundamental way of organizing, that of "decentralizing" (Livermore, 1935), which was only "discovered" in 1921 by the executives at du Pont, and soon afterward spawned the country's first wave of popular business publications

(Chandler, 1962). Thus, the data itself may have shifted; Dewing's negative empirical study was published in the same year that du Pont made their now-famous reorganization, and could not have taken the new organizational form into account. Dewing's data therefore measured large-firm performance operating under functional structures, while Livermore's study may have shown positive results because of the increasing popularity and implementation of the "new" divisionalized structure. Livermore (1935) saw monopoly and control as the exception, while the efficiency-seeking manager became the rule, in the explanation of why large firms might merge and otherwise grow large. Still, it was not until Penrose (1959) and Chandler (1962) derived theory of sufficient persuasive weight that the new paradigm had gained dominance over the old.

Penrose (1959) noted that corporations grow and become large because of management's relentless search for efficiency in their current operations. Managers diversify to exploit the special knowledge and skill that is developed among all employees during their current operations because there are always micro-inefficiencies in any production process. Thus, firms grow and become large out of their micro-level exploitation of resources in order to achieve economies of scope. For example, a chemist might be employed to develop a solvent, but once her work is largely complete and passed on to production personnel, that chemist's knowledge might be applied to the development of a dye process, then a paint process, etc. In this way, Penrose (1959) made a distinction between two types of corporate leaders: entrepreneurs and managers. Entrepreneurs were described by Penrose as those individuals who cared more for prestige, power, and wealth, than for efficiency and profit; managers were characters of the converse: always striving to maximize shareholder wealth by maximizing efficiency and revenues. Taking the entrepreneurial situation as the exception, and the managerial situation as

the rule, Penrose proposed that it was not size by which efficiency met a balanced return, but the rate of growth of a firm. She argued that it took time for managers to learn diversifiable knowledge and skills, and if managers expanded their company too fast, inefficiencies would result. Mergers were seen by Penrose as a mechanism by which the maximum growth rate could be increased, but the existence of an optimally efficient size could not be identified. This measurement, the growth rate of the firm, offers an alternative measurement that has not been tested in the empirical literature; after all, limits to growth rate may have more to do with individual differences within the management team (each manager's learning capacity, intelligence, experience, etc.) than some measurable quantity (such as Dewing's equipment-to-human worker ratio). In a computer simulation, however, all simulated agents are created with only a small, finite set of individual differences, making it possible to measure, and possibly test, Penrose's growth-rate-limit hypothesis. Furthermore, not only can and should the rate of growth of an agent's size be measured, but also the rate of diversification. For example, a firm may be able to grow faster, without a loss in efficiency, using a related strategy rather than an unrelated strategy because, as Penrose might argue, that it will take more time and attention to understand an unrelated expansion than a related one. Of course, "understanding" must be simulated in order to test this hypothesis. This can be done by the implementation of a search routine for investigating mergers by simulated agents. Thus, a simulated agent might conduct a search in an industry it is considering merging with by comparing a minimum number of interested agents found as a result of the search. Such a search costs the searching agent time and expense. After it makes an offer, there is a less-than-100% chance that the merger will actually take place. In this way, agents with propensities (profile elements) to diversify aggressively with less search effort are expected to grow and/or diversify faster than growing agents that spend more time

searching before choosing an agent to merge with. Also, Penrose's microinefficiencies might be simulated by programming agents (another profile element) with a threshold accumulated value before engaging in merger activity. The structural organization of a merger, what the organization might look like after a simulated merger takes place, is next addressed *via* a discussion of Chandler (1962).

Chandler's (1962) historical evidence supported Penrose's (1959) theory, even though Chandler's work was finished before Penrose (1959) was made available (Penrose, 1995). With regard to the entrepreneur/manager dichotomy, Chandler noted that, in the cases of du Pont and General Motors, it was not until these companies' founders (Penrose's entrepreneurs – Henry du Pont and William Durant, respectively), whom Chandler (1962) termed industrial imperialists, turned over their respective companies to managers (Peirre du Pont and Alfred Sloan, respectively) that efficiency through managerial control was even considered. While each organization arrived at a diversified organization from different motivations (du Pont from war-to-peacetime business conversion; General Motors from imperialistic expansion of its entrepreneurial founder), each diversified firm that Chandler studied arrived at organizational structures that were very similar to each other, and each appeared to Chandler as a decentralized, divisionalized structure. It was this structure that allowed for Penrose's theory of growth to work most effectively: If management had acquired sufficient skill and knowledge in a particular area sufficient to diversify, these managers could set up a separate division in order to sell new products to these new customers. The responsibility of disaggregate success or failure would rest on this new division's leaders, and it is this incentive that would motivate these new managers to succeed. In contrast, the functional structure lacked both the necessary motivation for success, and the appropriately separable measures of performance with which an objective

central office might determine the success or failure of the new division. The same rationale can be applied to diversification by acquisition in that an acquired firm now becomes a “division” in a larger structure and its managers become independently responsible for its performance and success. An unsuccessful division that performs poorly can be sold without substantially affecting the rest of the corporation, and Penrose (1959) pointed out that the ensuing market for buying and selling of corporate divisions results in a substantially more efficient economy. However, after investigating the history of a number of U.S. industries, Chandler (1962) noted that there were some industries that were slower to convert to the more efficient organizational state than others, but he maintained, through his “structure follows strategy” proposition, that there was still a use for the functional structure when a single-business strategy is pursued by a company’s management (while a divisionalized structure followed from a strategy of diversification).

Chandler’s (1962) observations offer both a means by which simulated diversified agents might diversify, and an interesting area for study under simulation. The former offering suggests that diversified organizations containing multiple agents need not be reorganized, but consistent with the M-form structure, may keep its own separate operations, with the exceptions that the acquiring agent’s profile be applied toward decision making (simulating the firing of management of an acquired firm) and that the organization’s wealth be stored, and distributed, centrally. The latter offering suggests that the firm’s task environment influences the state of diversification in a firm. From a population ecology perspective, one might say that certain firms, with certain diversification properties (rate of growth, extent of related diversification, extent of unrelated diversification, etc.) are selected out of the environment, while other better-fitting ones survive. Thus, we would expect to see in a simulation, after first initializing the

model to produce a wide array of different agents in different task environments (along the dimensions of the environment as discussed above), surviving agents with certain common characteristics at the end of many simulation iterations, with different successful characteristics emerging when the agents are exposed to different environments. If diversity can be thought of as an organizational structure, then this approach suggests a contingency theory of diversification.

We have thus arrived at two emerging themes from the discussion of the diversification literature to this point: (1) the efficiency debate in which sides are taken as to whether firm size reaches a point at which further growth is inefficient, or whether size is not at all a limiting factor, but instead what is limiting is the rate at which firms grow; and (2) diversification is contingent on conditions in the task environment. These two themes will be highlighted throughout the remainder of this review.

Normative Analysis: The Classification Approach

With the establishment of the new paradigm, wherein corporate growth and efficiency are believed to be positively related through economies of scope, researchers turned toward identifying different types of diversification strategies and associating them with different levels of performance and types of structure. Chandler's (1962) work was closely followed by Ansoff (1965), who developed a detailed flow chart of the decision process of corporate executives, at least in the case of Lockheed, a corporation that Chandler did not investigate. Part of this decision process flow chart included the decision to diversify, with diversification being an important "growth vector component" (p. 109) which involved both new products and a new mission; if only one of these or neither (product and mission/market) were required to be new,

the action was called merely an “expansion” (p. 128). Thus, Ansoff (1965) allowed for unrelated diversification (what Ansoff called “diversification”) as a viable strategic choice for managers, rather than only related diversification (what Ansoff termed “expansion”). This is a significant departure from Penrose’s (1959) growth theory, which accounted for unrelated diversification only as an inefficient entrepreneurial activity. However, Ansoff (1965) explained that managerial types (as opposed to Penrose’s “entrepreneurial” types) of corporate decision makers might find more reasons to diversify in an unrelated fashion. Importantly, Ansoff (1965) tied unrelated diversification to managerial choice, as part of an overall decision making process. He noticed that the goals of the firm may be closely related to emergent opportunities, which required goal flexibility: “The absence of an absolute ‘proper’ set of goals for a firm gives the management great latitude in exercising its risk preferences” (p. 131). Thus, choice of diversification is not separate from choice of, or preference for, the firm’s risk level, so that diversification level and risk level are inexorably linked. This view anticipated the portfolio management approach to unrelated diversification, as discussed below.

Rumelt (1974) extended Ansoff’s related/unrelated product/mission divisions (although Rumelt only cited Wrigley, 1970, as his main source) into a 4-division classification, with 5 sub-divisions, resulting in 9 different diversification strategies that corporate executives might employ. A comparison of Ansoff’s (1965) and Rumelt’s (1974) typologies are shown in Table VII. Clearly, the present product, present mission/market strategy of Ansoff can be associated with Rumelt’s single business and dominant vertical categories. At the other extreme, Rumelt’s three unrelated categories can be associated with Ansoff’s “diversification” strategy, the difference in Rumelt’s subgroups being only a matter of degree, measured in proportion to total corporate revenues. As for Rumelt’s linked strategy, it is possible that such diversity might arise

by alternating the two new/same mix strategies, as after only one alternation, the ends of the linked chain appear unrelated. A firm might fall into one of Rumelt's constrained strategies by following one of Ansoff's mixed strategies, but not both. This marks a fundamental difference in the development of diversification theory: in operationalizing diversification strategies, Rumelt's (1974) typology veered away from measurement of diversification and toward measurement of diversity, albeit at three different points in time (over ten years). In other words, Ansoff's theory was relevant toward the next singular diversification decision that might be made by a corporation's executives, while Rumelt's typology looks back, with selective bias, on a corporation's decision history, from a particular point in time. The benefit to Rumelt's (1974) typology is that data can be collected for reasonably valid, yet unavoidably subjective, categorization, whereas Ansoff's theory might only be testable if the researcher were observing each diversification decision as it was made, and in any case could only be ambiguously linked to the success of that single decision. On the other hand, Rumelt's typology takes the sum of numerous decisions – some that were successful and perhaps others that were unsuccessful – and compares it with an aggregated performance score. The result is a disconnection to some extent between diversification theory and the diversity that is actually measured.

Despite this disconnect between theory (diversification) and operationalization (diversity), Rumelt (1974) found diversification strategy to be significant predictors of dependent variables which included measures of growth (in sales, earnings, and earnings per share) and firm performance (return on capital, return on equity, and price-earnings ratio) when a weighted regression model was applied to a random sample of 100 firms from the Forbes 500 list in the years 1949, 1959, and 1969 (a total of 246 different firms). Using the four categories, his weighted model was able to explain only about half the variance (R-squared) that could be

explained by the full, 9-category model, which for Rumelt provided validity and justification for the full 9-category model over the 4-category model. In Rumelt's words:

“We are led to the conclusion then that the system for capturing the essence of top management's goals and concept of the corporation's purpose and scope is a better predictor of financial performance than simple measures of diversification. This result helps to validate the system of categories used here because it provides me assurance that at least a portion of reality has been captured.

Although performance differences existed among the major categories of diversification strategy (Single, Dominant, Related and Unrelated), the explanatory power of the system was more than doubled by breaking these categories into subcategories” (Rumelt, 1974, p. 152).

By “simple measures,” Rumelt was referring to so-called product count studies conducted by Gort (1962) and Eslick (1970) which found little or no correlation between performance measures and 4-digit Standard Industrial Classification (SIC) product counts. Clearly, Rumelt (1974) was arguing that his categorization method captured in sufficient strength Ansoff's theory of management strategy, at least the growth component of Ansoff's theory, while others (neither Wrigley's 4-category system nor Gort's 4-digit SIC product counts) could not measure management's strategic growth decisions with any acceptable level of significance.

Rumelt's (1974) main findings included a grouping of diversification strategies with performance, and a test of the reasons for diversification that had so far been offered in the literature. With regard to strategy grouping by performance, Rumelt (1974) found the highest performers to be corporations in the Dominant-Constrained and Related-Constrained categories,

while the low-level performers were the Unrelated-Passive and Dominant-Vertical categories (moderate performers were Related-Linked, Single Business, and Acquisitive Conglomerate). Rumelt explained the persistence of the low-performers by first noting that Dominant-Vertical corporations experienced significant barriers, both psychological and material, to broader diversification, given that those still Dominant-Vertical firms were found in heavy industries which required massive capital outlays, such as those companies in the aluminum and steel industries. Alternatively, Unrelated-Passive firms were characterized as firms that either had grown too quickly through the merger of two large corporations – consistent with Penrose’s (1959) growth proposition – or firms that had found Dominant-Constrained and/or Related-Constrained configurations unsuccessful. Thus, Rumelt proposed that it was not that executives chose a diversification that they thought might result in the best performance, but more likely that executives found themselves in a situation-moderated interaction between performance and choice of diversification strategy. Rumelt’s executive decision-makers chose the best-performing diversification strategy given the situation that the corporation found itself in.

Rumelt’s (1974) test of the reasons for diversification that he offered is summarized in Table VIII. Of these results, perhaps most surprising was the lack of support for the Portfolio Risk explanation, as this explanation was a simple extension of stock portfolio investments at the individual level that is commonly used in financial analysis. Results indicated that those firms with the highest risk-premium ratios (RPRs) were also the highest performers (Related-Constrained and Dominant-Constrained firms), so the numerator (growth in earnings per share) may have dominated the ratio. Results for the Organizational Scale explanation were as expected, given the literature discussed above, since support for growth lends credence to Penrose’s (1959) growth proposition, as it implied that larger firms could grow faster; the finding

that multidivisional firms were not more profitable than non-divisionalized firms supports the idea discussed by Chandler (1962) that functional structures may still be useful among more focused firms (Rumelt did not test this particular proposition discussed by Chandler). With regard to the superiority of performance of the related diversifiers over unrelated diversifiers, these results also supported Penrose's (1959) growth proposition, since she only saw efficiencies resulting from related diversification. Conglomerate performance results, a recent organizational form according to Rumelt (1974), were interesting in that the "bigger fool" theory (generally, the popularity of a strategic decision increases a firm's value because its announcement increases a firm's stock price, not because of the value that the decision adds to the firm: I am a "fool" for buying a stock based on a popular decision only if I cannot find a "bigger fool" to sell the stock to) was only partially supported; perhaps by the year 1969, unrelated diversification had not yet become popular among investors. Evidence for popularity of the multidivisional structure, however, was observed by Rumelt (1974), as the proportion of divisionalized firms increased dramatically from 1949 to 1969, regardless of diversification strategy classification (but proportionate increases were greater among the diversified classifications, so Chandler's "structure follows strategy" proposition was also supported).

It would be interesting to re-create Table VIII using simulated data, or at least to set up a framework within a simulated environment that could allow for such a re-creation. How many of Rumelt's categories be included in a simulation? Single-business, and dominant-vertical categories are straightforward (discussed below), but because the simulation model only includes the sale of a single product, using the proportion of sales from different products, as Rumelt (1974) had done, is neither simple nor necessary for a simulation study on diversification. We might have more success at applying Rumelt's theory rather than his operationalizations.

Certainly, related-type diversifiers can be identified as agents that merge with other agents only within one defined task environment; unrelated diversifiers merge with agents outside of only one task environment. Related-constrained and dominant-related categories can be simulated by an agent that maintains a certain ratio of related-to-unrelated merged agents. Likewise, dominant-constrained can be modeled by an agent that rarely diversifies, and when it does so, it merges only under very favorable conditions (identified below) and only with agents near to it on the simulated landscape. Additionally, an unrelated “passive” strategy might be simulated by the entry of a high threshold of retained earnings before a merger is sought, while an “acquisitive conglomerate” strategy would be profiled with a low threshold. Thus, we have in our model the potential for inclusion of seven diversification strategies: two non-diversification strategies, one conservative strategy, two related diversification strategies, and two unrelated strategies. This provides somewhat finer grain than Wrigley’s (1970) four categories (single business, vertically integrated, related, and unrelated), but somewhat less than Rumelt’s nine categories (the simulation of a linked strategy would be difficult to simulate without increased simulation complexities). Rumelt himself reduced the number of categories in his follow-up study (Rumelt, 1982) from 9 to 7; here, a category is added back to the typology (acquisitive vs. passive) since it can be objectively modeled (Rumelt’s categorization of acquisitive versus passive was potentially too subjective), and the two linked categories are dropped. Note that the operationalization of these categorical measures is closer to theoretical strategies and avoids circular reasoning.

Ansoff’s (1965) perspective can also be studied in a simulation using an event-history methodology (discussed below). Here, the decision is the level of analysis, and the association with this diversification decision to performance (after including an appropriate iteration lag

time) would be a useful complement to a Rumelt-like diversity study of successful agent organizations at the end of a simulation run (after many iterations).

Rumelt's (1982) modified replication using recent data was also written to address criticism and test some further questions. First, Rumelt was able to arrive at his original results even after controlling for industry effects, with the exception that the high return on capital with regard to the Related-Constrained (RC) group was an industry effect, raising "the question of why RC firms are concentrated in high-profit industries" (Rumelt, 1982, p. 368) and suggesting that "perhaps it is time to consider the diversification strategies of participants as an aspect of industry structure." In a parallel work that incorporates a country effect (rather than an industry effect), Luffman and Reed (1984) set out to test the reliability of some of Rumelt's (1974) results using a larger British dataset, and to confirm results from a prior British study (Channon, 1975), but applied their analysis over a later and shorter time period (496 data points taken at 1970, 1975, and 1980, compared to Rumelt's 246 data points taken at 1949, 1959, and 1969). Despite these differences, if Rumelt's (1974, 1982) major conclusions are generalizable, then Luffman and Reed's (1984) results should have replicated Rumelt's findings. Table IX compares Rumelt's (1974) hypotheses and results to Luffman and Reed's (1984) findings, where comparable. In contrast to Rumelt's (1974) finding that the related categories were highest performing, Luffman and Reed (1984) found firms in the unrelated category the highest performers, on average. Thus, not only did Luffman and Reed (1984) call into question the generalizability of Rumelt's results, but the existing theoretical reasons for diversification were also called into question. Note that Luffman and Reed's (1984) findings represent the revival of the Livermore-Dewing debate, this time framed in terms of scope rather than scale. Rumelt's results (1974, 1982) suggest that large organizations, which perhaps can only diversify

unrelatedly due to the government's anti-monopolization controls, that become too unrelated are inefficient (thus taking Dewing's side), while Luffman and Reed (1982, 1984) suggest no such limit to unrelated diversification (taking Livermore's side).

However, Luffman and Reed's (1984) study a number of additional aspects of diversification. In a converse approach as compared to Rumelt (1974), Luffman and Reed (1984) argued that emphasis in analysis should be placed on those firms that chose to diversify (or contract) in between the data collection points rather than those that did not change. This approach resembled the event-related approach Dewing (1921) had applied, and it provided evidence of at least one critical strategic decision by a firm's executives, so their approach may also fit better with Ansoff's decision model. In their study of transition companies that changed their diversification strategies twice, Luffman and Reed (1984) observed that the Dominant strategies served formerly single firms only as a temporary staging area for a second move into predominantly related diversification strategies, and to a lesser extent Related-Constrained to Related-Linked and Dominant to Unrelated transitions were also observed. While both Rumelt (1974) and Luffman and Reed (1984) would agree that Related-Linked and Unrelated strategies served as ultimate ending points in a growing firm's diversification strategy, Rumelt found the intermediate-stage strategies higher-performing, while Luffman and Reed (1984) found the final stages higher-performing in the Unrelated case and no difference in the Related-Linked case. Luffman and Reed (1984) attributed the executive decision to diversify (rather than stay the same) to a managerial reaction to growth in sales: "It may be that large sales growth generates larger cash flows which prompts companies to diversify and thus spend the cash" (p. 98). Penrose's (1959) logic might also be extended to Luffman and Reed's (1984) observations: When a small firm grows suddenly, it inevitably finds itself initially starved for cash, but this

experience (if survived) may demand that the firm's executives develop the skill of being able to obtain cash when needed. This initial-growth learned skill may lead to an overabundance of cash when increased sales is sustained over time, which could then lead into Luffman and Reed's (1984) diversification explanation. Thus, in Chandler-like terminology, one might conclude that "diversification follows sales growth." This suggests a number of two-step types of diversification strategies for simulation: (1) begin with a related-constrained strategy, and then after the organization reaches a threshold size (say, 4 agents), (2) switch to an unrelated-acquisitive strategy. Alternatively, one might switch from a dominant-constrained to an unrelated-passive strategy after a similar size threshold. The computer simulation need not parallel Luffman & Reed's (1984) exact findings; it only requires the identification of a threshold size in each agent's profile which, if met, triggers a (randomly chosen) switch in strategy.

An additional extension in Luffman & Reed (1984) study beyond that of Rumelt (1974) was the comparison of size with performance. Since British-only firms were used in the sample, the size distribution was expected to be over a wider range (i.e., included more and smaller firms) compared to the Rumelt (1974) sample. The results contradicted Dewing's (1917) law of balanced return: large (and giant) corporations were both higher performers and more efficient. These results certainly reached beyond anything that either Dewing or Livermore might have expected, as it implies that significant scale efficiencies can be achieved with corporations far larger than any that existed in either Dewing's or Livermore's data sets. Alternatively, it may be that large and giant organizations exert a certain tacit control over prices in industries even if its market share is less than 40%, as recommended in the La Follette bill and highlighted by Brandeis. Thus, Luffman & Reed (1984) reiterates the study of organizational size as a useful

variable for study in a computer simulation, and in particular the effects of size (and growth) on performance.

Modern Diversification Theory: Topics for Study

We have thus far developed a set of guidelines, and a number of diversification strategies, that can be applied toward the framework of a diversification simulation model. As summarized in Table VI, simulated agents should be programmed to merge into multidivisional structures (with one agent representing one division) under one “parent” agent (which redistributes revenues and makes decisions on further diversification), according to a number of different strategies, across multiple landscapes with differing environments. This simulation is expected to be parsimonious in that it captures much of the diversification framework discussed in the literature, and yet remains reasonably simple in that there remains only one product, acquired agents continue their autonomy, strategies are simple interpretations of theory, etc. However, modern theoretical discussions in diversification have left unresolved a number of issues that may be studied more clearly through computer simulation. This section discusses the numerous ways in which computer simulation may contribute to and advance current thinking in diversification.

Table X provides a chronological roadmap for diversification research across 25 years to its present state. It highlights a number of common issues throughout these years; issues that both remain unresolved despite widespread focus and may be advanced with the aid of simulation. Below, I discuss each recurring issue in turn, and I identify ways that the current study can contribute toward resolution.

Measures of Diversity

The discussion to this point has only addressed the categorical method of diversity measurement; as this methodology is unavoidably subjective (e.g. in determining the difference between an unrelated-linked firm and an unrelated-constrained one) and not conducive toward the analysis of large databases (yet also suffers from small numbers problems, discussed below), several alternative methods have emerged. Rumelt's (1974) qualitative method was itself intended as an improvement over the product-count method that had, at least until that point, not yielded useful results. Hall & St. John's (1994) product-count equation for Diversity, D , is:

$$D = 1 - \frac{\sum m_j^2}{\left(\sum m_j\right)^2} \quad (1)$$

where m_j is the proportion of total sales in industry segment j where j is measured at the 2-, 3-, and 4-digit standard industrial classification (SIC) code. These authors (Hall & St. John, 1994) compared the product count measure to entropy measures, or Herfindahl index, first used by Berry (1975) for total entropy (DT), adding separate entropy measures for related (DR) and unrelated (DU) diversification:

$$DT = \sum_{i=1}^n P_i \ln \left(\frac{1}{P_i} \right) \quad (2)$$

where P_i is the proportion of the firm's total sales in the i^{th} industry segment and n is the number of industry segments (4-digit SIC codes each constitute one industry segment);

$$DR = \sum_{j=1}^M DR_j P_j \quad (3)$$

where DR_j is the diversity within industry groups, P_j is the proportion of the firm's total sales in the j^{th} industry group (2-digit SIC codes each constitute one industry group), and M is the number of industry groups;

$$DU = \sum_{j=1}^M P_j \ln \left(\frac{1}{P_j} \right) \quad (4)$$

with terms defined as above. Results using these measures, compared to each other and compared to the Rumelt and Wrigley categories, were far from convergent or consistent. While Baysinger & Hoskisson (1989) found a high degree of association between the entropy measure (2) and Rumelt's categories, Montgomery (1982) and Hall & St. John (1994) observed notable differences in that the Rumelt categories performed better as predictors of firm performance (using accounting measures such as return on sales, return on assets, and return on equity), while they all confirmed Berry's (1975) use of the entropy index, equation (2) as a better predictor of firm growth. Furthermore, when Hall and St. John (1994) applied cluster analysis to the results of equations (3) and (4), they could not reproduce Rumelt's categories. Robins and Wiersema (2003) revived Montgomery and Hariharan's (1991) concentric index,

$$CI_k = \sum_{i=1}^N \sum_{k=1}^N P_{ki} P_{kl} d_{il} \quad (5)$$

where, CI is the concentric index for focal firm k , P_{ki} is the percentage of sales for firm k in industry i , P_{kl} is the percentage of sales for firm k in industry l , and step function:

$$d_{il} = \begin{cases} 0 & \text{when } i \text{ and } l, \text{ belong to the same 3-digit SIC;} \\ 1 & \text{when } i \text{ and } l, \text{ belong to the same 2-digit SIC, but} \\ & \text{different 3-digit SIC;} \\ 2 & \text{when } i \text{ and } l, \text{ belong to the same 2-digit SIC} \end{cases}$$

which serves to weight the diversification such that CI will be greater for firms that are unrelatdly diversified. Using a concept of relatedness that follows the resource-based view of competitive advantage ("a portfolio of businesses is bound together by some shared strategic resources or capabilities", Robins & Wiersema, 2003, p. 45), the authors demonstrated through a number of stylistic examples that "like the related entropy index, the concentric index also cannot be relied upon to be consistent in all cases" (Robins & Wiersema, 2003, p. 52). To explain this "disjunction between theory and method" (Robins & Wiersema, 2003, p. 45), the

authors introduced a term, “pure diversification,” which was defined as “the number of businesses in the corporate portfolio” (Robins & Wiersema, 2003, p. 47), as the “true” phenomenon that the indices of entropy and concentricity were inconsistent in measuring. As their stylistic examples demonstrated, however, by “pure” diversification, Robins & Wiersema (2003) meant *organizational* diversification; the problem being that the indices were the result of combinatorial summations of sales ratios. For example, for a firm that diversifies from 80% in its primary-business 3-digit SIC (with its secondary business of 20% coming from a different 3-digit SIC, but the same 2-digit SIC as its primary business) to 50% in its primary and 50% in its secondary businesses, the concentric index would remain unchanged (while DR would increase). Organizationally, the firm has not changed its structure, but has only realized an increase in sales from its secondary business. Robins and Wiersema (2003) may have overlooked that such an observed change in DR may have resulted from an environmental change: more demand from the firm’s secondary business; the diversification strategy of the firm’s managers may not have changed at all; management does not directly choose sales or revenues, but it does choose organizational structure around its strategy (Chandler, 1962). In any case, the measure that may capture more of the intent of a firm’s strategists may be the concentric index in this example, but other stylistic examples demonstrated that, in other situations, CI measured diversification in the opposite direction from the observed organizational diversification. Thus, both measures are suspect.

Other studies pointed to additional problems. Nayyar (1992) collected survey data from service-industry CEOs, in which they were asked to (1) list the firm’s 10 most significant businesses, (2) estimate the proportion of the firm’s sales from each business, (3) list the firm’s 10 most significant resources, and (4) indicate which businesses used which resource(s). If more

than one business used the same resource, these businesses were identified by Nayyar as “related.” Assuming that this survey data most closely measured top executives’ diversification strategy, Nayyar reproduced Rumelt’s categorical data and Berry’s entropy measure (equation 2 above). Comparing this survey data to the conventional means of obtaining categorical and entropy data, Nayyar concluded that the entropy measure underestimated the extent of unrelated diversification, and the Rumelt measures misclassified unrelated diversifiers as related.

Hoskisson, Hitt, Johnson & Moesel (1993) used DR (equation 3 above) and DU (equation 2) to objectively categorize firms into Rumelt’s categories. They found that 70% of firms were correctly classified, noting that Rumelt’s method may be more “precise,” while classification using DR and DU may be more objective and can be applied to the analysis of large datasets.

In this work, I follow closely Rumelt’s categories, but I apply these categories to organizational structure, not proportion of sales. The reason for this is that any division’s sales is dependent on environmental variation (discussed below as an influential moderator), and since the simulation explicitly models different environments, it becomes important to establish diversification strategy as an independent phenomenon from environmental variation. Therefore, this work takes the structural approach to diversification strategy: if an agent feels compelled to diversify, it searches for candidates and makes a choice according to its profile; the shifts in sales proportions from each division in the new structure is a result of the environment’s properties and access to landscape resources, but this shift is not the choice of the agent, and it is an agent’s choices that we are primarily interested in (i.e., which choices result in high and low levels of effectiveness and efficiency) with regard to our understanding of strategic management.

Performance Measures

A perhaps more important, and much more controversial, topic has been the link between diversification, as an independent variable, and its significance in predicting firm performance. As we shall see presently, not only are the independent variables suspect in terms of precision and validity, as discussed above, but so are the various dependent variables.

Amihud and Lev (1981) found support for their hypothesis that unrelated diversification is an agency cost when they applied Tobin's q method to estimate the following:

$$M_{ij} = \beta_0 + \beta_1 D_{mi} + \beta_2 D_{wi} + \beta_3 S_i + u_i \quad (6)$$

where M_{ij} is the number of acquisitions made by firm i according to type j (horizontal, vertical, product extension conglomerate, market extension conglomerate, pure conglomerate), D_{mi} and D_{wi} are dummy variables for the extent of owner control (measured by shareholder ownership) over firm i , S_i is firm i 's size (a control-type variable), u_i is a firm-specific factor (error) term, and $\beta_0, \beta_1, \beta_2$ and β_3 are essentially regression coefficients. The regression fit compares the slope of β_1 across three types of acquisitions: horizontal, vertical, and conglomerate, where the data in each line is separated vertically by dummy variable D_{mi} . Results indicated that β_1 was significantly positive and different from zero for the conglomerate regression line, and that $\beta_1 > \beta_2$, indicating that "the propensity of firms to engage in conglomerate mergers is monotonically increasing as we move from strong owner [$D_m, D_w = 0$] through weak owner [$D_m = 0; D_w = 1$] to management control [$D_m = 1; D_w = 0$]" (Amihud & Lev, 1981, p. 611). These results implied that managers engage in conglomerate mergers more than owners. Amihud & Lev (1981) then conducted a second test which used the formula

$$x_{it} = \alpha_i + \beta_i x_{mt} + u_{it} \quad (7)$$

where x_{it} is firm i 's ROE in period t (using data over a 10-year period), while x_{mt} is the period-specific average ROE for all firms in the economy. If the coefficient of determination (R^2) is

high when this equation is fit to the data for firm i , this implies that the firm's return varies closely with the economy's return. The greater the R^2 , the greater the firm's diversification, since by portfolio theory, increasing diversification tends toward market risk and away from firm-specific risk. Now Amihud & Lev (1981) replaced where M_{ij} with a normalized coefficient of correlation (R_{in}) as the dependent variable in equation (6) and arrived at the same order of slopes and significances: $\beta_1 > \beta_2$ and only β_1 was significantly greater than zero. Since ROE was used in this second test, however, this second set of results implied that managers use unrelated diversification in order to make their firm's level of risk more like the average market risk, thus confirming expectations derived from agency theory.

Apart from being convoluted, Amihud and Lev's (1981) analysis made a number of assumptions at a number of critical steps in their methodology. Perhaps most notable was their assumption that conglomerate diversification results in the tendency toward market risk; results from Luffman & Reed (1984) showed that the risk-return relationship among diversification strategies is often not a tradeoff at all. Another problem with Amihud & Lev's (1981) methodology is that related diversifications (product and market extensions) were lumped with unrelated diversifications ("pure conglomerates"), which the resource-based view of the firm would not have allowed strategic management researchers to do, and only "pure conglomerates" would be expected to follow from management's self-interest; product and market extensions have been seen as efforts to improve efficiency through economies of scope since Penrose (1959). Furthermore, horizontal mergers are widely considered to be motivated by the desire to obtain increased market power (Hitt, Ireland, & Hoskisson, 2005; Palich et al., 2000); if so, this will increase a firm's size as well, and as executives of larger firms generally get paid more than executives of smaller firms, one would expect agency theory to predict that manager-owned

firms would also engage in higher levels of horizontal diversification; yet Amihud and Lev (1981) did not observe this result.

Thus, Amihud and Lev's (1981) results are problematic, and researchers in strategic management responded to Amihud and Lev (1981) with a barrage of studies that addressed the diversity-performance link more directly. By the time Chatterjee & Wernerfelt (1991) studied the elusive link, empirical findings had fallen into three camps: (1) those that agree with Amihud and Lev (1981) and Rumelt (1974) that related diversification is associated with highest performance, and that unrelated diversification may be considered an agency cost (Montgomery, 1979; Bettis, 1981; Rumelt, 1982; Palepu, 1985; Varadarajan, 1986; Varadarajan & Ramanujam, 1987; Jose, Nichols & Stevens, 1986; Lubatkin & Rogers, 1989); (2) those that agree with Luffman and Reed (1984) that unrelated diversification can result from the pursuit of efficiency (Michel & Shaked, 1989; Rajagopalan & Harrigan 1986; Elgers & Clark, 1980; Chatterjee, 1986); and (3) an article that found no significant difference between related and unrelated diversifiers (Lubatkin, 1987). By the time Palich, Cardinal & Miller (2000) conducted their meta-analysis, some ten years after Chatterjee & Wernerfelt (1991), they were able to draw from 55 empirical articles on the diversity-performance linkage. These authors resolved the debate somewhat by concluding that there must be an inverted-U (i.e. concave) relationship between diversity and performance (these results are discussed below, since extent of diversification can be considered a moderator). Throughout this literature stream, we see the persistence of the same type of argument as the Dewing-Livermore argument discussed above, now along the lines of the Rumelt-Luffman & Reed debate (rephrased in terms of economies of scope). This debate was carried out directly in a series of commentaries in the *Strategic Management Journal* between Amihud & Lev and Hoskisson & Hitt (among others), this time reformulating the

debate into an agency-cost/efficiency decision debate. Denis, Denis & Sarin (1999) tried to settle the issue by first finding support for Amihud & Lev (1981), then qualifying their findings: “However, unlike Amihud and Lev, we are uncomfortable with concluding that it is the desire for personal risk reduction that drives managers to diversify” (Denis, Denis & Sarin, 1999, p. 1074). However, the debate continued: Lane, Canella & Lubatkin (1999) used Amihud & Lev’s (1981) dataset, but more direct analysis, to find opposite results from Amihud & Lev (1981); Miller (2004) noted that diversifiers realized a popularity “discount” during the year prior to an unrelated diversification which made the strategy falsely profitable; and Boyd, Gove and Hitt (2005) used Amihud & Lev’s (1981) data to show that results were largely uninterpretable due to measurement error. In an unheeded moment of clarity, Reed and Luffman (1986) noted that most diversification moves may be motivated by idiosyncratic benefits such as reducing risk, strategic flexibility, earnings stability, the use of spare resources, adaptation to customer needs, synergy, growth, etc., so that large dataset studies merely confused the issue; and Helfat & Eisenhardt (2004) argued that economies of scope may be intertemporal (carried out in series), and if so, it would be detected as higher performance at lower levels of diversification; Nayyar (1992) found that when asked, CEOs reported performance data that was different from publicly available data, making the performance measure unreliable. Of course, any number of performance variables was used in these studies, such as ROI, ROE, ROS, return on total capital, sales growth rate, EPS growth rate, price-earnings ratio, above-industry-average performance, industry-expert firm rankings, Jensen’s alpha, stock performance, and failure rate, yielding conflicting, or at least inconsistent results that in instances supported one camp, and in other instances supported another, often within the same study.

It was not only the Amihud and Lev (1981) side of the debate that included suspect methodology; Rumelt's (1974) methodology and SIC-based measures, discussed above, was followed by a number of authors, and was dependent on sales to categorize the firm's diversification strategy. Although ROS as dependent variable was made independent from sales-based category to some extent, categorical and ROS always seemed to exhibit a higher R^2 than other dependent variables (ROE, ROI), and one wonders whether ROS and the independent variables were not entirely independent. For example, suppose a firm realized an unexpected increase in sales in its secondary area; not only would unrelated diversification increase, but so might ROS, since prices might be set higher in that period in order to curb demand to within the firm's capacity. This also suggests a reverse in causality, as discussed below.

Computer simulation simplifies the performance measurement and linkage debate because it removes real-world noise from not only the measure of performance, but also from the idiosyncrasies of the situation. Performance can be measured in the simulation model as a combination of efficiency and effectiveness by observing only the surviving agents and agent-organizations that have accumulated the most assets (work-in-process inventory plus working capital) per agent at the end of the simulation run. The characteristics of these "winners" could be compared to the characteristics of the earliest failures after a simulation initialization period (these agents are both ineffective and inefficient) and the lowest-performers (in assets per agent) at the end of the simulation run (these agents are effective, but inefficient).

Causality

In addition to the above argument that the diversification-performance link has not been consistently established, some authors (Rumelt, 1974; Reed & Luffman, 1986; Varadarajam & Ramanujam, 1987) have speculated that the direction of effects might be opposite of what is

expected. For example, Luffman and Reed (1984) speculated that “it may be that large sales growth generates larger cash flows which prompts companies to diversify and thus spend the cash” (p. 98). Thus, high performance may lead to greater diversification. One method that could be applied to a resolution of this issue is a study at the event-level of analysis. Miller (2004) conducted such a study, but his results were confounded somewhat by a “performance discount” (p. 1109) in the year prior to the diversification event. The present study does not include investor popularity, and causality can be made clearer by many more iterations and pseudo-random number generation (discussed below). Therefore, the present study has the potential to contribute considerably to the issue of causality.

Influential Moderators

The link between diversification and performance may be moderated by a number of factors, and in general it is suspected that related diversification is a necessary but not sufficient condition for higher performance (Varadarajam & Ramanujam, 1987). Individual differences (Jensen & Zajac, 2004; Hoskisson & Hitt, 1990), the environment (Finkelstein & Halebian, 2002; Delacroix & Swaminathan, 1991), country (Mayer & Whittington, 2003; Kogut, Walker, & Anand, 2002; Hitt, Hoskisson, & Kim, 1997; Luffman & Reed, 1984), effectiveness (Reed, 1991), risk (Bettis & Mahajan, 1985), market conditions (Lubatkin & Chatterjee, 1991), the extent of diversification (King, Dalton, Daily, & Covin, 2004; Palich et al., 2000), popularity of diversification strategy (Miller, 2004; Luffman & Reed, 1984; Reed & Luffman, 1982), structure, dominant logic, distinctive competence, and culture (Hoskisson & Hitt, 1990), characteristics of the merger (hostile, peaceful, etc.), acquisition premium paid, direction (horizontal/vertical),

regulation status (regulated/unregulated), method of payment, size of firm, and complementarity of firm resources, and prior acquisition experience (King et al., 2004).

To cope with so many moderators, one approach might be to find evidence for one or a few moderators at a time, as suggested by King et al. (2004), and to some extent the above list of literature constitutes a literature stream in the diversification literature. The approach taken in this study will be to remove, and otherwise control, moderating factors. For example, managerial characteristics and environment are carefully controlled by the agent profiles and the systematic variation of environmental variables, respectively. On the other hand, suspected moderators such as culture, country, regulation status, and method of payment are not a factor in the simulated environment developed here, thus considerably simplifying the task of establishing the link between diversification and performance. Specifically, this work contributes to extant literature because cross-country studies on international effects do not adequately separate environmental differences along the variables discussed in Part I (Table III) from country (i.e. government) differences; but the current work also separates diversification measurement from environmental influence by basing diversification on structure, not revenue.

Short Time Periods

Few studies on diversification have traced the issue over more than 10 or 11 years, whether these studies used categorical analyses (Luffman & Reed, 1984; Rumelt, 1982, Rumelt, 1974) or SIC-based measures (Chatterjee & Wernerfelt, 1991), or both (Hall & St. John, 1994; Montgomery, 1982; Palepu, 1985). Delacroix & Swaminathan (1991) stands as an exception, as their data covered the years 1946 to 1984, but as their interest was in firm survival and effectiveness, a longer time frame was needed to allow for a sufficiently large death rate. The issue was addressed by Reed & Sharp (1987), by conducting a simulation of Luffman & Reed's

(1984), which allowed for 50 additional iterations (years) of observation. Their contribution was the confirmation of Rumelt's (1974) classification methodology using the specialization ratio. Clearly, a significant advantage in using simulated data, as opposed to real-world data, is that there is virtually no limit to the amount of time that can be studied, and this advantage has already been demonstrated by Reed & Sharp (1987). Studying long time periods is an advantage of computer simulation in general, and more will be said (in Part III below) of how computational organizational theory studies exploit this advantage.

Small Numbers

When categorical analysis is used, often the matrix of diversification across industries is often too sparse in order to gain any significance in statistical analyses (Kogut, Walker, & Anand, 2002). Both Rumelt (1974) and Luffman & Reed (1984) had difficulty obtaining significant differences, especially when studying strategic change. Boyd, Gove & Hitt (2005) noted that, in order for Amihud & Lev (1981) and Lane, Lubatkin and Cannella (1998) to have detected small effects, a sample size of 547 would have been required (Cohen, 1992), but these researchers used a sample size of 309 (the same data set), and Boyd, Gove & Hitt (2005) claim that these researchers would not have been able to observe the required small effects. Both Denis, Denis & Sarin (1997), who also noted Rumelt's (1974) small number problem, and Boyd, Gove, and Hitt (2005) had a sufficient number of observations in their analyses (933 and 640, respectively), and their results supported the agency theory argument. However, no correction has been made of the categorical studies that employed Rumelt's (1974) categorical methodology (Hall, St. John, & Caron H., 1994; Nayyar, 1992; Luffman & Reed, 1984; Luffman & Reed, 1982; Rumelt, 1982; Montgomery, 1982; Channon, 1975; Rumelt, 1974), and perhaps there has been a decline in research using this methodology because of this limitation.

The computer simulation model developed here is rooted in the categorical methodology and may well revive interest in this method which has been considered more precise (Hoskisson et al., 1993). The current study is not as problematic as real-world studies in that at least there is no small numbers problem in a computer simulation; if there is, then numbers are increased and the simulation is run again. If there are, for example, only a few agents that changed from vertical integrators to dominant-constrained diversity (as Luffman and Reed, 1984, discovered in their results), then simulation initialization is changed so that this two-step strategy is somewhat more likely to occur and the landscape(s) are enlarged and programmed to accommodate more agents at the beginning of the simulation. Additionally, a simulation can be run thousands of times over (repetitions) in order to create more observations. Thus, categorical analysis can be very powerful in a computer simulation, because it is not limited to a small number of observations.

Conclusions

The topic of diversification is exactly the sort of topic that may benefit from computer simulation research, as real-world studies in this field have problems that computer simulation can overcome: diversity and performance measures, causal reversal, the presence of numerous influential moderators, short time periods, and small numbers. However, a computer simulation can and should draw upon the diversification literature in order to set up the simulation framework (see Table VI). What must be done next, then, is the development of a computer algorithm based on the guidelines in Table VI, taking care to account for the problems encountered in real-world simulation research, discussed above. At that point, a contingency theory of diversification might be developed, whereby different strategies are expected to be

successful under different environmental conditions. Note that such a simulation is based on the assumption that managers are efficiency-seeking and effectiveness-seeking, following Reed (1991) and Delacroix & Swaminathan (1991): at times effectiveness may trump efficiency in priority and *vice versa*. However, there is no programming of self-seeking behavior and agency theory which is based on this assumption; agents do not get “paid” for their decisions in this simulation extension; this aspect of diversification is programmed in the agency-stewardship extension of the baseline model, discussed in the next section.

Agency, Stewardship, Stakeholdership, and Strategic Orientation

A second area amenable to simulation involves the modeling of executive behavior according to agency and alternative theories. It would be useful if a contingency theory of executive behavior could be developed that answers the question, “In what type of environment is what type of executive behavior successful?” Members of the board of directors (BOD) of a corporation might be interested in these results because board members often serve two roles: as an aide to the CEO (and other top executives) in which to provide input on ideas for new, creative strategies, and as a control mechanism to curtail CEO and top management team (TMT) expenses by determining when and who to hire and fire, executive compensation, and approval of large allocations of resources (Conger, Lawler, & Finegold, 2001). This dual role of board members makes proper behavior ambiguous: When and how much should the BOD member adopt one role rather than the other? A contingency theory of executive behavior could begin to answer this question: in environments in which the simulation shows that agency theory-oriented agents, BOD members should place emphasis on their control function; in environments in which stewardship-reasoning agents perform higher than agency-reasoning

agents, BOD members can feel more free to act as a sounding board for CEO and TMT ideas. Currently, no “balance” between agency and stewardship theories has been approached by researchers (Kulik, 2005), so the theory developed herein has important research implications as well.

The remainder of this section is arranged as follows: Agency theory is described and then re-established in terms of dynamic positioning toward ever higher pay package points, then agency theory alternatives are discussed, followed by a brief discussion of how corrupt agents might behave in yet a different manner. As above, implications and guidelines for computer simulation is discussed throughout, and is summarized in Table XI.

Agency Theory

Agency theory is certainly at the heart of our current understanding of corporate governance. According to the ISI Social Science Citation Index, Jensen & Meckling’s (1976) work has been cited 3,580 times in the period 1980 to 2005. Not surprisingly, most of those citations are in work dealing with agency theory and corporate governance. For example, in the *Academy of Management Review*’s 2003 special issue on corporate governance, all seven articles in that forum cited Jensen & Meckling (1976). In their introductory article, Daily, Dalton, and Canella (2003) stated that “Jensen and Meckling (1976) proposed agency theory as an explanation of how the public corporation could exist, given the assumption that managers are self-interested, and a context in which those managers do not bear the full wealth effects of their decisions” (p. 371). Any discussion of managerial self-interest must therefore start with Jensen and Meckling (1976).

How does agency theory actually operate, given the recent crisis in corporate governance? Most proponents of agency theory have regarded the Enron and other scandals as a “market failure” in that it was agency theory’s mechanisms of control that failed to work – thus, agency theory could predict Enron’s downfall if the mechanisms could have been determined to be too weak to control its management sufficiently. If this is true, then agency behavior could be modeled in a computer simulation directly. Table XIII re-lists Eisenhardt’s (1989) listing of relevant positivist empirical studies, which exhibit almost unanimous empirical support for agency theory. Based on these and other results, Eisenhardt concluded that agency theory is a valid, testable, theoretical construct. I argue that agency theory’s mechanisms for control give agency reasoning managers a “playing field” in which they can operate self-servingly. It is this set-up of the rules of the game that is detrimental to the system, not the weakness of mechanisms (the “rules”). To this end, Jensen & Meckling’s (1976) classic article is re-visited, opposing and mutually exclusive assumptions are identified, and a simulation framework is then constructed from this more realistic description of executive behavior.

Reconsidering Agency Theory

In professionally managed companies, top management does not always act to maximize the owners’ return on investment, and “agency costs will be generated by the divergence between his interest and those of outside shareholders” (Jensen and Meckling, 1976, p. 313). Mechanisms used to align the interests of the manager with those of the shareholders in publicly-traded companies take the form of threats of takeover, competition in product markets, competition in executive labor markets, and monitoring by outside shareholders and boards of directors (Rediker & Seth, 1995). Also, according to Jensen (1986), monitoring is done by

creditors with high debt levels or others with expectations of salary and perquisites. These mechanisms, outlined in detail by Rediker & Seth (1995) and summarized in Table XII, are limited in use because they are associated with (agency) costs, so there always exists an “agency problem” (Fama, 1980) in that managers’ behavior will never be fully “aligned” with the interests of the outside shareholders or “risk bearers” (Fama, 1980). However, a number of these mechanisms have been extensively studied and constitutes an emerging field of literature in its own right. The market mechanism of external takeover has led to the empirical study of managerial efforts in establishing various shark repellants (Cyert, Kang, & Kumar, 2002; Frankforter, Berman, & Jones, 2000; Singh & Harianto, 1989); and competition in managerial labor markets has led to studies in top management turnover (e.g. Griffin & Wiggins, 1992). Monitoring mechanisms were the focus of Rediker and Seth (1995) and others, particularly with regard to the board of directors (Golden & Zajac, 2001; Finkelstein & D’Aveni, 1994; Kosnik, 1987). Monitoring by the business press could be added here as an action that helps mitigate the agency problem, but this type of monitoring has not yet been empirically tested with regard to its effects, if any, on the mitigation of the agency problem. Finally, financial incentives such as CEO and top management stock ownership and other compensation has also led to a number of empirical studies (Elloumi & Gueyié, 2001; Walking & Long, 1984).

In addition, “it is likely that the most important conflict arises from the fact that as the manager’s ownership claim falls, his incentive to devote significant effort to creative activities such as searching out new profitable ventures falls” (Jensen and Meckling, 1976: 313). In other words, in addition to agency costs, divergence of interest also means that managerial attention is redirected toward his or her own interests, and away from the interests of the shareholders. Thus, according to agency theory, publicly held firms endure by either finding ways to solve the

agency problem, or to align the manager's behavior with shareholders' interests in such a way that agency costs are low enough to permit corporate profits to exist.

Prima facie, it appears that agency costs, especially incentives, overran Enron's revenues in such a way as to generate huge losses. However, that conclusion is too simplistic and ignores what is in practice a complex relationship between remuneration and managerial self-interest. We need to take a close look at the agency theory at Jensen & Meckling (1976) first developed in order to arrive at a better understanding as to what happened at Enron.

A Detailed Look at the Agency Problem

Following Jensen and Meckling's (1976) graphical model of the agency problem, we can explore agency costs. First, defining the variables:

$$X = \{x_1, x_2, \dots, x_n\} \quad (8)$$

where X is the vector of n non-monetary benefits (health benefits, luxurious office, ...) received by the manager;

$$P = \sum_{i=1}^n p_i \quad (9)$$

where P is the total market value of the manager summed across all n non-monetary benefits received by the manager;

$$C = \sum_{i=1}^n c_i \quad (10)$$

where C is the total market cost to the firm summed across all n non-monetary benefits given to the manager; and

$$B = \sum_{i=1}^n (p_i - c_i) \quad (11)$$

where B is the net benefit to the firm. P , C , and B , then, are all functions of the vector X , and if there are a large number of valuable benefits, then these functions could be assumed to be continuous without loss in generality.

Given that the payment of additional incentives to managers will be most influential when the value of the incentive package is low, it follows that, at low levels of non-monetary benefits to the firm, adding an additional increment of benefit, B , marginal returns to the firm will be positive. There are, however, diminishing returns to increments of X at high levels of non-monetary benefits, so that $B(X)$ takes on a concave shape. The optimal level for each x_i in X will be at the point when marginal return is zero and $p_i = c_i$, say, at vector X^* . Past this value, say at vector Y such that $Y > X^*$, there exists a managerial utility, F , such that $F = B_Y - B_{X^*} > 0$, which is the cost to the firm. A manager will have some preference for some level of benefits, say, at Y^* , and will choose his or her level of non-monetary benefits such that $F = B_{X^*} - B_{Y^*}$.

For a manager-owner, where management is not separated from ownership, there is a one-to-one trade-off between expenditures on non-pecuniary benefits and the firm's wealth, which for a manager with 100% ownership, represents monetary returns, as shown in Figure 4. In this case, the firm's budget constraint would be indicated by a line with the slope between firm value and managerial utility at -1 . The triangular region defined by the axes and that line, constitutes the space of possible pay package points that a firm can afford to give its manager-owner; any pay package point within this region, but not on the budget constraint, would result in surplus that could be used for other purposes, such as reinvestment. Along the constraint line, we identify three points to demonstrate the payoff. First, when $F = 0$, the manager-owner receives no utility. Second, at the other extreme, $V = 0$, the manager-owner receives all utility and no wages. Each individual, however, has an infinite set of indifference curves along which he or she is indifferent toward the mix of wages and utility. The shape of this curve is convex because at low levels of utility a manager would require higher wages to compensate for the "poor conditions" of the work, while at high levels of utility "poor pay" would lead to demands

for even greater utility. Since there is an infinite number of indifference curves, there exists one of these curves that is exactly tangential to the budget constraint. Jensen and Meckling (1976) call this point the “optimal pay package” for the owner-manager case, which constitutes an important starting point for the case when manager and owner become separated.

Suppose now that the manager-owner sells some stock to investors so that outside ownership is a significant proportion of the total firm value, as shown by the left-side brackets on the vertical axis in Figure 5. The constraint line now has some slope, say α , equal to the proportion of ownership that the manager retains; that is, $-1 < \alpha < 0$, while outside ownership is now $1 - \alpha$. This new line is also associated with a tangential indifference curve at point A that is now *outside* the firm’s budgetary constraints. At this critical point, Jensen and Meckling (1976) reasoned that the market must adjust for the manager’s propensity to choose a greater utility, so that, keeping firm value constant, the proportion of outside ownership is increased to the point that the constraint line with slope α is adjusted downward so that the same selling price buys a higher proportion of the firm from the manager. This adjusted constraint line, in combination with the owner-manager constraint line after intersection at B, define an adjusted region of affordability for the partial-owner-manager. The partial-owner-manager’s decision to take pay package B rather than A is the result of a negotiated contract, whereby he or she must choose somewhere along the $-\alpha$ line. To the left of B, his or her pay package is less than at point B. However, to the right of B, the firm cannot support such a lavish pay package. Thus, the market controls managerial utility to some extent, and F_0 is reduced to F_1 in Figure 5, with a corresponding increase in firm value and wealth from V_0 to V_1 . This means that, in order to attract outside investment, a partial-owner-manager will have to accept a lower level of perquisites that the manager-whole-owner would have chosen. At our negotiated point B =

(F_1, V_1) , the quantity $V^* - V_1$ is the reduced value of the firm, or agency cost. Arrival at B will likely result in some frustration for the manager, who must forgo a certain degree of ownership, wages, and perquisites.

If we now introduce a set of monitoring activities by, say, negotiating a contract whereby the partial-owner-manager agrees to spend no more than F_2 on non-monetary benefits, firm value and wealth would then increase a proportionate amount and an outsider's share of the firm would now be worth $(1-\alpha)V_2$ instead of $(1-\alpha)V_1$. Jensen & Meckling (1976: 323) noted that this more complicated contract might be made when the owners were allowed to monitor the owner-manager by "auditing, formal control systems, budget restrictions, and the establishment of incentive compensation systems." It is not clear why the owner-manager should agree to this since, as Jensen & Meckling (1976) noted, the owner-manager would not actually benefit from the increase in firm value. One might presume at this point that the monitoring activity adds to the frustration of the owner-manager, who is seeing her or his non-monetary benefits dwindle from F_0 to F_1 to F_2 (Figure 5). It may be that the owner-manager envisions increased returns when additional wealth $(V_2 - V_1)$ is reinvested in the company, which will eventually result in increased non-pecuniary benefits. Or, perhaps, this monitoring activity might be necessary for attracting investors to buy shares in the company in the first place. In any case, if the cost of monitoring the owner-manager were free, the pay package point would jump from B to G, but because such monitoring activity involves costs, the point C is arrived at instead. Actually, any point along the concave monitoring budget constraint curve between B and C may be chosen by the firm's outside ownership (see callout in Figure 5) with M being the vertical distance between this point on the curve and the -1 sloped line. The monitoring budget constraint is concave because of the expected diminishing returns from additional monitoring costs and point C, the

point of inflection of the monitoring budget constraint, is a rational choice for the “adjusted” pay package because firm value is maximized at that point. Agency costs at C are $V^* - V_2$. Note that this point is more efficient than the original owner-manager case in Figure 4 because it lies below, and not on the owner-manager line with slope -1 . This was Jensen and Meckling’s (1976) argument for the popularity and success of the public corporation over the privately owned firm. Jensen and Meckling (1976) then moved on to describe what happens to the pay package point when the firm grows in value: the path of the pay package is at a slope of less than 1 (i.e. biased toward more managerial utility than firm value), and proceeds at a decreasing rate as total firm value is increased.

It is worth noting here that modern economic theory does not contradict the basic tenets of agency theory. A modern economist would refer to the tendency (or risk) of the pay package point to drift from C to F as a moral hazard, and related agency costs are expected to increase with an agent’s risk aversion, the effort expended, and information asymmetry in favor of the agent (Laffont & Martimort, 2002). As Laffont and Martimort point out, “moral hazard would not be an issue if the principal and agent had the same objective function” (p. 146), but they do not. Moral hazard is seen to result from the preference a manager has for choosing projects with the highest private benefits. Deliberate credit rationing has been proposed as a tool to mitigate moral hazard (Holmstrom & Tirole, 1994), but only if the reduction in agency cost is greater than the opportunity cost associated with foregone profit due to an overly restrictive budget (Zhang, 1997). However, progress in recent economic theory has been toward an explanation of how moral hazard can be mitigated, rather than modeling how executive opportunism is allowed to proceed under current economic conditions.

Managerial Self-Interest

Eisenhardt (1989, see p. 63) listed the assumptions required to apply agency theory as being self-interest of involved parties, goal conflict between principal and agent, bounded rationality of participants, information asymmetry, efficiency of the equilibrium agreement, risk aversion, and information as a commodity. However, there are two additional implicit assumptions in Jensen & Meckling's (1976) seminal work that were not discussed by Eisenhardt (1989) and are not clearly recognized within the broader governance literature, but which are crucial for agency principles to work.

First, at point C, Jensen and Meckling (1976) noted that this point "will be the equilibrium point only if the contract between the manager and outside equity holders specifies with no ambiguity that they have the right to monitor to limit his consumption of perquisites to an amount no less than $[F_2]$ " (p. 325). It is apparent from this statement that Jensen and Meckling were referring to both contractual ambiguity in the form of contradictory statements or clauses that might be open to more than one interpretation, and the conditions of the contract as well. However, this is an assumption that cannot be met in most publicly-traded companies because of both the prevalence of contingent compensation, such as stock options, as well as the reduced monitoring that arises from diffuse ownership (Berle & Means, 1932). Further, at equilibrium, the possibility of no future increase in compensation would fail to provide incentive to any employee, including corporate CEOs. It is because of this assumption that, when not met, point C can never be an enduring point of equilibrium. Instead, because of self-interest, corporate executives will continuously seek to move the pay package point in their favor, and because information asymmetry works in favor of the corporate executive, insofar as outside directors depend heavily on corporate executives for their information (Baysinger & Hoskisson,

1990), the pay package point does indeed drift in the direction desired by management. Non-pecuniary benefits thus increase over time above level F_2 .

The second implicit assumption by Jensen and Meckling (1976) was that agent-managers would not be cognizant of their pay package point in relation to the limits of affordability; i.e. the distance from point C to point B in Figure 2. Given the manager's frustrated state in moving from point A to point C, if the manager knows this distance, or even that B and C are different points, then point C cannot be at equilibrium. However, the closer we get to point B, the closer we approach the sole-owner-manager situation, and agency theory fails to explain any advantage of an agency relationship over the partial-owner-manager situation. Using Jensen and Meckling's (1976) rationale, not only does the agent not know the distance from C to B, but neither does the owner. This is an unrealistic assumption since it can only come at the illusion of both parties (owners and owner-manager) that monitoring has no effect on the value of the contract. If it is unrealistic for the principal (why, then, pay monitoring costs?) it is also unrealistic for the agent-manager who has the aforementioned information advantage in the modern corporation. Those agents who violate these two implicit assumptions may be considered to be "agency-oriented managers" in that they are unconstrained by stakeholder or stewardship considerations that might cause point C to remain in equilibrium, and they act toward the maximization of their own self-interest under the constraints of effective control mechanisms and incentives as described by agency theory. When agency-oriented managers are mapped, as in Figure 2, we have a picture of managerial self-interest.

Managerial Greed

Executives are hired not only because they have extra-ordinary skills in maintaining and increasing firm value, but also because they can effectively communicate that value to investors

and creditors, often by highlighting a company's legitimacy, competitive advantage, and product innovation. But the same skills required to "sell" the firm's stock to investors can be used to convince the compensation committee that the manager's work is increasingly valuable. Thus, the pay package point drifts over time in part because of asymmetry between the comparatively small amount of information that is available to a company's board of directors, and that which is available to managers (Arrow, 1963). For example, a manager could argue that a transaction that moves debt off balance sheet adds value to a firm so that, in exchange for this "innovation," managerial utility should be proportionately increased. In that case, the pay package point moves to the right without moving up at all. Other activity, such as incorporating in the Bahamas for a tax shelter, might add value to the company by adding to the bottom line, as well as give the executive the impetus for more managerial utility. Yet another situation might be the successful sale of a non-profitable segment of the company, so that the firm's assets are decreased, but in a way that helps the firm improve profitability (by an increase in return on assets), so that the manager responsible has yet another argument for an increase in his or her managerial utility. The pay package point decision could then be considered a game in which, at every iteration, (1) a pay package point is set, (2) a manager causes it to drift in her or his favor, and (3) the pay package point is re-set. This occurs until point B is reached in Figure 2, and the company can no longer afford to pay the executive. Thus, an agent-oriented manager's utility always increases monotonically with time, regardless of firm value.

In addition to self-interest within a given firm-value context, agency-oriented managers work to increase the value of the firm in order to move point B in Figure 5 outwards by convincing directors to increase compensation in such a way as to keep the distance between C and F at a constant. This behavior can be illustrated by Enron executive Rebecca Mark's revival

of the Dabhol, India power plant deal as described by Bryce (2003). Apparently, Mark negotiated a deal with the Indian government that was more expensive than the government could afford to pay. Mark, who was getting a bonus (“incentive” as described by agency theory”) of 3 to 4 percent on the value of the deal, pushed through an unrealistically expensive project to include, for example, liquid natural gas (LNG) rather than coal because of LNG’s enormous expense. Bryce estimated that Mark made some \$25 million in compensation during the time she negotiated the Dabhol deal, even the deal itself fell apart and Enron took a loss on the project. Apparently, Mark was able to cite an increase in the value of Enron from the Dabhol deal as justification for her large bonuses. The situation is illustrated in Figure 6, with the pay package point moved to (F_3, V_3) for a less costly, but realistic deal, and (F_4, V_4) for the expensive, LNG-based deal.

The inappropriate decision will be chosen by the agency-oriented manager because the change in managerial utility is greater; that is, $(F_4 - F_2) > (F_3 - F_2)$; Wall Street would likely praise the move since $(V_4 - V_2) > (V_3 - V_2)$, and the company’s stock price would increase. The decision is clearly not sustainable – state governments would certainly react by re-instating pricing limits or by increasing fines – and any gains might be better labeled as one-time gains rather than gains from continuing operations, and such action might even forgo any future profits from trading if price limits are set too low. But “sustainability” is not an agency theory constraint and one-time gains can be used to drive up stock prices that result in gains for managers from contingent compensation when, as Fama (1980) pointed out in situations of “ex-post shirking, or perhaps outright theft” (p. 306), there is no ex post settling up. For example, if a manager rushes the process of setting up a contract so that revenues that would normally be seen next year can be reported this year it will cause a spike in the firm’s stock price. The

manager can then capitalize on the higher price by cashing in vested options that are in the money, and when the market corrects the price because next year's revenues will be lower, there is no financial penalty to the manager. This shortcoming of agency theory can be extended to account for changes in the pay package point resulting from managerial manipulation, and Figure 6 can thus be interpreted as a picture of greed. Thus, as incremental increases in remuneration from strategies become harder to achieve (i.e., as C approaches B), pure agents will increasingly take inappropriate actions that are timed to maximize gains from contingent compensation. Agency theory, at least as described by Jensen and Meckling (1976), does not take into account the manager's manipulation of the compensation process after the pay package point moves to point C in Figures 5 and 6. Unfortunately, the effects of this shortcoming do not remain solely at the level of senior executives.

With regard to computer simulation, modeling an agency-oriented agent is fairly straightforward: (1) such an agent receives a pay equal to or exceeding (by a variable mean increase, as defined by the agent's profile) the agent's pay in the previous iteration; (2) the agent has an increased propensity toward diversification and growth in order to keep up with its increasing demand; and (3) the CEO-agent receives a "growth bonus" every time an agent is acquired, at a fixed proportion (another profile element) of the acquired agent's capital.

Agency Theory Alternatives

Table XIII can be expanded by literature published since Eisenhardt's (1989) work, shown in XIV. Table XIV reveals that, among recent empirical works, only Rediker and Seth (1995) found strong support for agency theory since Eisenhardt (1989). The other authors all speculated about the possible limitations of agency theory, yet proceeded no further in theoretical

development. For example, after finding both board vigilance (congruent with agency theory) and CEO power (a factor not associated with agency theory) to have a strong influence on CEO duality (Finkelstein & D'Aveni, 1994), the authors state that:

“If agency theory does not provide a complete explanation of CEO duality, other theoretical perspectives may be valuable, and organization theories ... may be of particular value in understanding corporate governance in general and CEO duality in particular” (pp. 1101-1102).

Other authors, such as Frankforter, Berman, and Jones (2000) go so far as to suggest what those “other theoretical perspectives” might be:

Agency theory, with its heavy dependence on the assumptions of self-interest among economic actors, clearly seems limited in its ability to explain various phenomena in the governance realm. It appears to be time to undertake empirical explanations of alternative explanatory frameworks such as stewardship theory (Davis et al., 1997) and agent morality (Quinn and Jones, 1995) that take seriously the ‘other regarding (moral) aspects of human behavior (p. 344).

In addition to the perspectives noted above, a number of agency theory alternatives have arisen in the past decade, motivated out of anecdotal observation (such as my above application to the Enron director), the inability of agency theory to explain empirical studies (see Table XIV), the OT perspective that organizations are more complex than the assumptions of the agency theory model (Perrow, 1986), and the organizational behavioral perspective that executives are affected by intrapersonal psychological factors. Below, I discuss three alternative theories that might explain resolution of the agency problem *without* the application of control mechanisms: psychological attributes, other-than-shareholder concerns, and strategy.

Psychological Attributes

Grounded in organizational behavioral theories on motivation, stewardship theory is a model developed by Davis, Schoorman, and Donaldson (1997) that is based on psychological attributes and the fit of these attributes with the organization's situational characteristics. Stewards, then, are motivated by self-actualization and higher-order needs (Maslow, 1970), and intrinsic factors such as growth, achievement, and affiliation (McClelland, 1975; Alderfer, 1972; McGregor, 1966). They are high in value commitment (belief in the organization's goals), and have high identification for the organization. They use personal power rather than institutional power to influence others, are involvement-oriented rather than control-oriented, and are cultural collectivists. Finally, stewards are found more in low power distance cultures. Stewards are proposed to work well in the absence of agency controls, while non-stewards are well explained by agency theory. It may well be that successful directors act as stewards over the organizations they oversee. An explanation of the Enron failure, then, might be that executives (and directors) failed to act as stewards.

In a computer simulation, a stewardship-oriented agent could be modeled by allowing its pay to be decreased when it does not perform as well as the agent-organization had done in the past. In other words, the agent's pay is pegged to its performance; the agent extracts a certain fixed proportion of whatever capital is added after the current iteration is complete. This stands in sharp opposition to an agency-oriented CEO, who always argues for an increase in pay, and it is this contrast which we are interested in investigating through computer simulation.

Other-than-Shareholder Concerns

Criticism of agency theory fits the criticism of a bad play when the characters are thinly developed and few in number. Likewise, the characters in agency theory are shallow (only

economically driven and self-interested) and few in number (consider only the principal and the agent). While the criticism of shallowness is addressed by stewardship theory discussed above, the criticism of too few characters is addressed here. The agent morality view (Quinn & Jones, 1995) begins by positing that agents apply moral principles to actions on behalf of the principal, and only then consider the interests of the individual. Quinn and Jones (1995) posit that these moral principles must exist in order for agents to enter into agent-principal contracts in the first place. Furthermore, the moral principles of the agent might lead the agent to consider the welfare of other stakeholders before acting in the best interest of the principal (shareholders). On the other hand, Blair (1995) asked who else stands to lose if an organization declines, and asserted that those stakeholders, particularly employees, should have representation in corporate control structures. This idea of maximizing organizational wealth rather than shareholder wealth is congruent with both moral agency theory and stakeholder theory (Donaldson & Preston, 1995). In any case, these theories are concerned with widening the list of characters involved in the resolution of the agency problem, and one may posit that concern for stakeholders may explain at least part of the resolution of the agency problem that exists between directors and shareholders. In other words, stakeholder concerns and moral principles at least partly explain the agent-manager's resolution to the agency problem.

In a computer simulation, stakeholder-oriented agent might take a sample of selling/buying prices, and ensure that the agents it buys from and sells to are within a specified tolerance of the sampled average. If not, it lowers its selling price, or increases its buying price, to within the specified tolerance range in order to accommodate its supply-chain stakeholder. If the other agents also have a stakeholder orientation, this rule should increase the survival rate

and average performance of the entire supply chain, which may give the chain a competitive advantage over non-stakeholder-oriented agents.

Strategy

A third dimension that might positively constrain an agent-manager's action could be strategy. For example, Conger, Lawler, and Finegold (2000) interviewed a number of CEOs and discovered that the most important role of directors in regard to CEO needs was to act as a sounding board for new strategies. Based on this and other findings, the authors suggested that boards and CEOs work together to develop valuable resources that might be used as a competitive advantage. For example, boards and CEOs should (and often do) work together on succession plans for top managers, act to develop human capital within the firm, and help their companies obtain resources that are needed in order to be effective. Conger et al.'s (2001) findings and recommendations emphasize a resource based view (RBV) of the firm (Barney & Hesterly, 2006; Porter, 1987) in which successful firms – those with sustained competitive advantages – are seen as those firms successfully that acquire, develop, and keep scarce, valuable, and critical resources that competitors are not able to imitate or substitute for. Thus, Conger, Lawler, and Finegold's (2000) findings indicate that directors work with CEOs to develop valuable resources in order obtain competitive advantages.

Alternatively, Goodstein (2002) recently proposed an integrity-based view (IBV) of the firm in which he recommended that directors use the company's own vision and strategy statements, or core ideology, as a tool to decide on the approval or rejection of any TMT proposals. Use of the IBV would “provide an enduring basis for determining the company's best interests over time” (p. 4), and support Blair's (1995) argument for organizational maximization, but for strategic purposes rather than the representation of residual risk. While Goodstein (2002)

proposed the IBV as prescriptive, the IBV may in fact already exist to resolve a proportion of the agency problem, as evidenced by Conger et al.'s findings that directors help top managers develop new strategies. Thus, I argue that the RBV and IBV work together along strategic dimensions to at least partly explain the director's agency problem.

In our computer simulation, the simulated agent's "strategy" is diversification. A rule can be created here wherein an agent cannot increase its pay if it would mean that the organization's capital is insufficient to meet its yet-unfulfilled diversification strategy. For example, suppose that an agent-organization has, in its profile, an unrelated diversification strategy, but its current strategy makes it appear as if it were a related diversifier. Suppose the threshold for acquiring an agent is reached (whereby the agent organization can begin to search for and acquire an unrelated agent) at two more units of capital, revenues are 8 units, and the CEO agent's pay is at 6 units. The CEO cannot argue for a pay of 8 units because the surplus two units of capital must go toward meeting the agent-organization's strategy. Note that this rule helps to simulate, and explain, the bimodality phenomenon in diversification research (Reed & Sharp, 1987; Hoskisson & Hitt, 1990; Reed, 1991), whereby the distribution of diversity of most firms is either single business, or diversified, with few firms occupying intermediate strategies.

Integration of Theories: A Matter of Proportion

Which of the above four perspectives explains why organizations function well? Clearly, in the real world, no executive of an enduring organization behaves as all-agency, all-steward, etc., but at times may act as agency-oriented, at other times act stewardship-oriented, and still others demonstrate an unusual concern for stakeholders. Kulik (2005) recently took the

following position in a critique of the real-world applicability of stewardship and agency theories:

“while a stewardship-based culture goes a long way toward reducing the proliferation of perquisites, as compared to an agency-based culture, a culture based purely on stewardship is an equally unlikely and unbalanced solution, so that a ... question of balance between agency and stewardship in any organizational culture should be a pressing question for ... researchers” (p. 357).

Such a “proportions” argument was also taken by Fayol (1949) in describing how his general principles of management might be practiced. Of course, computer modeling is quite amenable to such a fixed proportion, and for this extension to the baseline model, a set of four proportions, each between 0 and 1, can be randomly generated at initialization as an additional profile element. Note that this configuration also allows for the possibility of extremes. For example, the set { .95, .02, .01, .23 } for orientations of agency, stewardship, stakeholderism, and strategy, respectively, describes a mostly agency-oriented manager. Furthermore, it may be that agent-organizations with such a profile might only be enduring and successful if they are also aggressive diversifiers, in order to keep up with the increasing demands of the CEO-agent.

Conclusions

We have thus arrived at how the baseline model might be twice extended toward a contribution to the literature on diversification and executive behavior. The goal here is to discover which diversification strategies, and mix of executive behaviors, might be appropriate for which environmental conditions. Each case would be useful to researchers and BOD members alike, the former in advancing theory toward the diversity-performance link and in

beginning research toward a proportions approach toward (ethical) executive behavior, and the latter in determining how much control BOD members should place on the firm's executives, as well as fruitful analysis toward appropriate CEO succession.

CHAPTER 4. LITERATURE, PART III: COMPUTATIONAL ORGANIZATION THEORY

In this section, I intend to show how the field of computational organizational theory (COT) has emerged despite some initial setbacks, identify a number of techniques used in this body of literature to conduct computer simulations, and identify where the COT literature falls short in its attempt to aid the more general field of OT. Put another way, I explore answers to three questions: (1) Why is there a field of COT? (2) What techniques can we extract from this field to aid in the development of our own computer simulation? and (3) How has the extant COT literature failed to bridge the gap with the OT literature? Two main findings of this literature review are that complexity has been misplaced (computational models have been made overly simple, while the analysis of results has become overly complex) and that COT research questions are poorly fit with questions in the OT field.

This literature review is different from other toolbox-like discussions of computer simulation. Jones (2003), for example, presented a number of techniques used in artificial intelligence programming, but a number of those tools, such as the use of multiple agents and landscape-based (ant) algorithms are considered here as consequences of the nature of the specific problems faced in the simulation of organizations. I also ignore a number of potentially useful tools such as Bayesian methods and neural networks, as I concentrate on the tools that are already in use in the COT literature. Since COT must overcome Bonini's paradox in order to be meaningful, the techniques listed here are oriented around the different techniques that CO theorists employ to overcome Bonini's paradox.

Why is there a field of COT?

This is a surprisingly valid question, and has been answered in a way that favors the emergence of a field only much more recently than the issue of organization-environment interaction was considered in the Part I of this literature review. The simple answer that the computer age is itself only a recent phenomenon is an incomplete answer, as COT emerged some 25 years after Cyert and March (1963) first proposed a computational model. Why did researchers not rush in to the field in 1963 and broaden Cyert and March's computer program that was published in code (in the FORTRAN IV programming language) as the culmination of their theory of behavior? Why was their computer model revisited only in 2000 by Prietula and Watson (2000)?

In fact, Cyert and March's (1963) computational work has been carried on by the field of cognitive psychology. While organizational theorists embraced Cyert and March's management perspectives of conflicting goals and feasibility rather than optimality, cognitive psychologists embraced the idea of using computation as a supplement to real-world research. Dutton and Starbuck (Dutton & Starbuck, 1971a) edited a volume on simulation at the individual and aggregate levels of analysis, with applications in both cognitive psychology and operations research, although articles concerned with political science and macro-level economics were also included. Cyert, March and their colleagues contributed to two papers in this volume (Cyert, Feigenbaum, & March, 1971; Cyert, March, & Moore, 1971), the second of which was a pricing model application of their duopoly simulation developed in Cyert & March (1963). Neither work had been mentioned in the management literature since, and they have only been cited twice in total, (Roy, 2004; Federico & Figliozzi, 1981), neither applying their work toward the advancement of organization or management theory in any way. Thus, while work had

continued toward extending the theory developed in Cyert & March (1963), this work went largely unknown to organization theorists, and largely unused by any other researchers.

Some insight might be gained from a consideration of how Starbuck (and Dutton) regarded simulation as a research tool. In their introduction to their book, editors Dutton and Starbuck (1971b) outlined a number of advantages and criticisms of simulation. On the positive side, simulation had, by 1965, become a “widely used methodology” in “all of the social sciences” (p. 3), with advantages including intelligible results compared to mathematical modeling, at least a modest degree of logical rigor, the freedom of repeatable experimentation using variation impossible in the real world. On the negative side, it was discussed that it may not be possible to replicate human thought or the “complex essence” of human beings by using computers, and even if such a thing were ever approached with a computer simulation, it would be nevertheless too complex to understand the causal relationships that led to the simulation’s particular output. The authors termed the extreme case of this negative aspect of simulation “Bonini’s paradox” (p. 4) after Bonini (1963), who concluded after his simulation of a firm:

“We cannot explain completely the reasons why the firm behaves in a specific fashion. Our model of the firm is highly complex, and it is not possible to trace out the behavior pattern throughout the firm.... Therefore, we cannot pinpoint the explicit causal mechanism in the model” (Bonini, 1963, p. 136).

It is evident here that, since Bonini (1963) made this conclusion after his effort to analyze the output of a simulation of a firm, such a subject for simulation became *ipso facto* reason for avoiding the application of simulation toward the inner workings of a firm or organization. A critical question for Dutton and Starbuck (1971, p. 5) was, “How complex must a model be to portray the behavior?” Simplifying techniques such as linear programming could be used to

model firm activity, but the behavior of interest must be at a sufficiently superficial level in order to avoid Bonini's paradox.

Consider Starbuck's (1976) book chapter in which he specifically discussed different approaches toward the study of organizations as adaptive systems within their environments:

“Clearly, it is no trivial task simply to describe this sort of adaptive system. . . . even if someone invests the massive effort to create a realistic mathematical model, practically no one will understand what his model says. Computer simulation offers a compromise between the verbal and mathematical, but the promise remains potential. The handful of published computer simulations either have concentrated on one microscopic subsystem of a real, observed organization, or have vaguely generalized about the qualitative properties of hypothetical, abstract organizations. Moreover, computer simulations have a propensity for luring researchers into Bonini's paradox. . . . But . . . gathering the data to document an insightful description is even more challenging.” (Starbuck, 1976, p. 1101).

In this work, Starbuck discussed no “advantages” upon the selection of a simulation approach in the study of organizations as adaptive systems, and it is significant in the above quote that Starbuck (1976) found only a “handful” of simulations in this area, which stands in contrast to the 1,921 articles uncovered in a study by Starbuck & Dutton (1971). Starbuck, Dutton, and their contemporaries seem to have considered such an application of computer simulation to be their prime example of where simulation would be an inappropriate method. To them, not only could an organization-environment simulation could not overcome Bonini's paradox, but an organization-environment simulation *was* Bonini's paradox. Furthermore, any work succumbing

to (or being) Bonini's paradox was not worth the effort. This conclusion explains why all of the studies in Dutton and Starbuck (1976) were oriented around individuals and, at the most complex, aggregates of individuals, while the simulation of "organizations" was considered off-limits.

At this point, one might wonder why and how, in good conscience, a field of computational organizational theory ever emerged at all. The avoidance of Bonini's paradox has most likely delayed the emergence and hindered the development of COT, and in any case, COT is still a beleaguered field compared to the use of simulation in other fields. For example, compare March's (2000) description of the simulation of organizations during the 1970s and 1980s:

"Rather than emanating from ambitions to develop empirically-informed models of social systems, efforts at simulation modeling during this period gradually took their impetus from enthusiasm for computer technology and system design. The more elaborate simulation efforts drew their inspirations from systems engineering more than from empirical social science and were more directed at providing engineering (design) advice than at describing social behavior.

Computer simulation settled into a tiny niche, mostly on the periphery of mainline social and organizational science" (March, 2000, pp. x-xi)

to Lewandowsky's (1993) description of the establishment of simulation in the field of psychology following the publication of Dutton & Starbuck (1971b):

During the two succeeding decades, the number of psychologists conducting simulations has increased considerably, and computer simulations are now nearly as common as experiments in some parts of the literature" (p. 236).

Thus, progress in COT has been regarded as especially anemic compared to a field such as psychology, explainable as discussed above by the perceived presence of Bonini's paradox in simulation when applied to organization theory. Conversely, the apparent institutionalization of computer simulation in psychology may have been aided by the perceived absence of Bonini's paradox in simulation when applied to psychology.

March (2000), however, believed that the book toward which his foreword contributed provided evidence of a resurgence of the use of computer simulation as a tool in organization theory. The birth of COT journals *Computational & Mathematical Organization Theory* in 1995, accompanied by editor-in-chief's Kathleen Carley contributing to an edited volume on the field (Prietula, Carley, & Gasser, 1998b) and the *Journal of Artificial Societies and Social Simulation* in 1998, also accompanied by an edited volume by the journal's editors (Gilbert & Troitzsch, 1999), lend considerable credence to March's (2000) observation of such a resurgence, which has developed into the field of COT. COT was defined by Prietula, Carley, and Gasser (1998a) as

“the study of organizations as computational entities. COT researchers view organizations as inherently computational because they are complex information processing systems. An organization as a computational system is composed of multiple distributed ‘agents’ that exhibit organizational properties (such as the need to act collectively and struggles for power), are assigned tasks, technology, and resources, and across which knowledge, skills, and communicative capabilities are distributed. Computational organization theory focuses on understanding the general factors and nonlinear dynamics that affect individual

and organizational behavior with a special attention on decision making, learning, and adaptation” (pp. xiii – xiv).

This description of COT stands in direct contradiction to Starbuck’s (1976) contention, quoted above, that the computer simulation of “adaptive systems” is inappropriate. I contend that the shift, or more accurately, the reversal, of the perceived appropriateness of computer simulation to issues in OT is the direct result of methods employed to overcome Bonini’s paradox. This contention is based on analysis of the COT literature, discussed below.

Simplicity

If it can be shown that organizational simulation is not unmanageably complex, as Bonini (1963) had found, then OT researchers could join psychology researchers in the use of simulation as a methodology. The COT literature has demonstrated that computer simulation of organizations need not be complex. For example, Carley and Prietula (1998) simulated an organization of WebBots, or agents that were assigned and carried out information-gathering tasks on the Internet. Successful fulfillment of the tasks required the WebBots to share information, but some WebBots were given the propensity for lying when communicating information to other WebBots. Specifically, these WebBots were given the capabilities of communication, location memory, social memory, rules of social engagement (i.e. the propensity for lying or not), and social judgment (a routine to try and guess if an interacting WebBot is a lying type or a truthful type based on social memory with that WebBot). As the number of WebBots (organizational size) increased from 2 to 5, simulation results indicated that the total number of questions asked and answered between WebBots was less for the case when all WebBots were trustworthy at a size of 4, but reversed at all other sizes, while overall effort steadily decreased on increasing size at nearly identical values in the case of lying WebBots and

all truthful WebBots. We would expect, or at least hope, that an all-trustworthy organization would be more efficient than a partially-lying one, but in a lying organization, the WebBots learned not to ask as many questions, making the lying organization more efficient (except at size 4). This raises the interesting issue of the potential for inefficiencies in a trusting organization, and confirms theory concerned with the “dark side” of trust as developed by Jeffries and Reed (2000). However, the reverse finding at the size of 4 WebBots constitutes a problem for trust theorists: What is it about 4 untrustworthy agents that results in trust being more efficient, and why is this result different from sizes of 3 and 5? This is a useful study, then, with an interesting conclusion, and yet it is based on simply designed agents performing simple information-gathering tasks, and uses a small number of agents. Other examples of the application of simplicity include the study of different hierarchical structures and their effect on performance with the comparison of two hierarchical levels in decision-making teams to only one level (Carley, 1996), and the simulation of organizational decision quality as a radar detection problem (given partial and simplified segments of an airplane’s profile, is it friend, neutral, or foe?) (Lin, 1998).

Note that Starbuck’s (1976) assumption that an organizational simulation must be based on accurate real-world input data is unfounded, at least to a certain extent. This assumption was apparently common during this period. For example, a methods book around this time (Simon, 1969) commented briefly on simulation as a research method as follows: “the value of the results of a simulation depends entirely upon the accuracy of the data about the behavior of the various units and about their relationships that are put in. ‘GIGO: Garbage in, Garbage out’” (p. 283). However, Carley & Prietula’s (1998) model is made valid not by accurate input data but by what I will term “face validity” and “loose coupling.” First, their model was as valid as the realness of

their programmed WebBots; if the WebBots seem reasonably realistic to a reasonable organization theorist, then the output must also be accepted as reasonable. Second, “loose coupling” qualifies the simulation output as output from a mere simulation; it is therefore treated differently from real-world data in that the behavior of the simulated results is more important than the specific numbers generated: one may find an efficiency reversal at size 5 (or 10) in the real world rather than at size 4, but the important result from Carley & Prietula (1998) was the motivation to look for a reversal in the first place with subsequent, real-world follow-up study. Loose coupling is commonly acknowledged in simulation studies by their contribution to hypothesis development, an input to real-world studies.

To conclude this discussion on simplicity, it may help to demonstrate by way of illustration Robert Axelrod’s (1980a) well-known study on a tournament of the iterated prisoner’s dilemma game. By Axelrod’s admission, the computer tournament was a simplified abstraction of real situations that involve prisoner’s dilemmas:

“Examples of what is left out by this formal abstraction include the possibility of messages to go along with the choices, the presence of third parties, the problems of implementing a choice, and the uncertainty about the actual prior choice of the other side. The list could be extended indefinitely. Of course, no intelligent actor should make a choice without taking such complicating factors into account. The value of an analysis without them is that it can help the decision maker see some subtle features of the interaction, features which might otherwise be lost in the maze of complexities of the highly particular circumstances in which choices must actually be made. It is the very complexity of reality which makes the

analysis of an abstract interaction so helpful as an aid to perception” (Axelrod, 1980, p. 5).

In other words, simulation is insightful when simplification is applied precisely because it is *not* the real situation. This argument stands in sharp contrast to an underlying assumption in Bonini’s paradox, that a simulation can only be useful if it sufficiently captures all the various aspects of the real situation. Thus, Bonini’s paradox need not be assumed to exist at all, and when it is not, the tool of simplification may be applied in a simulation analysis.

Hypothesis Development

In the above study, Bonini’s paradox was further avoided by eliminating the need for the determination of causality. The study developed a hypothesis (such as, “trustworthiness is more efficient than non-trustworthiness only when organization size = 4”) that can later be applied to a trustworthiness study involving real humans without the need for an explanation of the causal connection between efficiency and trustworthiness. In fact, computer simulation is particularly adept at creating testable hypotheses: “The computer does not test theory; it generates theory. It demonstrates the immutable logical consequences of a set of premises. From Dubin’s (1978) perspective, there is no better theory than that” (Krackhardt, 2000ap. 271), and computer simulation is often considered as a hypothesis-generation tool (Carley, 1999).

The effect of taking a hypothesis-generation view further insulates simulation from Bonini’s paradox, as relationships can be observed and hypotheses generated without in-depth insight as to the underlying causes of that relationship, and the generation of any hypothesis need not include causal relationships. In fact, few hypotheses in OT involve causality, as they typically consist of correlational studies involving the hypothesizing of statistically significant

associations between important operationalized variables (for example, in the linear regression on variables in a large dataset). To avoid organizational simulation because it cannot clearly establish causality is to hold organizational simulation up to a higher standard than the most popular factor-analytic and linearly regressive methods used in the social sciences. The newer method of SEM (systems equation modeling) can, at best, only establish pseudo-causality, while the method of time series analysis, which can establish an average causality between variables, is seldom used because of the difficulties involved in collecting data frequently over long periods of time. In many cases, however, simulation may be our best hope for establishing causality because simulation data can easily be collected over many simulated iterations. For example, Macy and Strang (2000), in studying the boundedly rational managerial adoption of ineffective innovations (fads) versus effective innovations over long periods of time, found that when innovations are moderately effective, “high costs increase rather than decrease the amplitude of fads” (Macy & Strang, 2000, p. 115). This is clearly a statement of causality, qualified by the notion that such a statement may be considered a hypothesis toward real-world confirmation; if instead this statement were found after the study of a real-world data set, it would be treated as an axiom and possibly occupy greater stature in the understanding of innovation theory. However, the scientific method generally regards *all* results, real-world or otherwise, as potentially fallible. To require simulation results to be more fallible than real-world results, especially when the simulation results yield only hypotheses rather than axioms, is again to hold simulation results to a higher standard than the real-world counterpart.

Pseudorandom Number Generation Control

An additional and very powerful technique that can be used to derive causality in computer simulation output is the control of the pseudorandom number seed. Pseudorandom number generation is discussed in the simulation literature (see Law & Kelton, 2000, pp. 404-405), but I have not discovered its use (yet) in the COT literature. However, it would not be an exaggeration that nearly all agent-based computer simulations incorporate variation in their models by use of computer-generated random numbers. These numbers are generated with the input of at least one number, called a “seed” number; the computer-generated random number also generates a new “seed” as input for the generation of the next random number. However, the numbers generated appear as if they are randomly generated, as demonstrated by any number of goodness-of-fit tests. A higher-level language such as S-Plus (the program language I plan to use in this work) has a set of special functions that allows for the generation of a random number that follows any number of specifiable probability distributions. At default, the S-Plus code takes the “seed” number from the specific time of day in the computer’s internal clock setting at the time a seed is requested. However, the seed number can be set by the user as, say, 1 or 10 or 53 or whatever. If the seed is set by the user in this fashion at the beginning of a simulation run, then every time the same simulation code is run, it generates exactly the same output numbers, because the computer language generates the same sequence of seeds, because that sequence is begun by the same seed number as specified by the user. This give the user considerable control over the interpretability of output. Suppose, for example, I had run a simulation under certain environmental settings and observed specific output, say, profitability accumulated by the top 5 surviving agents, averaged over 10,000 repetitions of the same simulation. Since seed generated from the calculation of the last pseudorandom number generated from the first simulation run is

used as the seed for the second run, and so on, the computer actually generates a long sequence of seeds and pseudorandom numbers as it continues through each repetition in sequence. At the conclusion of the simulation, the same five averaged numbers will be calculated every time the 10,000 repetitions of the simulation are run, as long as neither the code nor the seed (which is a line in the code) are changed. Suppose now, I wish to change the environmental settings in the code (but not the starting seed number), and I observe 5 different numbers after running 10,000 repetitions. I can confidently conclude that the change in the five average profitability numbers are causally connected with the environmental settings I had changed. For example, suppose I observed a general reduction in profits among the five averages after increasing environmental dynamism settings (no matter how small the difference – if the difference is not statistically significant, I can increase the number of repetitions to make it “significant” so the issue of significance carries less weight in this type of simulation study than real-world data). I can conclude that, in the given simulation code, increased environmental dynamism results in lower profits, on average. An explanation of how or why this causality occurred need not come from the simulation code as long as theory on environmental dynamism was used to construct the model in the first place and this theory predicts the simulation’s output; we defer to the original theory for an explanation, and we may choose to study additional simulation output data to arrive at further confirmation. Thus, pseudorandom number seed control can be used to determine causality between theory-based (and at least face validated) simulation input and output, and this established causality can be put toward the generation of new hypotheses while at the same time avoiding Bonini’s paradox. Put simply, setting the seed for pseudo-random numbers allows for experimentation in computer simulation.

Limited Scope

Rather than attempt to design a simulation to be all things for all research questions, as was Cyert and March's (1963) approach, simulations in COT are more limited in scope. Cyert and March's (1963) theory of firm behavior culminated in their simulation code, which included everything they had presented about the way firms, and individuals in those firms, behave:

“In previous chapters we have presented a verbal description of a behavioral theory of the firm as well as applications of parts of the theory to some specific problems In this chapter [w]e describe a general model of price and output determination in an oligopoly. The model is presented in the form of a computer program” (p. 149).

Their simulation code incorporated their ideas on conflicting goals, feasibility over optimality, organizational slack, standard operating procedures (termed “routines” in subsequent literature – for example, Perrow, 1972; Nelson & Winter, 1982 ; March, 2000), and conflict resolution.

Their simulation code included only two firms in one industry (a duopoly model) with 25 important parameters each, but their intention was simply to increase the number of firms simulated in order to arrive at a general model that could be applied to any number of situations or research questions. The problem here, according to modern COT, was that their simulation was not sufficiently limited in scope to be useful:

“We know of our cognitive limitations of understanding complex, nonlinear systems with feedback; simulation gives us an approach to learn about and understand these big rich worlds.

But this does not imply one simulation model or study can be used to do everything. Quite the contrary, usually it is one question, one simulation model,

one study. So, simulation modeling can be used to investigate a wide range of issues, questions, and problems; but any given model of this rich world is usually limited in the issues it can address” (Burton, 2000, p. 443).

In other words, there should be a research question that drives the simulation code, and one simulation idiosyncratically addresses one or two questions. Otherwise, if scope is overly broadened, then we have needlessly found Bonini’s paradox again.

Survival and Evolution

The applications of the concepts of survival and evolution were probably most responsible for the revival of simulation toward management theory, beginning perhaps with Robert Axelrod’s earlier studies. Axelrod applied first the tool of survival characteristics (Axelrod, 1980b; Axelrod, 1980a), and then extended this approach to include the genetic algorithm (Axelrod, 1987), an evolutionary tool. Axelrod’s first two studies involved a computer tournament of different strategies of the prisoner’s dilemma. Experts in various fields proposed a list of strategies in the original study (Axelrod, 1980a) and in a follow-up study (Axelrod, 1980b) where the same experts (all given the results of the first study) submitted their revised strategies. In the first study, the “tit-for-tat” strategy was the most effective, while in the second study, the “tit-for-tat” strategy was the most parsimonious. Axelrod’s conclusion from the two studies was that it is difficult to do better than the tit-for-tat strategy when playing the simple iterated prisoner’s dilemma game. In other words, it “paid to not only be nice, but be forgiving” (Axelrod, 1980b, p. 395), even against strategies devised to exploit such characteristics. The tournament approach used by Axelrod in these studies (where each strategy competed with each

other in a round-robin format) applies what I term here the “survival” simulation tool because, with each round of the tournament, the effectiveness of the tit-for-tat strategy became more and more obvious such that, by the end of the tournament, the superior effectiveness of the tit-for-tat strategy was obvious. Thus, applying the tool of survival in computer simulations has the effect of magnifying causal relationships in a gradual way throughout many simulation iterations; by the end of the simulation, the causal relationship(s) of interest are obvious. A more recent example of this technique may be found a study by Lee, Lee and Lee (2003) in which the survival of exploiters and explorers were measured at 10-iteration intervals for 100 simulation iterations (averaged over 100 repetitions). An average characteristic among the survivors in each group was also studied (average capital obtained) in order to conclude which strategy had been more profitable under various simulation conditions. By the end of the 100 iterations, it became obvious as to which strategy had performed better.

Axelrod (1987) extended his prisoner’s dilemma tournament to include Holland’s (1975) genetic algorithm, based loosely on Darwin’s ideas on evolution, which has since become a popular analysis tool (Jones, 2003; Miller, 2000; Edmonds, 1998). In this method, agent birth from recombination (and occasional mutation) is allowed to occur so that a newly born agent retains characteristics from its parents; if the parents are successful, they are more likely to produce newborn agents. and the chances are greater that the newborn agent will receive the genetic characteristics of success than if either or both parents are not successful. Eventually, through many generations equilibrium will be achieved, as agents with optimal characteristics will emerge and begin to dominate the population. Axelrod (1987) “killed off” half of the population (the lowest-performing half), or ten agents, every generation, and replaced the ten with the offspring from the remaining ten – one was a full recombination, or crossover of the

strategies of the parents, and the other offspring from each pair was similar, but accompanied by a minor (pseudo-randomly generated) mutation. With the employment of this algorithm, first setting up an environment where each agent competed with each of eight representative strategies from the earlier survival study, then removing this constraint and allowing each strategy to compete with each of the other strategies in each iteration, Axelrod found that exploitative strategies performed better than the tit-for-tat strategy after forty generations, but by fifty generations, tit-for-tat types of strategies emerged as dominant. This was a far superior analysis compared to the earlier expert-strategy tournaments because the strategies were generated initially at (pseudo-)random from a very large pool (2 to the 70th power) of possible strategies. If the tool of survival can extract causal relationships in a more or less linear fashion with the number of simulation iterations, then the genetic algorithm can extract causal relationships at a more or less parabolic rate. However, this tool is most useful when there are a very large number of possible strategies that can exist in an adaptation situation.

Note that simulations by population ecologists Harrison and Carroll (Harrison & Carroll, 2000; Harrison & Carroll, 1991) did not apply the genetic algorithm; the tool of evolution (via the genetic algorithm) is distinctly different from the organizational theory of organizational evolution discussed in a previous section. Simulations in population ecology usually force a density/size and density/age dependence on populations according to an exponential fit observed for real populations, such as in Lomi and Larsen's work (Lomi & Larsen, 2000b; Lomi & Larsen, 1996). In addition, the term "evolution" has been used as a term for organizational change, as in Miller (2000) and Sastry (2000). Thus, the term "evolution" has acquired three separate meanings: (1) a theory for organizational change and adaptation in the real world, (2) a tool for the uncovering of causal relationships in the simulation world, and (3) a general term

describing how organizations change over time. Only our use of the term, (2) above, attempts to address and reduce, if not remove, Bonini's paradox.

Equilibrium

This tool can be useful when computer simulations include many iterations characterized by numerous changes at the beginning of the simulation, less activity in the middle, and little change by the final iteration. Such a tool can extend real-world, yet temporally limited data and results such as Reed and Sharp's (1987) confirmation of Rumelt's (1974) use of the specialization ratio in the study of diversification, or it can provide a stopping rule in which the variable of interest is the time-to-equilibrium, as Harrison & Carroll's simulation studies on culture in organizations (Harrison & Carroll, 2000; Harrison & Carroll, 1991) (in this case, time-to-equilibrium represented time to a homogeneous culture). The tool of equilibrium is useful in that it is parsimonious in an iterative sense. For example, 10,000 iterations of a given simulation need not be conducted if activity after equilibrium are not of interest to the researcher; if equilibrium is obtained after only 100 iterations, this may represent a considerable savings in computation time. However, the time-to-equilibrium may be much longer than measurable by real-world conditions, as with Sharp and Reed's (1987) study, so computer simulation maintains an advantage over real-world study in this respect.

Extreme Conditions

Simulation is particularly useful in setting conditions that are more extreme than those that exist in the real world. We saw this in Axelrod's (1987) application of the genetic algorithm above, where half of the population was killed off every generation and only the most successful strategies were allowed to both survive and reproduce. In the real world of organizations,

acquisitions involve the purchasing of sometimes poorly-performing organizations, while in the area of social Darwinism, reform Darwinism has removed the high mortality rate requirement (whether real mortality or analogous types, such as employment) for real people, as discussed by Aldrich (1979), and summarized above. But allowing for, and deliberately setting, extreme conditions needs no “reform” in the simulation world, as extreme conditions can uncover relationships where none can be confidently observed in real-world data. This idea turns Bonini’s paradox on its head: it is the real-world combination of complexity and scale compression of variables that allows for even general trends to be obscured, making determinations of causality impossible. Modeling extreme conditions at least addresses the scale compression problem, and this tool may be combined with the tool of simplicity, discussed above, to arrive at the removal of both problems that contribute to the real-world Bonini’s paradox.

An example of this technique can be found in Lee, Lee and Rho (2002), whereby their simulation resulted in the emergence of strategic groups under non-extreme conditions, while under conditions of extremely high mobility barriers, and/or the absence of dynamic capabilities among simulated firms (agents), strategic groups were less likely to form. This simulation thus supported the theory of strategic groups for all but the most extreme conditions, thus validating works built on the assumption of strategic groups, such as Porter (1980).

Data Reproduction

A final tool used by some researchers is data reproduction. By modeling the premises of a theory, or two or more competing theories, and running simulations on the models, researchers can compare the simulation results to real-world data to arrive at a conclusion of the quality of

the theory that had predicted the observed outcomes. For example, Malerba, Nelson, Orsenigo and Winter (2000) modeled the verbal history of the computer industry (a “history-friendly” model) to see if they could reproduce data actually observed with the simulation model (“history replication”). If so (and they did), then the verbal history is supported; if not, then an alternative explanation set must be sought.

A second example of this technique may be found in Prietula and Watson’s (2000) extension of the Cyert & March (1963) duopoly model. The authors compared a list of stylized facts that have emerged in the industrial-organization economics literature (such as, “market prices in most oligopolies tend to be stable over time,” and “advertising intensity of an industry is positively related to profitability”, p. 577) to their simulation’s output. They found full support for five of the eight stylized facts, and partial support for two more. The only stylized fact not supported was expected the positive relationship between profitability and advertising intensity. The other seven stylized facts gained support from the study, as these facts were arrived at from Cyert & March’s (1963) observations of within-firm behavior, and despite the simulation of a duopoly rather than an oligopoly from which the stylize facts were derived.

The data reproduction approach is a somewhat weak technique that may be susceptible to its own paradox. On the one hand, and similar to the approach of experimentation in organizational behavior and psychology, the findings are stronger when a theory can be disproved rather than supported; on the other hand, if no evidence is found in support of the theory, then there is a tendency to doubt the veracity of the simulation code rather than that of the theory that the simulation disproves. Validation may actually exist in the converse: if an established theory can be modeled by a simulation to reproduce the results predicted by the

theory, then it may be the simulation that is validated, not the theory. At least, one has no method of determining the direction of validation.

Conclusions

The above discussion is by no means an exhaustive treatise on the tools used in simulation, and is limited in the number of studies discussed. However, the above discussion highlights a number of tools applied in the current study. To this end, it would be useful to conduct a somewhat more exhaustive comparison of all of the tools used from the above list in applicable articles found in both Prietula, Carley & Gasser (1998b) and Lomi & Larsen (2000a), along with some of the articles discussed above. This analysis is conducted in Table XV, and provides the insight that not all of the tools are used for every study, and that some tools (e.g. simplicity) are more frequently employed (and thus more important for the current study) than others (e.g. history replication). It also lends legitimacy to the current model, and makes our complex task of implementing the guidelines contained in Tables I and IV more parsimonious. For example, simplicity dictates that not all forms of legitimacy listed in Suchman (1995) need to be modeled in the simulation, and the elements that are modeled can be simplified. Finally, Table XV demonstrates that the current study need not succumb to Bonini's paradox, as multiple tools are in place to avoid it. However, there are two pitfalls in the extant COT literature that I have observed. I discuss these below and explain how they can be avoided in the current study as well.

Pitfalls in COT

Lack of Grounding in Extant OT Literature

It seems far too often that COT researchers are more concerned with testing and otherwise working with simple, ad hoc observations rather than drawing from the rich source of OT literature. This “tradition” of ad hoc model formulation probably began with Axelrod’s iterated prisoner’s dilemma studies discussed above. Axelrod (1980) noted both the wide use of the prisoner’s dilemma as a test methodology (“the *E. coli*. of social psychology”, p. 6) and the wide use of the concept as a theoretical foundation for social processes (applied to Oligopolistic competition, the arms race between the Soviet Union and the United States, collective bargaining, the meaning of rationality, cooperation with enforcement, etc.). However, while Axelrod (1980) argued that his contribution would be to discover, through his simulation, “how to play the game well” (p. 6), he did not explain how knowing how to play the game well contributed to the fields that used and applied the prisoner’s dilemma game. He merely noted that the prisoner’s dilemma game was widely applied, and that he was going to use it too. The result is that we have little meaningful use for Axelrod’s (1980) results. For example, how does the tit-for-tat strategy affect, say, economists’ conclusions about Oligopolistic competition? Analogously, Malerba et al’s (2000) simulation replicating diversification in the computer industry was constructed on industry expert explanations without grounding model construction in an extant organizational theory; as a result, these authors had nothing to say about their contribution to the diversification or population ecology (or any other) literatures. Furthermore, the ad hoc simplicity of simulation model development leads to an unnecessarily complex analysis, as discussed below.

Indecipherable & Seemingly Nonsensical Analysis

Perhaps as a consequence of the lack of grounding in the OT literature, many CO theorists are left without the language to discuss the usefulness of their findings. A number of papers are outlined thus: (1) ad hoc statement or observation, (2) model built based on the ad hoc observation, (3) results of the simulation discussed in terms of the ad hoc statement. Because step (1) is not grounded in OT theory, a nonsensical analysis ensues with little overall use to organization theorists. This is, of course, an unintended consequence; some CO theorists are no doubt trained in computer science with little or no background in organizational theory; it is no wonder that these individuals emphasize their strengths, the “computational” element of COT.

For example, Prietula and Watson (2000) were unable to relate the discussion of Cyert and March’s (1963) model to current issues in organization theory. Their contribution to OT was apparently to “provide insight into the original findings in terms of [Cyert & March’s (1963)] organizational constructs (through the analysis of routines)” (p. 567), yet their insight seems, at best, to repeat the parameters of the computer code. For example:

“Under upward pressure on production goals, the highly reactive firm raised its upper production limit by an amount larger than the less reactive firm. This caused a difference to emerge in the likelihood that production limits would be subsequently encountered (given sufficient demand) , which resulted in different organizational responses. Both firms encountered the lower production limits (6 and 11 times respectively), which resulted in an organizational decrease in slack (reducing cost) and an increase in sales pressure (increasing market share)” (Prietula & Watson, 2000, p. 573).

A reactive firm was programmed to be more likely to increase its production capacity when demands for production exceeded its current capacity, and increase its product price when profit and sales goals are in conflict. Their general conclusions were that “organizations that did not perform well organizationally did not perform well economically” (p. 565) and that organizations are sensitive to subtle changes in theory routines. The former conclusion is either ambiguous or circular, while the latter is more or less a re-statement of the simulation code’s design, as standard operating procedures (routines) were key to Cyert and March’s (1963) observations of organizational life.

Prietula and Watson (2000) could have evaluated their findings in ways that were more meaningful to organization theorists. One interesting finding was that highly reactive firms exhibited higher slack, charged higher prices, and were more profitable than less reactive firms. This provides support for the positive association between profitability and organizational slack, rather than the counter prediction implied by agency theory (Tan & Peng, 2003). It also implies that differentiators who by definition are able to charge higher prices (Porter, 1980) and first-movers (Miles & Snow, 1978) should react quickly to meet demand in excess of capacity in order to maintain any competitive advantage. Finally, high reactivity may be a way for organizations to achieve unseparated ambidexterity (Gibson & Birkinshaw, 2004; Birkinshaw & Gibson, 2004; Channon, 1975) by avoiding the tradeoff between exploitation and exploration: as long as an organization is a highly reactive exploiter, it might simultaneously carry out exploration with its accumulated slack. However, nothing like the above theoretical propositions were discussed in Prietula & Watson (2000), and their conclusions did not lead readers in this direction at all.

Prietula and Watson (2000) are certainly not alone in falling into an indecipherability/circularity trap in the COT literature. One simple way to determine when an author succumbs to this pitfall is to observe its major conclusion. Carley (2000) “found” that “although change is necessary for survival, it is not necessarily sufficient” (p. 264) and that “history matters” (p. 259); Johnson and Hoopes (2003) discovered that “firms develop biased estimates of their competitive environment” (p. 1057); and Malerba, Nelson, Orsenigo & Winter (2000) discovered that “competence-destroying technological change and markets for new products that favor significantly different product characteristics tend to decrease the performance of competence-driven strategies” (p. 374). With regard to the latter study, if this was their major conclusion, then the thrust of their theory should have been all about implications for the resource-based view in strategic management rather than a comparison of two ad hoc diversification strategies that were idiosyncratic to the personal computer industry and unrelatable to the discussion of diversification in the strategic management literature.

Conclusions

“Simplicity” and “complexity” in COT seems to have been misplaced. Analysis should be simple and theory driven, yet it is too often overly complex, while the simulation code itself should be theory-driven and more complex than ad hoc observations. Thus, a major critique of COT literature is that there has been a misplacement of simplicity and complexity: the simulation code should be more complex in order to capture more of the essence of the complex realities of organizational life, while the analysis should be simplified and focused on its relevance to extant organizational theory rather than a regurgitation of the simulation code. The first two parts of this literature review have been made in an explicit effort to avoid both pitfalls. On the one

hand, lack of grounded theory has been avoided by developing the model based on guidelines that are rooted in a significant proportion of the extant OT literature. On the other hand, the literature review conducted suggested that numerous theoretical implications should be simultaneously modeled; complexity derives from the overlapping nature of the many complementary organization theories themselves. In the final analysis of simulation results, a further pitfall must be avoided in this study, that of making either circular or ambiguous conclusions (or both). An explanation of how such conclusions might be avoided is discussed in the following two sections of this proposal: Theory Development and Methodology.

CHAPTER 5. ALGORITHM DEVELOPMENT

If computer simulation generates hypotheses (Prietula et al., 1998a), then the algorithm development of a simulation generates a set of propositions. This section, therefore, develops a set of propositions (algorithms) that are derived from the “guidelines” tables (Tables I, IV, VI, and XI), and also with the aid of the profile elements table (Table V). The central purpose of this section is to operationalize the preceding theoretical discussions into a coherent set of programmable rules; therefore, each algorithm segment will be discussed in light of how it carries extant theory through to the simulation code. A complementary goal is to compose a description of the computer code so that a line-by-line transformation of the algorithm corresponds to a section-by-section content of the actual computer code. The algorithms are divided into functional segments and constitute three rule sets: (1) the baseline, (2) the diversification extension, and (3) the executive compensation extensions. Numbers in parentheses during the discussion and explanation of each algorithm refer to the specific line numbers in the algorithm.

Baseline Algorithm

The baseline algorithm consists of eight different parts: Landscapes, agent profiles, internal activity, environmental scanning along with buying and selling, territory setup and retaliation, organizational transformation & death, movement, and miscellaneous/data collection. Each of these parts will be developed in its own section below.

Algorithm 1.1: Landscapes

Each landscape consists of a square space of square elements, like a chessboard, each constructed with different environmental parameters. This algorithm establishes differences

between landscapes in terms of resource abundance, the frequency of shifting resources, and the number of agents located on each landscape.

Algorithm 1.1: Landscapes

```
1 cells=22 (Number of cells on each landscape)
2 scapes=3 (Number of landscapes, analogous to real-world industries, for each of three
3 environmental dimensions; cube this value to get the number of landscapes)
4 iterations = 50 (Length of “time” of the simulation)
5 LANDSCAPES = ARRAY {cells x cells x scapes x scapes x scapes}
6 (to be filled with agent identification numbers)
7 RESOURCES = ARRAY {cells x cells x scapes x scapes x scapes}
8 (to be filled with the real-time quantity of resources in each cell)
9 RESOURCEMAX = ARRAY {cells x cells x scapes x scapes x scapes}
10 (to be filled with the maximum possible quantity of resources in each cell)
11 PEAKS = ARRAY {3 x 3 x 3} (the number of peaks in each landscape)
12 MAXPEAK = ARRAY {3 x 3 x 3} (the maximum value of each peak in each landscape)
13 MINPEAK = ARRAY {3 x 3 x 3} (the minimum value of each peak in each landscape)
14 RESETFREQ = ARRAY {3 x 3 x 3} (the frequency with which the landscape is reset with
15 different locations of peaks and valleys – initialized here but used in Algorithm 1.8, line 7)
16 NUMAGENTS = ARRAY {3 x 3 x 3} (the total number of agents located on each
17 landscape)
18 For each level of environmental munificence (low, medium, high) = i[1, 2, 3],
19 For each level of environmental dynamism (low, medium, high) = j[1, 2, 3],
20 For each level of environmental complexity (low, medium, high) = k[1, 2, 3],
```

21 Fill LANDSCAPE with agents, with no more than one agent per randomly-

22 determined location.

23 $PEAKS[i, j, k] = 5*(i^2)$

24 $MAXPEAK[i, j, k] = 5*i$

25 $MINPEAK[i, j, k] = i$

26 $RESETFREQ[i, j, k] = (4 - j)^3$

27 IF $k = 1$, $NUMAGENTS = 0.3*22^2$

28 IF $k = 2$, $NUMAGENTS = 0.6*22^2$

29 IF $k = 3$, $NUMAGENTS = 0.9*22^2$

30 Randomly locate each agent, using 1, ... , $NUMAGENTS$ as identification numbers,

31 on a LANDSCAPE element, ≤ 1 per element.

32 Randomly locate peak locations on $RESOURCEMAX$, and on these squares set

33 value to $MAXPEAK$

34 At 5x5 & 6x6 square perimeters around each peak, set $RESOURCEMAX$ to

35 $MINPEAK + 1$

36 At 3x3 & 4x4 square perimeters around each peak, set $RESOURCEMAX$ to

37 $MINPEAK + (MAXPEAK*1/3)$

38 For 2 squares away from each peak, set $RESOURCEMAX$ to $MINPEAK +$

39 $(MAXPEAK*2/3)$

40 For all remaining squares, set $RESOURCEMAX$ value to $MINPEAK$

41 $RESOURCES = RESOURCEMAX$ (cell resources can grow and be reduced by

42 agent harvesting each iteration, but cannot exceed their initial maximum values)

43 End all For loops

In the above algorithm, landscapes of resources are created with peaks and valleys similar to the way in which landscapes were generated in Epstein & Axtell's (1996) sugarscape, but that simulation was of a different scale: one landscape space of 50 x 50 elements (2,500 squares) with 400 agents and only two resource ("sugar") peaks generated in fixed locations. The current study use a smaller landscape (22 x 22 elements), but sets up 27 different landscapes (line 2), rather than Epstein & Axtell's single landscape. This study also creates a total of 7,840 agents (lines 27-29), compared to Epstein & Axtell's 400, and 13,068 total squares (lines 1-2) compared to Epstein & Axtell's 2,500.

The objective of Algorithm 1.1 is to establish differences between landscapes that are congruent with contingency theory. These differences are at the landscape level of analysis, and they will be expected to act as higher-level mediators of agent-level behaviors, the perspective held by Aragon-Correa & Sharma (2003), among others. Differences in environmental munificence across landscapes (lines 23-25) are established by increasing the number of peaks, the height of each peak, and the minimum resource value, for increasing levels of munificence (i) across the resource landscape (set up in lines 32-42). This difference should result in higher-munificence landscapes having the capacity to support more agents, and reflects Dess and Beard's (1984) description of environmental munificence (see Table III). Differences in environmental dynamism are reflected in the increasing resource reset frequencies across increasing levels of j , and applies to Dess and Beard's (1984) first component of dynamism, the "frequency of changes in relevant environmental activities" as indicated in Table III. Resources are intended in this simulation to be "relevant," as agents will be programmed to be dependent on these resources for revenue (directly for harvester types; indirectly for manufacturing and

retail types), so that a resource dependence (Pfeffer & Salancik, 1978) is created between resources and agents. Differences in environmental complexity across landscapes are established by increasing the number of agents (lines 27-29) across landscapes of increasing complexity (k). This variance in the number of agents is an application of geographical concentration, by the number of establishments, as described by Dess and Beard (1984). An agent in a more dynamic environment will have more choices to make with regard to which agents it can and should interact with, making the pursuit of profit more unclear than in a less complex environment. Note that in the creation of environmental differences between landscapes, not all environmental differences are simulated as are described to exist per Dess and Beard (1984) and detailed in Table III. This is justified by the application of the simplicity tool in COT; however, the application of this tool requires us to qualify our conclusions somewhat: we can conclude that the observed effects between environments represent only a subset of the possible effects that might be observed if all the elements of environmental differences were incorporated into the simulation. The specific choices as to which parts of Table III to incorporate into the simulation are a combination of salience and convenience; more environmental differences could be added to an extension of the baseline code that might further investigate the issue of fine-grained effects of specific types of environmental differences within each environmental variable, but such an effort is beyond the scope of the present study.

Note also that if the size of the landscapes (and the number of agents) is not sufficient to establish significant, ANOVA-tested differences between landscapes, then landscape sizes and the number of agents will be increased. Thus it must be noted that the specific environmental differences, and the mathematics used to create those differences, are arbitrary and are only important insofar as the significant differences they create between landscapes; any number of

alternative mathematical manipulations could have been used. This arbitrariness points out a weakness in the literature in that, while it is known that environments and industries differ in terms of munificence, dynamism, and complexity, it has not been established as to exactly how environments differ along these dimensions: linearly, exponentially, etc.

Algorithm 1.2: Agent Profiles

We now have a set of landscapes with a population of generic agents randomly located on each. Now each agent must receive a profile according to Table V, and this is done in Algorithm 1.2 below, with comments/explanations of the variable names in parentheses and function $\text{RAND}[\dots]$ indicating the generation of a uniformly distributed random variable.

Algorithm 1.2: Agent Profiles

- 1 For AGENT[i; j; k; 1, ..., NUMAGENTS]
- 2 TYPE = $\text{RAND}[0, 1, 2]$ (agent is either a harvester(0), transformer(1), or retailer(2))
- 3 CAPITAL = 15 (initial capital on hand for buying resources is 15 units)
- 4 CAPBEGIN = $\text{ARRAY}\{3\} = 0$ (total capital agent holds at the beginning of an iteration, for
- 5 the current & previous 2 iterations - for performance calculation)
- 6 CAPALLOCATD = $\text{ARRAY}\{3\} = 0$ Capital allocated, but not yet spent, for each
- 7 department (buying, processing, selling/searching); PROPBIAS determines which of the
- 8 three is given priority
- 9 DIED = 0 (0 = "not dead"; nonzero number here is the iteration that agent died on)
- 10 DIE = $\text{RAND}[9, \dots, 25]$ (number of contiguous periods of losses allowed before death)
- 11 STATUS = $\text{RAND}[0.00, \dots, 5.00]$ (initial status, or legitimacy, setting)

12 $PROPBIAS = RAND[0, 1, 2]$ (CEO's background bias is either buying (0), production
13 (1), or selling (2))
14 $BUYSELLPREF = RAND[0, 1, 2]$ (prioritize buying by type of criteria: supply-chain
15 oriented (0), lowest-price oriented (1), or highest status (2))
16 $BIASCHANGE = RAND[0.0, \dots, 1.0]$ (extent of randomization of $PROPBIAS$ and
17 $BUYSELLPREF$; see line 6 of Algorithm 1.3 below)
18 $PROFIT = 0$ (total $CAPITAL$ accumulated; a negative number indicates a loss)
19 $PROFITTIMES = 1$ (total number of contiguous periods with a positive $PROFIT$)
20 $LOSSTIMES = 0$ (total number of contiguous periods with a negative $PROFIT$)
21 $BUYFROMTIMES = ARRAY\{AGENTMEM \times 2\} = 0= 0$ (List of agents that an agent
22 has bought supplies from, up to agent's memory; second dimension is 1: AgentID
23 Number; 2: #transactions; used for calculating transaction cost efficiencies)
24 $INVBUFFER = RAND[0, 1, 2, 3]$ (over-order quantity)
25 $INVAVG = RAND[0, \dots, 9]$ (for the purpose of initialization, the moving average of
26 historical inventory is set to an initial number)
27 $MOVAVG = 3$ (for all agents, current demand is estimated by demand in the past 3
28 iterations)
29 $SOLD = [5, 5, 5]$ (the number of units sold in each of previous past 3 iterations)
30 $INVRAW = 1$ (initial quantity of raw material resources in inventory = 1 unit)
31 $INVFINISHED = 1$ (initial quantity of finished product in inventory = 1 unit)
32 $SELLPRICE1 = RAND[1.5, \dots, 10.0]$ (unit selling price when seller is biased toward
33 supply chain; i.e. $BUYSELLPREF = 0$)

34 SELLPRICE2 = RAND[1.5, ..., 10.0] (unit selling price when seller is biased toward
35 low-price; i.e. BUYSELLPREF = 1)
36 SELLPRICE3 = RAND[1.5, ..., 10.0] (unit selling price when seller is biased toward
37 status; i.e. BUYSELLPREF = 2)
38 RETAILPRICE = RAND[1.5, ..., 10.0] (unit selling price when seller is a retailer)
39 REACTIME = RAND[1, ..., 5] (reaction time, in iterations, to competitor trespass)
40 NOTREACT = 0 (number of iterations that an agent has not reacted to a trespasser)
41 REACTMAG = RAND[1.1, ..., 10.0] (reaction magnitude; see Algorithm 1.5, lines 14-15)
42 REACTPROB = RAND[0.0, ..., 1.0] (probability of attack on trespasser; see Algorithm
43 1.5, line 12)
44 AVERSION = RAND[0, 1] (if 1, agent chooses to move away from aggressive agents; if
45 0, agent moves toward greater resources)
46 TERRITSETUP = 0 (size of territory set up by agent; if 0, agent has not set up a territory)
47 MOVE = -1 (will be set later to 0, 1, or 2; if MOVE = 0, agent moves one square; if
48 MOVE = 1, the agent sets up a territory and does not move; if MOVE = 2, agent moves 2
49 squares)
50 SEARCHLAND = RAND[8, ..., MAXMEM] (minimum number of squares searched)
51 SEARCHED = ARRAY{7 x 7 x 1} (array of 0s and 1s that indicates for each agent
52 which square was Mapped and which was not – used in agent movement)
53 MAP = ARRAY{7 x 7 x 2} (array that stores landscape resources and agent locations
54 observed during search of agent's environment; number of "active" elements in array
55 depends on SEARCHLAND)
56 MAXMEM = 32 (maximum number of agents in any agent's memory)

57 AGENTMEM = RAND[8, ..., MAXMEM] (a particular agent's memory)

58 AGENTLIST = ARRAY{AGENTMEM} = 0 (each agent stores a list of up to 32 agent's
59 ID numbers from the agent's MAP)

60 COMPETLIST = ARRAY{AGENTMEM} = 0 (agent's list of known competitors)

61 SUPPLYLIST = ARRAY{AGENTMEM} = 0 (agent's list of known suppliers)

62 WHITELIST = ARRAY{AGENTMEM} = 0 (agent's list of preferred agents' types –
63 buyer or supplier – and locations)

64 BLACKLIST = ARRAY{AGENTMEM} = 0 (agent's list of non-preferred agents' types
65 – buyer or supplier – and locations)

66 BUYLIST = ARRAY{AGENTMEM} = 0 (agent's list of other agents that the agent had
67 bought from in the past)

68 BUYFROMLAST = ARRAY{AGENTMEM} = 0 (list of agents bought from in the
69 previous iteration)

70 INTERACTWITH = ARRAY{AGENTMEM} = 0 (agent's list of other agents that the
71 agent had interacted with on the current iteration – used to determine whether to place
72 agent(s) on its BLACKLIST or WHITELIST)

73 THRESHFLEX = RAND[0.1, ..., 8.0] (flexibility threshold: after interaction with agent,
74 if profits > THRESHFLEX, place on WHITELIST; if losses are > THRESHFLEX, place
75 on BLACKLIST)

76 TRANSFINCREM = RAND[0.0, ..., 1.0] (probability of an incremental transformation
77 event; see lines 20-22 of Algorithm 1.6)

78 TRANSFREORG = RAND[0.0, ..., 1.0] (probability of a re-creation/reorganization
79 transformation event; see line 26 of Algorithm 1.6)

80 THRESHREORG = RAND[0, ..., 10] (minimum number of contiguous loss periods
81 before reorganization is attempted)
82 CHANGEPRF = RAND[0, 1] (preference for change – incrementally or by re-
83 creation/reorganization)

The variables PROFIT (line 18) and DIED (line 9) will serve as the dependent variables in the regression analysis of results presented below (PROFIT is calculated from CAPITAL, line 3, and CAPBEGIN, lines 4-5; DIED will be converted to “Longevity” in Excel when surviving agents, with DIED = 0, are assigned a Longevity value of 50) because profitability is a common dependent variable used in the behavioral decision theory and strategic management perspectives, as well as Oliver’s revised institutional theory perspective that those agents with higher status also make higher profits, while longevity is a common predictor in studies which include perspectives of (neo-) institutional theory and organizational ecology.

Dependent variables are composed of agent characteristics (Table V), which are created from the theoretical perspectives of organizations (Table II). Specifically, BUYSELLPRF (line 14) accommodates various supply chain tactics (Rosetti & Choi, 2005), while AGENTMEM (line 57, limited by MAXMEM, line 56), SEARCHLAND (line 50) and MAP model intuition (Sadler-Smith & Shefy, 2004) and limited search (Cyert & March, 1963) or the scanning pervasiveness-decision quality tradeoff (Hough & White, 2003). Institutional theory is accommodated by the variable STATUS (line 11) around which will be constructed the mechanism of isomorphism with the aid of TRANSFINCREM (lines 76-77). Enactment, which involves both creeping commitment and entrenchment, is represented by MOVE (lines 47-49), as per Danneels (2003) as well as allowance for the possibility of differing entrenchment rates in THRESHREORG (lines 80-81). Bias discussed in the enactment perspective is modeled by

PROPBIAS (lines 12-13) internally, and by BUYSELLPREF (line 14) externally, while strategic flexibility (Shimizu & Hitt, 2004), at least with regard to internal weaknesses, is represented by variance in the variable BIASCHANGE (lines 16-17). Behavioral decision theory's strategic positioning (Ketchen, Snow & Street, 2004) is also represented by the variance in REACTIME (line 40) and REACTPROB (lines 42-43), as well as by AVERSION (lines 44-45) when it is set to zero (AVERSION supports resource dependence when it is set to one). Finally, organizational ecology's change-by-re-creation perspective is represented by TRANSFREORG (lines 78-79), where agents prefer change through either isomorphism (TRANSINCREM) or re-creation (TRANSFREORG) in the binary variable CHANGEAPREF (lines 82-83), while organizational death, a central concept in organizational ecology, is represented by DIED (line 9) at varying rates (DIE, line 10).

Algorithm 1.3: Internal Activity

At this point, each agent is located on a landscape, and each contains a wide range of traits with which to make decisions. The simulation is ready for its first iteration. What is needed first is internal activity that does not require interaction with other agents: fund allocation, harvesting, and transformation of resources. These tasks are carried out in Algorithm 1.3 below.

Algorithm 1.3: Internal Activity: Fund Allocation, Harvesting & Production

- 1 For each landscape,
- 2 For each agent,
- 3 CAPBEGIN[2] = CAPBEGIN[1]; CAPBEGIN[3] = CAPBEGIN[2]
- 4 CAPBEGIN[3] = CAPITAL

```

5 DEMAND = DEMAND/MOVAVG + INVBUFFER (expected demand)
6 IF {RAND[0.0, ..., 1.0] < BIASCHANGE} randomly reassign PROPBIAS
7 IF {PROPBIAS = 0}
8 THEN
9     Allocate all wanted & available capital to purchasing/harvesting, minus INVRAW
10    Allocate remaining capital evenly to manufacturing & sales departments, minus
11    INVFINISHED
12    Adjust CAPITAL downward
13    IF {PROPBIAS = 1},
14    THEN
15        Allocate all wanted & available capital to conversion, minus INVFINISHED
16        Allocate remaining capital evenly to harvest & sales departments
17        Adjust CAPITAL downward
18    IF {PROPBIAS = 2},
19    THEN
20        Allocate all wanted & available capital to sales
21        Allocate remaining capital evenly to harvest & manufacturing departments
22        Conduct conversion of resources for TYPE = 1 and 2; decrease INVRAW and
23        CAPALLOCATD[2]; increase INVFINISHED
24        Conduct harvesting for TYPE = 0 to the extent funded in CAPALLOCATD[1]
25        Adjust CAPITAL downward; adjust RESOURCES downward; adjust INVRAW
26        upward
27        Adjust STATUS upward due to unharvested resources on agent's square

```

28 End all For loops

29 End

In this algorithm, an important decision must be made: How should available CAPITAL be distributed? Each agent faces three alternatives: to favor resource buying, resource conversion, or selling expenditures up to projected demand (and then half of the remainder is allocated to the other two efforts). These alternatives model bias that managers have that is rooted in their backgrounds, as held by the enactment perspective. PROPBIAS (lines 7, 13, and 18) determines which bias is supported on an iteration-by-iteration basis. A relatively unbiased agent will exhibit a relatively high BIASCHANGE proportion that causes PROPBIAS to switch more frequently across iterations. This behavior is seen as “enactment” according to the following reasoning. Suppose every agent’s PROPBIAS = 0; in this case, all agents would tend to hoard resources up to what they expect their demand to be, even if their remaining CAPITAL cannot sufficiently cover conversion and selling expenses. In such an environment, resources would be more scarce than, say, when only 1/3 of the agents’ PROPBIAS settings were at zero. Thus, a bias toward the need for hoarding inputs among individual agents creates a problem of acquiring inputs for those same agents. Now assume that 1/3 of the agents’ PROPBIAS settings were set at zero; the effect on the environment from adding just one more agent’s PROPBIAS setting to zero would be an increased scarcity in resources in some small way. The effect of PROPBIAS, then, models the reality that “managers construct, rearrange, single out, and demolish many ‘objective’ features of their surroundings” (Weick, 1969, p. 64). Conversely, a relatively flexible agent with a high value for BIASCHANGE models the ambidextrous (He & Wong, 2004) and strategically flexible (Shimizu & Hitt, 2004) agent.

Note that the method of demand must be determined. Since this is not a study on the association between demand calculation method and firm performance, the intent here is for all agents to calculate their demand in the same way; in this case, a moving average of the demand for the previous three iterations was considered sufficient. Also assumed above is the setting of the price of harvesting one resource unit to one unit of capital, thus avoiding effects such as inflation and supply-demand curve adjustments.

Algorithm 1.4: Search, purchase, and sell

Next, the agents must interact with their environments: they need to search for local sellers and buyers, prioritize who they prefer to interact with, and then conduct buying and selling activities. Algorithm 1.4 is shown below, and constitutes the core of the baseline simulation, as it entails agent interaction.

Algorithm 1.4: Search, Purchase and Sell

```
1 For each landscape,
2   For each agent,
3     Search the 8 adjacent squares and add identified agents to AGENTLIST, if not already
4       on the list.
5     IF {SEARCHLAND > 8}
6     THEN
7       Randomly search the 14 squares that are a distance of two away and add identified
8         agents to AGENTLIST, if not already on the list.
9       Deduct cost of search from CAPALLOCATD[3]
10      IF {SEARCHLAND > (8+14)} THEN
```

11 Randomly search the 22 squares that are a distance of three away and add identified
12 agents to AGENTLIST, if not already on the list.

13 Deduct cost of search from CAPALLOCATD[3]

14 Store MAP of the landscape & agent types for squares searched and save for
15 Movement algorithm

16 For each agent identified in search, add the searching agent to each searched agent's
17 list

18 Out of the list of agents in AGENTLIST, create the following lists:

19 COMPETLIST = list of agents of the same type

20 SUPPLYLIST = list of candidate agents to buy from

21 Sort SUPPLYLIST as follows:

22 IF {RAND[0.0, ..., 1.0] < BIASCHANGE} randomly reassign BUYSELLPREF

23 IF {BUYSELLPREF = 0} (for agents with supply-chain preference)

24 THEN

25 Sort all agents in SUPPLYLIST by supply-chain preference (those with supply-
26 chain preference are first, then those agents with STATUS preference, then
27 those agents with price preference), then by STATUS (resolve ties randomly)

28 IF {BUYSELLPREF = 1} (for agents with low-cost preference)

29 THEN

30 Sort all agents in SUPPLYLIST by price preference (those with price preference
31 are first, then those agents with supply-chain preference, then those agents with
32 STATUS preference), then by STATUS (resolve ties randomly)

33 For all agents on list, sort by selling/buying price; resolve ties randomly

```

34     IF { BUYSELLPREF = 2}   (for agents with high-status preference)
35     THEN
36         Sort all agents in SUPPLYLIST by STATUS (resolve ties randomly)
37         Place all WHITELISTed agents at the top of the list (sorted by price)
38         Place all BLACKLISTed agents on the bottom of the list (sorted by price)
39     End For Loop (each agent)
40     For each agent, in order of highest status,
41     WHILE {{CAPALLOCATD = 0} & {there are no more buyers}}:
42         IF {TYPE = 2} (if agent is a retail agent)
43         THEN
44             Increase CAPITAL of retail agent; decrease INVFINISHED
45             (unless INVFINISHED = 0, or no agent available to sell to)
46             Buy one unit from agent at the top of SUPPLYLIST, adjusting for
47             BUYFROMTIMES
48             (unless CAPALLOCATD[1] = 0, or no agent available to buy from)
49         ELSE IF {TYPE = 1} THEN (if agent is a manufacturer)
50             Buy one unit from agent at the top of SUPPLYLIST, adjusting for
51             BUYFROMTIMES (unless CAPALLOCATD[1] = 0, or no agent available to
52             buy from)
53             Adjust up INVRAW
54             Adjust down CAPALLOCATD[1] as a result of purchase:
55                 CAPALLOCATD[1] = CAPALLOCATD[1] - SELLPRICE +
56                 BUYFROMTIMES*0.01

```

```

57         Adjust up CAPITAL of agent on SUPPLYLIST:
58             CAPITAL = CAPITAL + SELLPRICE[of buyer] + BUYFROMTIMES*0.01
59             IF {BUYFROMTIMES < 81} BUYFROMTIMES = BUYFROMTIMES + 1
60         Adjust statuses of each transacting agent as a result of the transaction
61             IF {(INVFINAL = 0) OR (no agent available to sell to)} AND {(FUNDPURCH
62                 = 0) OR (no agent available to buy from)} THEN remove agent from list
63     End While loop for each agent (line 41)
64 End all For loops
65 End

```

Similar to the biased resolution of the decision internal distribution of CAPITAL in Algorithm 1.3, in Algorithm 1.4 the decision as to how agents should be rank-ordered for interaction preference is similarly biased, and thus incorporates another aspect of the enactment perspective. In this case, agents rank-order their interaction preferences by the supply-chain preference of candidates (when BUYSELLPREF = 0; see line 23), by lowest price (when BUYSELLPREF = 1; see line 28), or by highest STATUS (when BUYSELLPREF = 1; see line 34). The reasoning is similar to the enactment rationale detailed in the discussion of Algorithm 1.3: if, for example, more agents ranked their preferred interaction agents by highest STATUS, then the task of finding a high-STATUS agent to interact with would be more difficult, environment-wide, than if less agents ranked their preferred interaction agents by highest STATUS. Also, the biased decision described in Algorithm 1.3 concerning PROPBIAS carries through to Algorithm 1.4 when allocated CAPITAL is expended (lines 9, 13, and 55-56).

Within the behavioral decision theory perspective, Sadler-Smith and Shefy's (2004) intuition is modeled with the use of WHITELIST and BLACKLIST, where the WHITELISTED

agents are placed at the top of the interaction preference list (line 37) and the BLACKLISTed agents are placed at the bottom of the interaction preference list (line 38), regardless of BUYSELLPREF's setting. Another concept rooted in the behavioral decision theory perspective, Simon's idea of bounded rationality, is modeled by the search algorithm (lines 3-13) in that only a small part of the agent's landscape is searched, up to 32 and as few as 8 spaces, no more than 3 squares away. The search-cost tradeoff that is also supported by the behavioral decision theory perspective is modeled in lines 9 and 13 when the agent searches more than its adjacent 8 squares (the adjacent 8 squares are searched for "free").

Both the transaction cost economics perspective (Williamson, 1975) and the supply-chain efficiency concept (Rosetti & Choi, 2005) is modeled (in lines 46-47 and 50) when costs are reduced based on the number of previous transactions between the interacting agents (i.e., through the variable BUYFROMTIMES). This implies that costs are initially high and that transaction diseconomies exist; one way to defray costs would be to repeat transactions with the same agents and realize supply-chain efficiencies, while another way would be to vertically integrate, as modeled in the diversification extension (Algorithm 2.1).

Two elements of the above algorithm should be noted. First, those agents with a supply-chain cost reduction development preference are expected to sort secondarily on the basis of STATUS, only taking price into account as a tertiary consideration. This is because it is expected that agents (and real-world firms) interested in forming supply chains take a long-term perspective on current prices, as expenses are expected to drop with each transaction (as per Rosetti & Choi, 2005; also see Oliver, 1997). On the other hand, supply-chain efficiencies can only be realized with the sharing of proprietary information between supply-chain participants, and such agents are more likely to trust and choose supply-chain partners with the highest

available status. Second, note that sales cannot be used to fund purchases in the same iteration, since purchasing is based on funds made available in Algorithm 1.3. However, agents are allowed to purchase in lumps. Chen and Munson's (2004) study noted that lumpy demand is a phenomenon that also exists in general in the real world, making a further, though incomplete, modeling of behavioral decision theory. Generalization of demand lumpiness is proposed as an area for further study and is considered in Chapter 8, Discussion.

Algorithm 1.5: Territory Setup and Retaliation

It may be possible for some agents to set up a defensive stronghold around their part of the landscape; if a territory is already established, intruders may be attacked if criteria, based on agent characteristics, are met.

Algorithm 1.5: Territory Setup and Retaliation

```
1 For each landscape,
2   For each agent,
3     IF {Area defined by TERRITORY does NOT contain an agent of same type}
4     THEN TERRITSETUP = TERRITSETUP + 1
5     IF {(TERRITSETUP >= 5) AND ((MOVE = 0) OR (MOVE = 2))} MOVE = 1 (set
6       up a territory AND don't move)
7     IF {(Area defined by TERRITORY contains an agent of same type) AND (MOVE =
8       1)} (there is potential to retaliate against trespasser)
9     THEN
10      IF {NOTREACT >= REACTTIME} (if the agent determines that it's time to react)
11      THEN
```

```

12     IF REACTPROB > RAND[0.0, ..., 1.0]  (if intended reaction is successful)
13     THEN
14         CAPITAL of attacking agent's capital is reduced by REACTMAG
15         CAPITAL of attacked agent's capital is reduced by REACTMAG2
16         NOTREACT = 0
17     ELSE  NOTREACT = NOTREACT + 1
18     End all For loops
19 End

```

The formation of territories, or strongholds, lies within the strategic management perspective, for example as described in general as a paradigm for competition by D'Aveni (1994), and illustrated by specific example in the aerospace industry (Rosetti & Choi, 2005) as discussed above. Thus, the setup of a territory models the preoccupation of an organization's strategic position relative to the respective position of other competitors, and to retaliate against close competitors if they are proximate to the organization's own competitive position. Thus, Algorithm 1.5 is wholly in support of the strategic management perspective.

Note that the agent reacts to an intruder in its territory only if it has set up a territory, there is an intruder, and it is time, after a delay of REACTTIME iterations, to retaliate. Even if these criteria are met, the reacting agent may decide not to react, or the reaction attempt may have failed; even if the reaction occurs, it varies in effectiveness according to REACTMAG, an agent profile element. A successful reaction also costs the attacker capital, which is the expected behavior in the real world (for example, in the construction of a set of attacking advertising ads). Researchers note that retaliation costs the attacker capital (D'Aveni, 1994) and in general retaliation and direct competition degrades industry profitability (Porter, 1980).

Algorithm 1.6: Organizational Transformation and Death

Each agent needs to determine how well it performed and whether and how it should transform, if not die, based on the agent's PROFIT record. Algorithm 1.6 is justified by the organizational ecology and institutional theory literature discussed in Part I of the above literature review and summarized in Tables I and IV.

Algorithm 1.6: Organizational Transformation and Death

```
1 For each landscape,
2   Rank all agents by STATUS
3   For each agent,
4     Move all CAPALLOCATD to CAPITAL
5     CAPGEBIN[2] = CAPBEGIN[3]; CAPBEGIN[1] = CAPBEGIN[2];
6     CAPITAL = CAPBEGIN[1]
7     PROFIT = CAPBEGIN[1] – CAPBEGIN[2]
8     IF {PROFIT > 0}
9     THEN
10      PROFITTIMES = PROFITTIMES + 1
11      LOSSTIMES = 0
12      Adjust STATUS upward
13    IF {PROFIT < 0}
14    THEN
15      LOSSTIMES = LOSSTIMES + 1
16      PROFITTIMES = 0
17      Adjust STATUS downward
```

```

18     IF {LOSSTIMES > DIE} kill agent: DIED = iteration #, and break out to the next agent
19     IF {LOSSTIMES > THRESHREORG}
20     THEN
21         IF {(CHANGEPREF = 0) AND (RAND[0.0, ..., 1.0] < TRANSFINCREM)}
22             (incremental transformation)
23         THEN
24             Determine an agent to copy from: IF no agent is being copied, or if one agent is
25                 totally copied, THEN assign an agent to copy from the top 5 performers; ELSE
26                 continue copying from identified agent
27             Copy a profile element from agent
28             Adjust copied agent's STATUS upward
29         IF {(CHANGEPREF = 1) AND (RAND[0.0, ..., 1.0] < TRANSFREORG)}
30         THEN
31             re-initialize agent's profile according to Algorithm 1.2
32     End all For loops
33 End

```

The perspective of organizational ecology is modeled in Algorithm 1.6 by allowing agent death (line 17) and by allowing organizational change by reorganization (lines 29-31). Agent death models the mechanisms of purposeful selection and retention (Aldrich, 1979), with PROFIT being considered a reasonable and salient selection/retention criterion. Note that after an agent “dies,” it undergoes no further activity in the simulation for the remainder of the iterations. However, there is no clear way to predict *a priori* whether Algorithm 1.6 will produce sufficient death rates to allow for organizational ecology to be an influential perspective in the

simulation results; the issue must be resolved iteratively. If no or little evidence of organizational ecology is found after an analysis of the initial results, some of the above variables can be changed. For example, the averages of DIE and THRESHREORG could be reduced among all agents at initialization, thus causing more loss-induced agent deaths and reorganizations (“births”). If on the other hand evidence of population ecology is observed among the simulation results, this would imply that the death and reorganization/birth rates are sufficiently significant. Furthermore, since the mechanism of variation is directly supported in Algorithm 1.2 with the initialization of agent characteristics as uniform random variables, all three prerequisite mechanisms of the organizational ecology perspective would at that point be met.

The institutional theory perspective is also modeled in Algorithm 1.6 by modeling mimetic isomorphism through the incorporation of incremental transformation (lines 21-28), which occurs when $LOSSTIMES < THRESHREORG$, $CHANGE PEF = 0$, and $TRANSFINCREM$ is greater than a uniform random variable of the same range (between 0 and 1). When these criteria are met, the agent chooses to copy an agent that is chosen randomly from among the five most profitable agents in its landscape. Modeling deinstitutionalization (Oliver 1992) and consistent mimetic isomorphism (Dacin, Goodstein & Scott, 2004), the copying agent copies one target agent completely before it moves on to copy a different agent’s characteristics. STATUS points are added to the copied agent (line 28) to model legitimacy (Deephouse, 1996). Thus, Algorithm 1.6 goes a long way toward modeling both organizational ecology and institutional theory perspectives.

Algorithm 1.7: Movement

Movement of an agent is considered a basic property of artificial intelligence programming (Jones, 2003). In our landscape, agents move in order to position themselves for greater profitability and longer survival by applying landscape resources more efficiently, relative to both the resource landscape and the positioning of other agents. The Movement algorithm follows.

Algorithm 1.7: Movement

```
1 For each landscape,
2   For each agent, in order of STATUS,
3     Re-Map agent's MAP according to SEARCHED locations to account for already-
4       moved agents.
5     IF {MOVE = 1} break out of loop and go to the next agent (this agent has set up, or is
6       trying to set up a territory and is not moving, as per Algorithm 1.5, line 5)
7     IF {SEARCHLAND > 15} MOVE = 0; ELSE MOVE = 2 (models the search-speed
8       tradeoff)
9     IF {AVERSION = 0} (if agent is not aversive to other agents, then use the resource
10      map to decide move)
11     THEN
12      Identify the highest unoccupied square with the highest resource (resolve ties
13        randomly)
14      IF {identified square's resource > occupied resource}
15      THEN MOVE (one or two) square(s) in the direction of (or onto if adjacent) that
16        higher-resource square
```

```

17     ELSE do not move
18     IF {AVERSION = 1} (if agent is aversive to other agents, then use the agent map to
19     decide move)
20     THEN
21     For each same-TYPE agent on the MAP, calculate a competitiveness score:
22     COMPETVE = (5 - REACTIME)*REACTMAG*REACTPROB
23     Rank mapped same-TYPE agents in order of COMPETVE
24     IF {for top-scoring agent, COMPETVE < 10} do not move
25     ELSE (now the agent is compelled to move)
26     IF {there is only one agent on the MAP}
27     THEN
28     IF {an unoccupied nearby square is found in the opposite direction of the
29     aggressive agent} THEN MOVE there ELSE do not move (resolve multiple
30     choices by moving to the square with the highest resource)
31     IF {there are two or three agents on the MAP}
32     THEN
33     Calculate a vector in the opposite direction from the agent
34     IF {an unoccupied adjacent square is found in the opposite direction of the
35     vector}
36     THEN MOVE there (resolve multiple choices by moving to the square with the
37     highest resource)
38     ELSE do not move
39     ELSE (i.e. there are more than three agents identified on the MAP)

```


40 Choose the three highest-ranked agents and calculate a vector in the opposite
41 direction, then proceed as above in MOVEing to an available location.
42 End all For loops
43 End

Agents either move toward greater landscape resources, modeling resource dependence theory (as per Pfeffer & Salancik, 1978), or away from competitors, modeling niche theory in the Strategic Management perspective (Porter, 1980), according to the agent's characteristic, AVERSION (lines 9 and 18), a binary random variable. When moving away from competitors, a competitiveness score was calculated for each competitor in an agent's MAP, since a competitor is only considered aggressive if it simultaneously reacts quickly (low REACTIME), with high magnitude (high REACTMAG), and frequently (REACTPROB is low). Furthermore, the search-speed tradeoff identified by Ketchen, Snow and Street (2004), among others, is modeled in line 7 where an agent is allowed to move only one space if it has searched more than 15 spaces in that iteration (but the agent can move two spaces otherwise). However, as no more than two squares can be traversed per iteration, line 7 and the limits to the MOVE variable is consistent with Ketchen, Snow & Street's (2004) discussion on strategic positioning, and Danneels' (2003) creeping commitment.

Note that the search-first-then-move procedure detailed in the algorithm describes a movement that is more complicated, and intelligent, than Epstein and Axtell's (1996) landscape movement; their agents could not move along diagonals, toward higher-resource squares, or away from other agents. However, Algorithm 1.7 requires a considerable amount of code because a movement rule set must be written for each of the 32 possible squares, each square with a secondary, and some with a tertiary square, that an agent might move to. The payoff is

considerable however, as movement across a landscape is made to be far more realistic and intelligent than the Epstein and Axtell (1996) simulation.

Algorithm 1.8: Miscellaneous and Data Output

The agents are ready for their next iteration after some preparation (“Miscellaneous”), and after all iterations are complete, data must be collected by printing out important variables that will be copied into Excel for analysis. The algorithm is shown below:

Algorithm 1.8: Miscellaneous and Data Output

```
1  Miscellaneous:
2  For each landscape:
3    Factor = (A*iterations – iteration)/(A*iterations)
4    where A = (1.1, 1.3, 1.5) for i = (1, 2, 3)
5    MINPEAK = MINPEAK*Factor (reduce the peak minimum after each iteration)
6    MAXPEAK = MAXPEAK*Factor (reduce the peak maximum after each iteration)
7    IF {RESETFREQ is a multiple of the iteration number} THEN re-generate landscape
8  For each Agent:
9    Move the SOLD list used for moving average estimate of demand:
10     SOLD[2] = SOLD[3]; SOLD[1] = SOLD[2]; SOLD[1] = 0
11     Reset list of competitors and SEARCHED array
12 REPEAT the above algorithms, beginning with Algorithm 1.3, for 50 iterations
13 Data Output:
14 For each Landscape
15 For each Landscape location
```

```

16     PRINT {RESOURCES; NUMAGENT}
17     PRINT {Munificence (total unharvested resources left on each landscape); number of
18         agents alive; RESETFREQ; NUMDEAD; LANDSCAPES; RESOURCES}
19     For each agent:
20         PRINT {NUMAGENT; PROFIT; STATUS; TYPE; DIE; DIED; AGENTMEM;
21             PROPBIAS; BIASCHANGE; SELLPRICE1; SELLPRICE2; SELLPRICE3;
22             RETAILPRICE; REACTIME; NOTREACT; REACTMAG; REACTPROB;
23             TERRITSETUP; AVERSION; MOVE; SEARCHLAND; BUYSSELLPREF;
24             THRESHFLEX; TRANSFINCREM; TRANSFREORG; CHANGEPRF}
25     End all For loops.
26 End.

```

There are two interesting aspects of this algorithm. First, environmental dynamism is modeled by the periodic resetting of landscapes as per RESETFREQ, a landscape characteristic (see line 7). Second, organizational ecology is modeled by setting a continuous decline of resource peaks (and valleys) across iterations (lines 3-6). This prevents equilibrium in the form of a steady state to be established (with no deaths) which would negate the effects of organizational ecology since the mechanisms of retention and selection would at that point be dormant; instead, a steady death rate is established through the steady decline of resources so that data collection at the last iteration is still influenced by the organizational ecology perspective. An illustration of the types of survival curves that might be expected in the analysis of the simulation's results is shown in Figure 7. In this figure, deaths begin at zero as it takes time for agents to accumulate contiguous loss periods before they die. Then the death rate increases substantially as represented by the steep segment of the curve. Finally, the death rate

slows to a constant, moderate rate due to decreasing resources per lines 3-6 in Algorithm 1.8. One must take care that the landscapes at the higher complexity (i.e. population) settings do not fall below the complexity setting at the next-lower complexity/population, as this would indicate a reversal of complexity conditions between the two landscapes. One must also take care not to stop the simulation before a moderate, steady death rate (i.e. equilibrium) is established because the characteristics of those agents that have died early (within the initial high-death-rate region) can be contrasted better with the characteristics of those agents that have survived (to verify the presence of the organizational ecology perspective) if the two groups are separated by a number of intermediate observations. This discussion is continued in the Methodology section below.

Extension #1: Diversification

The above algorithm set constitutes essentially a set of propositions as to how firms selling a commodity are basically expected to behave, albeit in a substantially simplified way. The baseline simulation is now positioned for extensions which contribute to our understanding of strategic management in specific areas of interest. The first issue that this study will address is diversification strategy, with the goal to test some or all of the questions raised in Table VI (discussed in the Methodology section below). Suppose, for example, that computer code is written and then validated (per the discussion in the Methodology section below), and then extended to accommodate agents that diversify, as is intended for this study. If diversification is indeed contingent on the environmental variables specified herein (Algorithm 1.2), one would be able to compare significant differences in the frequency of occurrence of agents with certain diversification strategies between groups of survivors versus the early dead, and groups of agents

in most-harsh environments as compared to least-harsh environments. To this end, the modifications to the baseline model are outlined in Algorithm 2.1 as follows:

Algorithm 2.1: Diversification

1 At program initialization, add:
2 NumSubs = 30 (Maximum number of subsidiaries that a diversified agent can have)
3 CEOLIST = ARRAY[landscapes x NUMAGENTS x NumSubs] = 0 (list to keep track
4 of CEO agents – the second dimension – and the agents that are subsidiaries – the
5 third dimension, up to 30 subsidiaries are allowed)
6 To Algorithm 1.2, add:
7 PROPENDDIVERS = RAND[1, ..., 8] (Randomly assign a diversification strategy
8 code: 1 = single business; 2 = vertical integrator; 3 = dominant-constrained; 4 =
9 dominant-linked; 5 = related-constrained; 6 = related-linked; 7 = unrelated-passive; 8
10 = acquisitive conglomerate)
11 SR = 0 (Rumelt's Specialization Ratio to determine which type of agent the HQBU
12 (headquarters business unit) should try to acquire next)
13 RR = 0 (Rumelt's Related Ratio, also to determine which type of agent to acquire next)
14 DIVERSIFIED = 0 (all agents begin as single business units; when an agent is
15 acquired, DIVERSIFIED is changed to 1; when an agent acquires another agent, the
16 agent becomes a headquarters (HQBU) and DIVERSIFIED is changed to 2)
17 THRESHDIVFY = RAND[5, ..., 30] (amount of CAPITAL that must be exceeded
18 before an agent is interested in diversifying)
19 ACQRACCEP = RAND[0.0, ..., 1.0] (probability that agent will accept becoming a
20 subsidiary of another agent)

21 IF {PROPENDINGERS = 1} ACQRACCEPT = ACQRACCEPT – 0.3

22 (because some single-business-strategy agents will never agree to be acquired; also

23 ensures that single agents will persist)

24 To Algorithm 1.3, add:

25 For each landscape,

26 For each agent,

27 IF {DIVERSIFIED = 2}

28 THEN

29 CapMain = all CAPITAL and CAPALLOCATD of HQBU and all SBUs within a

30 Euclidean distance of 15 from the HQBU

31 CapPeriph = all CAPITAL and CAPALLOCATD of all SBUs further away than a

32 Euclidean distance of 15 from the HQBU, and all SBUs on different landscapes

33 SRdenom = CapMain + CapPeriph – (all CAPITAL and CAPALLOCATD)

34 SR = (all CAPITAL and CAPALLOCATD of HQBU)/SRdenom

35 (Specialization Ratio = "proportion of a firm's revenues that can be attributed to its

36 largest single business in a given year," Rumelt, 1974, p. 14)

37 RR = CapMain/CapPeriph

38 (Related Ratio = "the proportion of a firm's revenues attributable to its largest

39 group of related businesses," Rumelt, 1974, p. 16)

40 IF {DIVERSIFICATION = 0}

41 THEN

42 -- insert Algorithm 1.3 code here --

43 ELSE (in this case, the agent is diversified)

```

44     IF {DIVERSIFIED = 2}
45     THEN
46         Calculate the HQBU's CAPITAL by adding up all CAPALLOCATD in all
47         SBUs and in HQBU and transfer over to HQBU's CAPITAL
48         CAPBEGIN[3] = CAPITAL
49         Re-allocate CAPITAL to CAPALLOCATD, in HQBU first and then evenly to
50         all SBUs, based on demand estimates; each SBU allocates specific amounts
51         to CAPALLOCATD based on PROPBIAS of HQBU
52     End all For loops
53 End
54 To Algorithm 1.4, add:
55 To the beginning of Algorithm 1.4, add:
56 Allocate all CAPALLOCATD back to HQBU's CAPITAL
57 An acquisitive conglomerate (PROPENDIVERS = 8) will diversify before spending $$
58 on operations:
59 IF {(DIVERSIFIED != 1) AND (PROPENDIVERS = 8) AND (CAPITAL >
60 THRESHDIVFY)}
61 THEN
62     Acquisitive conglomerate attempts to diversify: search a 3 x 3 square chosen at
63     random on a landscape chosen at random and create a list of acquisition
64     candidates
65     Sort list of candidates by BUYSELLPREF (supply-chain preference, lowest price,
66     or STATUS) since an acquisition is essentially a purchase

```

67 Choose the highest affordable candidate, if one exists:

68 IF {PROFIT of candidate > 0}, Capital Required = (5 + 2*PROFIT of

69 candidate)

70 IF {PROFIT of candidate < 0}, Capital Required = 5

71 Re-distribute remaining CAPITAL among subsidiaries as above

72 End all FOR loops

73 After all FOR loops are ended, but before END:

74 For each landscape,

75 For each agent,

76 IF {(DIVERSIFIED = 1) AND (CAPITAL > THRESHDIVFY)}

77 THEN

78 IF {PROPENDINGERS = X} (X = 2 to 8, each a different diversification

79 strategy)

80 THEN

81 Create a list of candidates (for example, a vertical integrator will include only

82 different-type agents on the same landscape) and sort based on PROPBIAS

83 Calculate the CAPITAL required for acquiring each agent (cost of capital,

84 assets, and two iterations of projected income) on the list of candidates

85 “Offer” to buy the first affordable agent (i.e., the first agent in which the capital

86 required < CAPITAL); if none affordable, then break out & go to the next

87 agent

88 IF {RAND [0.0, ..., 1.0] < ACQRACCEPT of acquisition candidate} (if the

89 acquisition is agreed to)


```

90         THEN
91             Move the new subsidiary's CAPITAL to the HQBU agent
92             CAPITAL = CAPITAL – Required CAPITAL (adjust the HQBU's
93             CAPITAL)
94             DIVERSIFIED = 2 for acquiring agent
95             DIVERSIFIED = 1 for acquired agent
96             Add acquired agent to the subsidiary portion of CEOLIST
97             Maximize BUYFROMTIMES for vertically integrated agents
98     End all For loops
99 End
100 To Algorithm 1.5, add:
101 IF {(an agent is identified as a trespasser) AND (is a member of the same diversified
102     organization)}
103 THEN exempt the agent from an attack
104 End
105 To Algorithm 1.6, add:
106 IF {DIVERSIFIED = 1} apply the profile elements of the HQBU during incremental
107     transformation events; else proceed through Algorithm 1.5 in the same way.
108 End
109 To Algorithm 1.7, add:
110 IF {(AVERSION = 1) AND (an identified aggressive agent is a member of the same
111     diversified organization)}

```

```

112 THEN do not be compelled to move away from this agent (i.e., remove agent from list of
113 agents on MAP, ranked in order of COMPETVE)
114 End
115 To Algorithm 1.8 (Miscellaneous), add divestiture routine:
116 For each HQBU
117 Find the worst-performing SBU
118 IF {LOSSTIMES of SBU < DIE of HQBU}
119 THEN divest the SBU:
120 DIVERSIFIED of (former) SBU = 0
121 Remove (former) SBU from CEOLIST of HQBU
122 End
123 To Algorithm 1.8 (Data Output), add:
124 PRINT {CEOLIST, NumSBUs, DIVERSIFIED, PROPENDDIVERS, THRESHDIVFY,
125 ACQRACCEPT}
126 End

```

In this extension, agents can “acquire” other agents for a CAPITAL of 5 if the acquired agents are unprofitable, or for a CAPITAL in proportion to the acquired agent’s PROFIT if it is positive (lines 67-70). Size was limited to a 31-agent organization (30 SBUs and one HQBU; see line 2). This decision was made more on a comparison of the total number of iterations (50) than on the Penrose (1959)/Dewing (1921) scope/scale debate discussed above. Eight of Rumelt’s (1974) nine diversification strategies are modeled (lines 7-10), based on the calculation of Rumelt’s (1974) specialization ratio (SR; lines 11-12, 33-36) and related ratio (RR; lines 13, 37-39), although the definition of “related” must be further defined. In order to be counted as

“related,” an agent must be located within 15 spaces (Euclidean distance) of the HQBU (lines 29-32) on the same landscape. This rationale is justified when each landscape is thought of as a strategic positioning on an industry map with two dimensions that all participants use to compete or avoid competition (Porter, 1980). Consequently, the “product mix” of an agent on one side of the landscape is expected to be substantially different from that of an agent on the other side of the landscape, and thus an acquisition of one by the other might be seen as an unrelated diversification. This rationale seems to agree with Rumelt’s description of an unrelated diversification strategy as “firms that diversify (usually by acquisition) into areas that are not related to the original skills and strengths, other than financial, of the firm” (Rumelt, 1974, p. 11). For example, a firm that makes wooden pencils that acquires a firm that makes plastic pens is diversifying unrelatedly because the process used to manufacture a plastic pen is almost completely different from a wooden-pencil manufacturing process, even though both acquiring and acquired firms are found in the same “writing utensils” industry.

Another decision that was made for the purpose of simulation was the distinction between acquisitive conglomerate (PROPENDINGERS = 8) and unrelated passive (PROPENDINGERS = 7) strategies. Rumelt defined acquisitive conglomerate firms as “firms that have aggressive programs for the acquisition of new unrelated businesses” (Rumelt, 1974, p. 32). In the simulation world, this definition suggests that acquisitive conglomerates spend CAPITAL allocated for operations on acquisitions instead, while unrelated-passive diversifiers conduct an acquisition from their CAPITAL only in excess of their ongoing operations expenses. Thus, acquisitive conglomerates attempt to diversify before they engage in operations, and they calculate if candidates are affordable for acquisition based on all of its pooled CAPITAL (lines

57-72); unrelated-passive diversifiers first conduct operations, then pool their unused CAPITAL to determine if there is enough surplus funds to make an acquisition.

Yet another important operationalization involved making a distinction between Rumelt's constrained/vertical, linked, and unrelated diversification strategies. Rumelt (1974) described constrained/vertical strategies as those firms which sought to merge with other businesses that were not altogether different from the core work that the firm was already conducting. Over time, however, a firm might conduct a series of mergers which, at the time, the mergers were related to some work or product that the firm already did or sold, but when comparing an early merger to a late merger, these two firms appeared unrelated. Finally, as detailed above, unrelated diversifiers were described as acquiring other firms which appeared unrelated to the firm's current portfolio of business. Differences in these three types of strategies were modeled in the simulation by the type of searching done in preparing a list of candidates. For the constrained/vertical strategy, agents use those agents identified on their current MAP that had been applied to the identification of candidates to buy from in Algorithm 1.4. For the linked strategy, agents use their own MAP to form a list for their first acquisition, but then they construct a list of acquisition candidates from one of their SBUs (randomly chosen if more than one SBU exists). Finally, agents with an unrelated diversification strategy choose a landscape at random, and then search a nine-square block at random from that landscape from which they create their list of candidates. Thus, constrained/vertical, linked, and unrelated strategies are carried out in a fundamentally different way, in terms of how each type's list of candidates are created.

The majority of the code modification is made to Algorithm 1.4 (lines 76-99) where agents acquire other agents using diversification strategies 2 through 7, after CAPITAL has been

expensed on operations. A key distinction must be made between how the diversification strategies are used in the research literature and how these strategies are applied in this simulation. The difference lies in the determination of which, if any, type of diversification the agent make during each simulation iteration. The simulation, therefore, applies Rumelt's diversification strategy in determining present firm behavior and is forward-looking. Rumelt and subsequent researchers using his method, however, used the typology in a backward-looking manner to describe a firm's composition at a single point in time; in effect, these researchers had little choice but to measure *diversity* to study diversification strategy. In the present study, *diversification behavior* is "measured" in order to study diversification strategy. Furthermore, data is collected in this study based on the strategy of each agent, and not on each multi-agent organization's composition at simulation termination. The purpose of this study, then, is not to measure the success of successfully executed strategies, but to measure the success of behavior with regard to diversification.

It was assumed for the purposes of this study that all agents approach diversification in the same way, as an acquisition. An acquisition is regarded as a purchase by the acquirer, and therefore, acquisition candidates are ranked on the basis of BUYSELLPREF according to the same procedure used in ranking candidates for the purchase of raw materials. This decision seems reasonable in that supply-chain oriented agents will want to integrate with like-minded agents, while STATUS and price are also ways that firms in the real-world determine which companies to acquire. For example, a turnaround expert in the real world searches for a poor-performing, high-potential company to purchase and replaces its management after acquiring it; a consequence of the market for corporate control (Fama, 1980). In the simulation world, an agent acquires an agent because it agrees to be acquired at a low price, and subsequently many of

the acquired agent's characteristics are replaced by those of the acquiring agent's (if not directly, then eventually by isomorphism; see lines 106-107); modeling a replacement of the acquisition's management by the acquirer would occur in a real-world turnaround effort, as the acquiring management would most likely hire new management that carries similar characteristics to themselves. The extent of centralization, however, is not total because Chandler (1962) suggested a substantial degree of autonomy is reasonable: at times, agents retain their own profile elements for making decisions (e.g., in ranking buy lists), while at other times, the CEO agent's profile elements replace the subsidiary's (e.g. in diversification and divestment decisions), although the influence is toward centralization the longer the SBU belongs to the HQBU through incremental transformation.

Divestment was made on the basis of PROFIT rather than with the aid of BUYSELLPREF because it is assumed that in the real world, the core reason that divisions are divested is for poor performance (lines 116-120), rather than poor reputation or supply-chain orientation. Thus, asymmetry exists between acquisition and divestment decisions, and consequently it is conceivable that an agent may acquire an agent and divest it in the same iteration. However, this behavior would be the result of a shorter LOSSTIMES characteristic of the HQBU than the acquired-then-divested SBU, and with such a poor characteristic, the HQBU cannot last for long and will likely die before long. This sort of result, where agents die soon because of their poor characteristics, is exactly the sort of result we would expect in an environment in which organizational ecology is influential; therefore it is not unreasonable to allow such irrational diversification activity to occur and to assume that ecological mechanisms prevent such behavior from occurring among survivors.

Note that vertical integrators receive an added and unique benefit in that any transactions occurring between vertically integrated agents are conducted at the lowest possible transaction cost (line 97). This is the major benefit to vertical integration according to Williamson (1975); if this benefit is significant, then vertical integrators will be observed with relatively high performance, but if this is not observed to be the case, then transaction costs could be reduced further. On the other hand, if transaction costs are so low that vertical integrators are by far and consistently the highest performers under any environmental extreme, then transaction costs could be added to transactions between vertically integrated agents in order to arrive at a more reasonable situation. Note that while both Rumelt (1974) and Luffman and Reed (1984) found vertical integration to be among the least profitable strategies, since the simulation is conducted on only one rationale for vertical integration (the pursuit of lower transaction costs), in the simulation world we would expect instead that vertical integration should perform quite well; what matters, however, is which environments the vertical integration strategy performs better in and which environments vertical integration performs worse in. In other words, this study is interested in a contingency theory of vertical integration that is based on transaction cost economics reasoning, and not in how well vertical integrators perform overall.

Extension #2: Executive Compensation

In this extension, we build on Extension #1 by paying imaginary CEOs of single-business agents and imaginary executives of SBUs. At any time, the CEO's compensation decision rule follows one of four different methods: agency, stewardship, stakeholder, or strategic fit. Compensation does not appear to the agent as merely an additional expense, but some benefits are received when certain payrules are applied. For example, a fit-based payrule allows an agent

to either reduce costs relative to better-fit agents (by paying its CEO less for the relatively poor fit), or if the agent is well-fit, it can be seen as paying its CEO a premium for this strategy. The goal here is to determine the most successful mix of compensation rules.

Algorithm 2.2: CEO Compensation

```
1  At program initialization, add:
2  PAYRULE = 0  (payrule to use for current iteration, set at either 1, 2, 3, or 4 below)
3  PAYOLD = 0  (used to calculate CEO's pay by the agency payrule)
4  Fill FIT = ARRAY[7 x 27] = rank ordering of 7 diversification strategies for each of 27
5  landscapes
6  To Algorithm 1.2, add:
7  PROPENPAID[1] = RAND[0.0, ..., 1.0]  Agency payrule frequency proportion
8  PROPENPAID[2] = 1 - PROPENPAID[1]  Stewardship payrule frequency proportion
9  PROPENPAID[3] = RAND[0.0, ..., 1.0]  Stakeholder payrule frequency proportion
10  PROPENPAID[4] = 1 - PROPENPAID[3]  Fit payrule frequency proportion
11  To the beginning of Algorithm 1.3, add:
12  For each landscape,
13    For each agent,
14      IF {agent is a single-business or a CEO}
15        THEN
16          Assign PAYRULE = (1, 2, 3, or 4) by comparing RAND[0.0, ..., 1.0] to
17            PROPENPAID
18          IF {PAYRULE = 1}  (CEO is paid according to agency theory)
19            THEN
```


20 $PAY = PAYOLD + RAND[1.0, \dots, 2.0] * (\text{number of subsidiaries})$

21 $MOVE = 2$

22 $CAPALLOCATD[3] = CAPALLOCATD[3] + 0.2 * RAND[1.0, \dots, 2.0]$

23 IF {REACTPROB < 0.9} REACTPROB = REACTPROB + .1

24 IF {PAYRULE = 2} (CEO is paid according to stewardship theory)

25 THEN

26 IF {PROFIT+3 > 0} $PAY = 3 + 0.3 * PROFIT$

27 IF {PROFIT+3 < 0} $PAY = 3$

28 IF {PAYRULE = 3} (CEO is paid according to stakeholder theory)

29 THEN

30 Calculate the average PROFIT of all the agents in INTERACTWITH

31 IF {average PROFIT+3 > 0} $PAY = 3 + 0.3 * PROFIT$

32 IF {average PROFIT+3 < 0} $PAY = 3$

33 IF {PAYRULE = 4} (CEO is paid according to strategic fit)

34 THEN $PAY = (9 - FIT) / 2$

35 where “FIT” is a weighted scale that depends on the diversification results of

36 Extension #1; if the strategy chosen by HQBU in Extension #2 is the

37 highest-performing in Extension #1, then FIT is at a maximum (4.0); the

38 second-highest-performing strategy receives a lower pay (3.5), etc.

39 THRESHREORG = THRESHREORG – 1 (change threshold is decreased

40 when a non-subsidiary agent is paid by the strategy PAYRULE)

41 $COMPENSLIST = COMPENSLIST + RAND[1.0, \dots, 3.0]$

42 $CAPITAL = CAPITAL - PAY$

```

43         PAYOLD = PAY
44     End all FOR loops
45 End
46 To Algorithm 1.5, add:
47 IF {(COMPENSLIST > 0) AND (PAYRULE = 4)}
48 THEN Restore old THRESHFLEX and THRESHREORG after the new one has been
49     used to determine an organizational change event
50 End
51 To Algorithm 1.6, add:
52 IF {(COMPENSLIST > 0) AND (PAYRULE = 1)}
53 THEN Restore old REACTPROB after the new one has been used to determine a reaction
54 End
55 To Algorithm 1.7, add:
56 IF {(COMPENSLIST > 0) AND (PAYRULE = 1)}
57 THEN
58     Allow the one agent in the organization to move two squares (movement is increased
59     when a non-subsidiary agent is paid by the agency theory PAYRULE)
60 End
61 To Algorithm 1.8 (Data Output) add:
62 PRINT {PROPENPAID[1], PROPENPAID [2], PROPENPAID [3], PROPENPAID [4]}
63 End

```

How should each payrule be modeled? There are two types of decisions that had to be made. First, the determination of the payrule proportion frequency configuration, and second

how each payrule should be constructed. With regard to the first decision, each agent was modeled to compensate its executive only on the basis of one single payrule upon each iteration, but that payrule was allowed to vary from iteration to iteration. To this end, each of the four payrules were given a frequency proportion (a number between 0 and 0.5, adding up to 1.0) such that those with a higher frequency proportion for the agency payrule, for example, would more frequently use the agency payrule across a number of iterations than would an agent with, say, a higher frequency proportion for the stewardship payrule. However, a further problem was realized in that the theoretical antithesis to agency was stewardship, and that the proportion determining each payrule frequency should not be independent. When applying these opposing theories to actual payrules, it was decided to apply what has become an operationalization theme in this study. That is, when opposite perspectives require agents to behave in opposing ways, half of the agents are assigned one type of behavior while the other half are assigned with the other opposing behavior. For example, in coding tendencies toward transformation by incremental or reorganizational methods, the former modeling an aspect of institutional theory and the latter modeling an aspect of population ecology, the population of agents was divided equally through the binary variable CHANGE_PREF; half of the agents changed incrementally, and the other half changed transformationally. With regard to the distribution of the four payrules, then, a similar approach was taken in Algorithm 2.2. Since agency is “opposite” from stewardship, then let one proportion represent both payrule frequencies. Thus, if the proportion of frequency for the agency payrule is A, and if the proportion of frequency for the stewardship payrule is S, then $A = 1 - S$; the more frequently the agency payrule is applied, the less frequently the stewardship payrule is applied, and *vice versa*. Using an analogical argument, the stakeholder perspective is similarly antithetical to the strategic fit perspective, since stakeholder

theory emphasizes the performance of other-than-self entities that are related, while the fit perspective emphasizes the positioning of the self related to others. Thus, if the stakeholder payrule frequency proportion is K and the strategic fit payrule frequency proportion is F , then $K = 1 - F$; the more frequently the stakeholder payrule is applied, the less frequently the strategic fit payrule is applied, and *vice versa*.

The second type of decision, how to model each payrule based on the operationalization of extant theory, was resolved fairly straightforwardly. First, since I argued for the existence of a pay package point drift under agency reasoning in the above literature review, this phenomenon was modeled by paying the CEO what it was paid in the previous period, plus a random premium based on the number of subsidiaries (plus the HQBU itself) that the agent owns (see line 20). However, giving a CEO what s/he wants should highly motivate the CEO, so some benefits are modeled into this payrule: the agent has the maximum allowable mobility of 2 squares (line 21), the agent is able to search several extra squares (line 22), and the agent becomes more aggressive against competitors. Second, since in the real world the interest of a steward is aligned with the interest of his/her shareholders, and since the interest of shareholders is firmly in the profitability of the firm, then in the simulation world agents paid under the stewardship payrule are paid in proportion to the agent's PROFIT from the current iteration (see lines 24-27). Third, since important stakeholders to any agent in the simulation are those agents which interacted with it, the stakeholder rule pays the CEO in proportion to the average PROFIT of the agents that were interacted with (see lines 28-32). Fourth, "strategic fit" was determined to be the success of the diversification strategy from the output of the diversification extension. Thus, an array, called FIT, was introduced into this extension with the ranking from each strategy's average PROFIT entered number-by-number into this array. The CEO's pay was determined to be: (9 –

ranking)/2 (see line 34), so that the CEO of an agent with the highest-ranked diversification strategy fit was paid 4.0 units of CAPITAL, and the CEO of the worst-fit agent was paid 0.5 units of capital. A CEO paid in this fashion would be more motivated to find a better overall fit; to model this expectation, agents using a fit-based payrule will experience a decrease in THRESREORG of one unit (lines 39-40).

Note that all specific calculations of benefits and pay are arbitrary, although they are considered reasonably comparable, as it is not expected that any agent pay out more than 4.0 units of CAPITAL to its CEO in any single iteration, except for particularly large organizations under the agency payrule, but that exception can be justified by economies of scale: larger organizations can apparently afford to pay their executives more. Still, it must be noted that we should not compare the profitability of each payrule as diversification strategies can be compared in the output to the diversification extension, simply because all payrule calculations, while seemingly reasonable, are arbitrary. What can and will be studied here instead is the success of each payrule in isolation, as well as any interaction between the two payrule frequency proportions. Therefore, an appropriate question might be, “Was agency theory more strongly associated with PROFIT or Longevity among agents in more harsh landscapes?” But an inappropriate question would be, “Was more frequent use of stewardship pay more strongly or positively associated with more profitable agents than pay the frequency of use of pay based on strategic fit?” The second question asks for the comparison of absolute magnitudes of arbitrary calculations, while the first question asks for the relative change in magnitude of the same calculation under different conditions.

Since approaches toward determining the profitability of each of the four different payrules are somewhat limited, a second approach, and further extension, of the CEO

compensation extension was constructed. This additional extension allows agents to rudimentarily seek out payrule proportions that will yield higher PROFITS. In this way, we will be able to observe shifts, or migrations of agents, toward one direction or the other in frequency histograms away from and toward less PROFITable strategies. This second CEO compensation extension is shown below and is discussed further in the Methodology section, as it is essentially a *post hoc* study in response to methodological difficulties encountered in the first CEO compensation extension.

Algorithm 2.3: CEO Compensation Extension #2

```
1 To the end of Algorithm 1.2 add:
2   MixBest[1] = PROPENPAID[1]
3   MixBest[2] = PROPENPAID[3]
4   MixBest[3] = 0
5 To Algorithm 1.8 (Miscellaneous), add:
6   For each landscape,
7     For each agent,
8       IF {PROFIT > MixBest[3]}
9         THEN
10          Increase PROPENPAID[X], where X is determined by PAYRULE used in that
11            iteration to a proportion not tried previously by that agent, up to 0.40
12          Decrease appropriate complementary proportion
13          MixBest[3] = PROFIT
14          MixBest[1 or 2] = PROPENPAID[1 or 3, based on X and PAYRULE used]
15        ELSE IF {PROFIT < 0}
```

```
16      THEN
17          Decrease PROPENPAID[X] to a proportion not tried previously by that agent,
18              up to 0.40
19          Increase appropriate complementary proportion
20      End all For loops
21  End
```

Conclusion

The above algorithms present a reasonably detailed representation of the actual computer code, and were actually used to construct the code itself. Taken together, the above algorithms are necessarily complex, as they are rooted in multiple OT and strategic management perspectives. Furthermore, the above algorithm set stands as a significant contribution to the field of COT, as no set of algorithms, until now, has been constructed with the purpose of accommodating so many different, even opposing, perspectives. It was demonstrated that “opposing” perspectives do not imply “incompatible” perspectives; the strategy toward incorporating competing viewpoints was to allow variance in agent characteristics that would allow for both perspectives to influence agent outcomes. However, in order to avoid the overwhelming complexities of the real world, the above algorithms rely on COT’s use of simplicity to avoid unnecessary complexities; for example, all three types of environmental dynamism were not modeled, as it was deemed sufficient to model one type of dynamism for detection the differences in agent characteristics across different levels of dynamism. Thus, the algorithm set, while complex, is reasonably parsimonious. As a consequence, the code also brings us to the point of a virtual sea of data and potential data to analyze. Therefore, the next

section, Methodology, is critical in the extraction of useful information from the data generated using the algorithms in this section.

CHAPTER 6. METHODOLOGY

This section discusses the apparatus that will be employed for the simulation runs, the variables used, the methods of validation for the baseline code and extensions, and what statistical methods were applied to the data analysis.

Experimental Apparatus and Procedure

The simulations were run using version 7.0.1 of S-Plus (using the Microsoft Windows XP Professional 64 Edition operating system), which serves a dual purpose. First, S-Plus acts as a programming language similar to C++, and it can readily accommodate the code represented by the algorithms presented above. Second, S-Plus serves as a random number generator and statistical toolbox, as there are a number of random number functions available that can be embedded into the computer code and statistical tools that can be applied toward data analysis either *in situ* or *a posteriori*. The 64-bit version of Windows XP was used so that 6GB of system memory could be used, overcoming the 32-bit version's limit of 4GB.

The computer hardware included two water-cooled AMD Opteron 250 (2.4GHz) central processing units (CPUs). These particular chips are exceptionally fast compared to the maximum speed available commercially, and according to this author's experience in running simulations, the expected speed of one of these chips is approximately equivalent to a Pentium 4 CPU running at a speed of 5.0 GHz. Unfortunately, S-Plus does not have the ability to employ two processors (except for matrix math), so the code could only be run by one CPU. However, the simulation can be run with 100% of the one CPU's processing effort, while miscellaneous, idle processing conducted automatically by other programs (often 2% to 5% of total load) can be

handled by the other CPU. Thus, computation times involved 100% computational effort of one AMD Opteron 250 CPU.

The baseline code consisted of about 3,400 lines and required approximately 30 hours to run. The simulation time is approximate, as only two to three iterations could be run at a time before the program ran out of memory. The diversification extension consisted of approximately 5,000 lines, while the CEO extensions consisted of as many as 5,800 lines in its longest version; the longest version required approximately 60 hours of runtime. Total estimated runtime exceeded 200 hours for all simulations conducted during this study.

The effort to reduce the considerable runtime of the simulations to 200 hours total included setting the landscape sizes to only 22x22, while only one repetition and 50 iterations were run for each simulation. However, as the relatively “small” landscape size resulted in the use of 484 spaces per landscape and the generation of 7,840 agents, it was nevertheless considered sufficient for the present exploratory study, as real-world categorical diversification studies have been conducted on the order of 2,000 companies or less. Furthermore, as the 7,840 agents are small enough in number, the entire population of 7,840 agents was used in the data analysis; no sampling was necessary.

After each simulation was run for the specified 50 iterations, each variable was printed on-screen by S-Plus and then copied over to MS Excel for the appropriate graphs and ANOVA tests; S-Plus was used for multiple regression analysis and output (importing the data back from Excel) because of the restrictive 16-variable limit in Excel’s regression analysis tool; S-Plus was also used for the Wilcoxon rank sum test, while Excel was used for t-tests, both used in testing differences between groups. Histograms were constructed with the help of PHStat2, an Excel statistics plug-in, while conditional effects plots were constructed with the aid of an Excel macro

made available by Jeremy Dawson at <http://www.jeremydawson.co.uk/slopes.htm>. Finally, model assumptions were checked in MS Excel with the aid of some PHStat2 functions such as normal probability plots; however, the regression assumptions were checked from within the S-Plus regression function.

Baseline Validation Methods

Checking Model Assumptions

While the assumptions of the Wilcoxon rank sum tests and Pearson Chi-squared contingency table tests are readily met because of the nature of the simulation data, the assumptions behind the ANOVA, 2-sample t-tests, and regressions were carefully checked. It was determined that all of the regression models met the assumptions of reasonably normally distributed errors, while t-tests were conducted only on samples drawn from PROFIT, which was noted to be distributed with a higher peak and smaller-area tails than the normal distribution (making these t-tests somewhat conservative).

The assumption of normally distributed error terms for the 2-way ANOVA tests (Figures 12-14, 18-20, and 26-28) was confirmed; constant error variance of the residuals, however, was not confirmed for the tests for munificence in Figures 12, 18, and 26; as well as the tests for complexity, shown in Figures 14, 20, and 28. In each case, error variance increased with increasing estimates of the dependent variable, as can be observed by the ratio of the highest-to-lowest column error variance ($660445/30329 = 21.8$ for the ANOVA test in Figure 12, and $3896/222 = 17.6$ for Figure 14). Usually, an ANOVA test may be suspected of non-constant error variances if this ratio is substantially greater than 3.0 (Dean & Voss, 1999). In the each case, the following transformations of the observations were attempted in an effort to reduce this

ratio: square root, natural logarithm, and reciprocal. In Figures 14, 20, and 28, the reciprocal was found to be most effective, reducing the error variance ratio to 1.68 from 21.8; in Figures 12, 18 and 26, the natural logarithm appeared most effective (reducing the ratio to 3.66). In all cases, the transformations either reduced the p-value, or increased the p-value slightly. For example, the p-value in Figure 14 changed from 0.022 to 0.0021, and the p-value in Figure 14 changed from 2.37E-7 to 3.02E-7. Thus, as no tests results were reversed due to the unequal variances, the untransformed ANOVA tests were reported in all figures. However, the reader should keep in mind that the p-values in Figures 12, 18, and 26 are artificially high by about an order of magnitude due to nonconstant error variances in the untransformed data.

Validation

It will be assumed here for validation purposes that a “valid” baseline simulation is one that includes evidence of significant contributions from each of the organization theories presented in Part I of the above literature review (summarized in Table II). In other words, a valid simulation must show significant contributions from institutional theory, behavioral decision theory, enactment, strategic management, resource dependence, contingency theory, transaction cost economics, and population ecology. Variables used in the validation analysis are shown and explained in Table XVI, while the steps of the methodology, with specific methods used, are outlined in Table XVII and include (1) the use of a simple chart of the number of agents alive across all iterations to confirm model equilibrium and complexity separation; (2) two-sample difference tests (Pearson χ^2 contingency table or Wilcoxon rank sum tests, as applicable) among Table XVI variables for early dead compared to survived agents to confirm population ecology; (3) regression of variables in Table XVI for the confirmation of the presence of strategic choice, institutional theory, behavioral decision theory, enactment, and overall model

significance; (4) two-sample difference tests (Pearson χ^2 contingency table or Wilcoxon rank sum tests, as applicable) among Table XVI variables for agents that are in least harsh and most harsh landscapes to confirm contingency theory at the agent/individual level of analysis; and (5) 2-way analysis of variance (ANOVA), using 1 way as a nuisance factor, to confirm differences between environments (contingency theory) at the landscape level of analysis.

Extension Methods

Cyert & March (1963) studied 24 independent variables, and 25 dependent variables, in a number of multiple linear regressions (24, one for each independent variable), but they identified only a few significant coefficients. For example, the variable that described “initial propensity to modify price in reaction to failure on profit goals” (p. 179) was found to be significant (similar to the variable "THRESHREORG" used in the present study). Since numerous variables were not significant in their model, the authors arrived at reasonably simple results from their complex model. In this study, a similar multiple linear regression (really two different multiple regression models, one for each dependent variable) was used to compare the results of the extension outputs with the baseline results. However, because the intent of this study was to find differences in profits between different environments and diversification strategy or CEO pay rule, additional methods were applied. First, difference tests (t, Pearson χ^2 contingency table, and Wilcoxon rank sum tests, as applicable) were applied to the comparison of average profits between groups of agents under different environmental conditions, diversification strategies, and CEO compensation payrules. Second, frequency histograms of CEO pay rules (after agents were allowed to change the proportion of each pay rule toward higher profits) were applied to the analysis of the most profitable pay rule after regression methods indicated interaction between

pay rule frequencies. The methods used for the analysis of the diversification extension and the CEO pay rule extensions are summarized in Tables XVII and XVIII, respectively.

To guarantee similarity, each simulation was run after removing the extension code for the next higher extension. Thus, the the diversification code was run first to derive the FIT matrix, then the CEO extension code with pay rule optimization was run, followed by the CEO extension code without pay rule optimization, and finally the baseline. Thus, with the exception of the diversification code which needed to be run first to fill FIT, the only difference between each successive simulation run was the code that had been removed from the next-higher extension.

The COT principle of experimentation by setting random number seeds was applied to program initialization. Agents with exactly the same characteristics were used for all of the simulations, even though agent characteristics were randomly assigned. This was done by assigning the same random number seed at the beginning of program initialization. Agent sameness was maintained across code extensions by adding initialization code for each extension to the end of the baseline initialization section.

CHAPTER 7. RESULTS AND ANALYSIS

Baseline Validation

A table of correlations is shown in Table XX. It indicates independence between each variable studied under regression, which suggests that multicollinearity is not significant for this data set. Only one correlation appeared that was greater than 0.40, that between “MOVE adj” and “TERRITSETUP”. Some correlation between these variables was expected, however, as TERRITSETUP is only nonzero when the agent has set up a territory, and in this case, MOVE adj is zero, by definition. It is interesting to note, however, the low correlation between PROFIT and Longevity of 0.26. This low correlation suggests that those agents which make a high profit are not necessarily the agents that survive the longest – an important principle which Institutional Theory attempts to explain (survival is through the most legitimate, not the most profitable), as does Population Ecology (survival is decided by the environment, which selects only the “fittest” organizations). In the simulation, an agent must do more than merely generate a profit to survive; it must position itself as part of a profitable supply chain which has access to ample resources, it must achieve sufficiently high enough status in order to receive priority in choosing the best agents to transact with and in order to move to more desirable landscape locations before others do, it must replace its less-profitable characteristics with more profitable ones, cope with its biases, etc. Thus, the issues of profitability and legitimacy, and what cause them, are two separate issues both in real life and in this simulation’s results.

Below, each of the eight theories/perspectives shown in Table II that were used to develop the algorithms and computer code will be discussed in turn with regard to evidence found of their significance in the baseline code (except TCE, which is verified in the

diversification extension). The reader is reminded of the central assumption that it is reasonable to require of the baseline simulation that each of the theories have a general, but significant, effect on the performance and survival (efficiency and effectiveness) of the agents in the simulation.

Population Ecology

When environments change, some organizations with certain characteristics are selected to survive, while others, without those characteristics, are selected out of the environment. However, the mechanisms of variation, selection, and retention are expected to be higher in harsher environments. We might, therefore, expect death rates in harsh environments to be greater than those in more benevolent environments, due to the lower “carrying capacity” of the harsher environments. Some evidence of different carrying capacities is found in Figure 8, a plot of the number of agents alive in each landscape across all simulation iterations. Clearly, there are differences in death rates of agents between landscapes during the high deathrate period between iteration 10 and approximately iteration 30, and this chart confirms that the minimum number of iterations required before general equilibrium has been reached at approximately 30 iterations. However, harsher environments were not necessarily accompanied by higher death rates in the non-equilibrium period. For example, environment 333 (high in munificence, dynamism, and complexity) exhibited the steepest death rate curve and reached equilibrium only at a population equivalent to the low-complexity landscapes. On the other hand, the harshest environment, 133 (lowest in munificence but highest in dynamism and complexity), exhibited only a moderate death rate, although the curve was the steepest in the equilibrium region greater than 30 iterations, which suggested that it may not have gone through a high death rate

adjustment followed by an equilibrium state. Some explanation for this unexpected behavior will be discussed below when landscape deaths will be compared toward the confirmation of contingency theory.

A more measurable expectation is the observation of significant differences between the profile elements of those agents which died early on in the simulation and those agents which survived through the final iteration. As the population ecological view is not specific enough to predict exactly which profile elements might exhibit differences, two-sample difference tests (Pearson χ^2 contingency table or Wilcoxon rank sum tests, as applicable), for Table XVI variables were conducted on average values of each analysis variable listed in Table XVI (note that, while the Wilcoxon rank sum test searches for a difference between group medians, means are reported in Table XVI). The results are summarized in Table XXI. Overall, ten of the sixteen variables were found to be significantly different between the early-dead and survived groups (these p-values are highlighted in bold font in the table), at an individual level of significance of 0.01, although an individual level of significance of 0.001, would have identified eight of the ten significant differences. Of these variables, PROFIT and DIE were expected to be significant, as the decision to decide agent death or life each iteration was determined by the number of contiguous periods of negative PROFIT, as defined by uniform random variable DIE. Further, TYPE's differences were not surprising, as the simulation was expected to create a situation where some segments of the supply chain were generally more profitable than others, similar to Porter's (1985) value chain analysis at the industry level. By the end of the simulation, there were clearly more surviving retailers than harvesters. Thus, the general finding that agents with higher PROFITS and TYPE, which are outcome variables rather than input random variables, confirms the intent of the algorithm in that agents with higher PROFITS and of a

certain TYPE are selected to survive, while others are selected out of their environments.

Certainly, the results of the baseline would have been suspect if PROFIT and TYPE differences had not been observed to have been different between early dead and survived groups.

The variable SEARCHLAND related was observed to be different between early dead and survived groups, but in directions opposite from that expected. It was anticipated that perhaps agents with higher levels of SEARCHLAND would be selected for survival; however, high levels of SEARCHLAND (the population mean was set at 20) could have led to an increase in complexity for the agent, which is expected to have a negative influence on agent longevity (see confirmation and analysis below). Also, since agents pay 1/5 a unit of capital for every unit beyond the adjacent 8 units searched, the decrease in SEARCHLAND could merely reflect this tradeoff. In any case, this result actually serves to confirm the utility of Simon's (1946) bounded rationality idea in that too much information is needlessly complicated, and may result in a misuse of the simple decision tools (such as interaction preference rules) that agents have at their disposal. Thus, as long as simple decision rules are used, adding to the number of alternatives meets with diminishing, and at some point decreasing, returns.

The nonsignificant differences of variables ReactTime*Mag*Prob (a score of the agent's aggressiveness toward competitors), and THRESHFLEX (the threshold level before an INTERACTWITH agent is transferred to a BLACKLIST or WHITELIST) were somewhat unexpected. Since TERRITSETUP was significantly higher in the survived group, it may only be important that an agent set up a territory rather than defend it aggressively, as a territory can only be set up when there are no nearby competitors. With regard to THRESHFLEX, it was expected that those agents with lower values might be more apt to survive, but this was not observed. Furthermore, since the variance between the early dead and survived groups (5.164

and 5.221, respectively) did not decrease, intermediate THRESHFLEX values were also not found to be optimal. It may have been that lower THRESHFLEX values were helpful to those agents with a cooperative configuration (for example, those agents who preferred to buy based on supply-chain agreements and those who moved toward higher resources) in that value-adding agents were quickly added to the agent's WHITELIST, but this low THREXFLEX value may also have added agents to the BLACKLIST prematurely, before transaction costs were allowed to decrease over repeated interactions. High-value THRESHFLEX agents would have encountered the converse paradox.

Taken together, the results in Table XXI validate the existence of population ecology during the simulation to a reasonable extent. It has certainly been shown that, at least with regard to ten important variables, some agents with some characteristics were selected out of the simulation environment and others with different characteristics were selected to survive, and that those survivors were deservedly more "fit" (with significantly higher values of PROFIT, STATUS, DIE, and TERRITSETUP) than those that died early.

Institutional Theory

Early neo-institutional theorists (DiMaggio & Powell, 1983) suggested that isomorphism enhances an organization's effectiveness, and therefore is a rational, value-added activity for organizational members to engage in. Oliver (1997a) extended this idea to performance advantages, beyond mere survival, with evidence from Canadian firms, although Oliver argued only for a weaker, indirect association. In the present simulation study, the effects of the influence of mimetic isomorphism is linked to the variable STATUS: higher-STATUS agents move and interact before lower-STATUS agents. As a result, high-status agents should

encounter little trouble in finding and transacting with other agents in a nearby supply chain, while low-status agents would tend to be starved to death. Also, the characteristics of highest-status agents are copied by all other agents in the same landscape. We would therefore expect that agents with higher status to primarily live longer and secondarily have higher PROFITS, while the converse can be said with regard to lower status agents.

Figures 9 and 10 exhibit the regression of all of the variables in Table XVI with PROFIT and Longevity as the dependent variables, respectively. The fitted slope coefficients for STATUS are shown to be positive and highly significant in both regression models, and as expected, the coefficient with Longevity as the dependent variable (0.0494) is about 10 times higher than the magnitude of the coefficient with PROFIT as the dependent variable (0.0037). These results lend strong support to the significant influence of mimetic isomorphism and the positive effects that STATUS has primarily on agent survival and secondarily on profitability.

Behavioral Decision Theory

As discussed above, the literature in this field is replete with the environmental search-speed tradeoff. The simulation code modeled first a search-cost tradeoff by charging each agent 1/5 of a unit of CAPITAL for each square searched beyond its adjacent 8 squares. Second, a search-speed tradeoff was modeled by allowing an agent to move 2 squares if SEARCHLAND was less than 15; and restricting an agent to only move 1 square if SEARCHLAND was less than 15. If there is an even tradeoff between SEARCHLAND and PROFIT, and another tradeoff between SEARCHLAND and MOVE, then no relationship between SEARCHLAND and PROFIT is expected (a high value of SEARCHLAND benefits the agent in that it learns more about its environment, but it will make less profit because of the extensive search and vice-

versa). Furthermore, the influence of SEARCHLAND on MOVE should negate any relationship between MOVE (or at least variable “MOVE adj”) and PROFIT. The results in Figure 9 indicate the lack of relationship that we expect given the tradeoff, since the coefficients for MOVE adj and SEARCHLAND are not significant.

The above discussion provides, admittedly, rather weak evidence (as the null hypothesis can never be accepted), but there is some further evidence, as the term SEARCHLAND² was found to be possibly negatively associated with Longevity with a p-value of the slope coefficient equal to 0.0564, as shown in Figure 10. This limited result is consistent with the ANOVA results summarized in Table XXI and discussed above in that surviving agents’ average SEARCHLAND was significantly decreased from 22.33 (early dead) to 21.26 (survived), compared with initial average for all agents at 22.00 landscape locations. While the association may be negative between SEARCHLAND and Longevity, it is nevertheless slight, at a slope coefficient of -0.0046 (Figure 10), and the average of survived agents is still near the overall agent average at initialization. The cost per square for searching could be decreased further (it had been decreased from 1.0 unit of capital per square searched to 1/5 unit of capital during simulation program development) in order to engineer a maximum search value, but the weakness of the association is expected to have virtually no effect on the overall results.

It is curious that the results suggest a negative relationship between search and longevity (Figure 10), but a search-PROFIT tradeoff with no relationship between search and PROFIT (Figure 9), as the search-cost tradeoff was programmed into the simulation code explicitly. An additional regression was conducted on the survivors, shown in Figure 11. Overall, we can presume that tradeoff exists because it was explicitly programmed into the simulation, and there is little evidence in the analysis of outcome variables to suggest otherwise.

Sadler-Smith & Shefy's (2004) intuition idea was modeled by the variable characteristic THRESHFLEX, as the decision in whether to and when to treat potential supply-chain partners as friend or foe is certainly a matter of intuition-as-expertise. There is no strictly rational, accurate way to determine the point at which a transacting agent is placed on its WHITELIST or BLACKLIST for future transactions, yet these decisions must be quickly made. THRESHFLEX is the characteristic that sets up the decision rule used to place interacting agents on their WHITE/BLACKLIST: for each iteration, if the agent's profit is greater than THRESHFLEX, place all of the agents on the INTERACTWITH list on the WHITELIST for future interaction priority; if the agent's loss is less than $(-1) * \text{THRESHFLEX}$, place all of the agents on the INTERACTWITH list on the BLACKLIST for future interaction avoidance. The exact value of THRESHFLEX, then, is a matter of intuition that may improve as an agent's experience increases ("experience", then, is modeled by making THRESHFLEX a uniform random variable). Unfortunately, THRESHFLEX was not significant in the ANOVA tests between early dead and survived (Table XXI), the regression of all agents with PROFIT as the dependent variable (Figure 9), and the regression of all agents with Longevity as the dependent variable (Figure 10). However, the results in Figure 11, exhibiting the regression results for survived agents only (with PROFIT as the dependent variable), does yield interesting and significant results for THRESHFLEX. In particular, THRESHFLEX was significant with a coefficient of 0.2245, whereas THRESHFLEX^2 was nearly significant ($p\text{-value} = 0.0521$) with a coefficient of -0.0201. These results suggest a maximum THRESHFLEX value of 0.1843, in units of CAPITAL, that maximizes agent profit. Thus, agents at or near a THRESHFLEX value of 0.1843 exhibit somewhat more "intuition" than other agents, and are more profitable as a result. The value of this supposed maximum is relatively low compared to the range of the uniform

random variable of 7.9 (from 0.1 to 8.0), but this results makes sense, given that the per-iteration profit of any agent was probably less than 4.0 for any given iteration, as average PROFIT for all agents after the final iteration was approximately -3.0. Why intuition was important only for survived agents is an unexpected result, however, especially in light of the nonsignificance of the Wilcoxon rank sum test for mean THRESHFLEX values between early dead and survivors in Table XXI. Intuition, as modeled in this simulation, apparently is not significantly and directly associated with longevity, but those agents with low THRESHFLEX values were associated with higher PROFIT among survivors. Perhaps the intuition effect, while measurable in Figure 11, is not significant enough to cause an agent's death, but THRESHFLEX near 0.1843 provides the agent with some benefit in terms of profit (such as reduced transaction costs with WHITELISTed agents) over many iterations.

Thus, some support has been found for the effects of the modeling of the search-speed tradeoff, the search-cost tradeoff, and the intuition-as-expertise advantage as described by various authors in the field of behavioral decision theory and discussed above. The evidence is not as strong as Institutional Theory and Population Ecology evidence, but evidence exists nevertheless, and given the high degree of complexity of the model, this evidence is deemed sufficient for validation purposes for this exploratory study.

Enactment

Enactment results in a biased evaluation during environmental scanning. Two variables directly model the enactment process: PROPBIAS and BUYSELLPREF. The former allows for prioritization of the CAPITAL allocation decision (if CAPITAL is insufficient to meet demand in all three departments, the non-favored departments will receive less CAPITAL than they need to meet demand) while the latter allows for biased ranking of transaction candidates (based on

STATUS, selling/buying price, or supply-chain orientation). While it is unreasonable to assume that some agents have no bias (because this does not occur in the real world), it is possible to test the influence of enactment by allowing the agent characteristics PROPBIAS and BUYSELLPREF to be randomized, each agent to a different extent, after each iteration of the simulation run. The extent of randomization, modeled by the variable BIASCHANGE, is expected to be positively associated with performance and survival: those agents who change their biases (PROPBIAS and BUYSELLPREF) more frequently (with BIASCHANGE values closer to 1.0) exhibit less bias over time. Results, however, show that BIASCHANGE was an important factor in an agent's longevity, but not in terms of profit. Less bias over time was positively and significantly associated with longevity according to the results in Figure 10, while surviving agents were, on average, significantly lower in bias than agents which died early (with BIASCHANGE mean values 0.517 compared to 0.485, respectively), as shown in Table XXI. Perhaps this result is all that should have been expected in any case, as the reduction of bias/enactment primarily enables an organization to more readily and accurately adapt to its environment in an evolutionary sense, which is primarily a longevity-increasing factor. In any case, strong and significant evidence of enactment has been found, thus validating the importance of this perspective in the results of the baseline simulation.

Strategic Management

In this view, a manager's choices matter in such a way that some firms do well when its managers make some choices, while firms others do poorly by making other choices. By "poorly", I mean the extent of profitability; around this view has developed the entire field of strategic management, and within this field resides the assumption that managers can make choices which increase the profitability of their organizations. For example, Hitt, Ireland, &

Hoskisson (2005) define strategic management as the integration of resources and capabilities toward the attainment of above-average profits as compared with those profits of its competitors. David (1997) defined strategic management instead as the attainment of organizational effectiveness: “the art and science of formulating, implementing, and evaluating cross-functional decisions that enable an organization to achieve its objectives”. Thus, for the strategic management perspective to be considered valid in this study, decisions should be positively associated with both dependent variables PROFIT and Longevity. Of course, the extensions to the baseline simulation are all about managerial and governance choices; the former concerning the choice of diversification strategy and the latter concerning the executive compensation decision. In the baseline simulation, agents “choose” interaction memory, the rapidity of movement across the competitive landscape, the relative permanence of their biases, their pricing scheme, at what point they go out of business, at what point and how frequently they change and/or copy their characteristics, etc.

Evidence that at least some of these choices matter with regard to profitability can be seen in the variable characteristics PROPBIAS, BUYSELLPREF, Markup, and Change. Each of these variables will be discussed in turn. The variable characteristic PROPBIAS was observed to be significantly and negatively associated with PROFIT in Figures 9 and 11. This suggests higher-than-average returns for agents who chose to satisfy their CAPITAL needs for the buying function first, over their selling and manufacturing needs. The variable characteristic BUYSELLPREF was found to be significantly and positively associated with PROFIT among surviving agents (Figure 11), and nearly significant with a p-value of 0.0595 among all agents (Figure 9). These results suggest that those agents, and especially the surviving agents, which preferred to interact with others on the basis of STATUS received significantly higher-than-

average returns than those that prioritized their interaction choices on the basis of either supply-chain orientation or lowest-price. The variable Markup, along with Markup², which represented one half the amount that an agent added to its selling price above its current buying prices, was found to be significant everywhere (Table XXI and Figures 9 through 11), and provides strong evidence, for the significance of the strategic management perspective. Those agents, overall, which set their Markup value to 0.4018 (or 0.8036 units of CAPITAL added to each unit's buying price) realized higher-than-average returns, all other factors being equal (See Figure 9); this value was slightly higher for surviving agents (0.4253 and 0.8506 respectively; see Figure 11). However, those agents exhibiting maximum Longevity were found at a much greater Markup value of 3.0594 (or 6.1188 units of CAPITAL added to each unit's buying price), and surviving agents exhibited a significantly higher average Markup than early-dead agents (5.66 compared to 4.56; see Table XXI). This suggests that the Markup choice is at least two-dimensional, and therefore quite complicated: on the one hand, offering a small markup (about 0.4) will increase transaction frequency with those agents having a lowest-price buying preference, and this increased frequency will probably be retained over time if the seller is put on the buyer's WHITELIST; on the other hand, agents can considerably increase their longevity and insulate themselves from long periods of contiguous losses by increasing their Markup values to 3.1, but their higher prices will doubtless chase away some buyers. Thus, the choice of selling price is strongly associated with both an agent's profitability and longevity. Finally, the variable characteristic Change, the probability with which agents consider changing their characteristics each iteration, was found to be significantly and positively associated with Longevity (Figure 10) while surviving agents exhibited a significantly higher Change probability (from 0.546 to 0.579; see Table XXI). These results suggest that agents which change more frequently, and at times

try to improve their characteristics by copying high-PROFIT agents, realize increased longevity, compared to lower-change-frequency agents.

Resource Dependence

Those organizations which have more access to important and rare resources are believed to exhibit higher performance and survive longer than those firms that have less access. In our simulation, a bias toward satisfying buying needs before manufacturing and marketing (selling) needs should be associated with higher PROFITS and Longevity. As discussed above, the variable characteristic PROPBIAS was found to be significantly and negatively associated with PROFIT, but not with Longevity, so that the regression models in Figures 9 and 11 offer partial evidence of the significance of resource dependence. What is of interest in Figures 9 and 11 is not merely the significance of PROPBIAS, but also the negative direction of the correlation coefficient, indicating that those agents with a PROPBIAS value of 0 (a buyer's-needs-first bias) were most profitable. This result not only offers a validation of the baseline model, but also provides strong evidence in support of resource dependence theory itself. However, this support is only in terms of profitability, not longevity.

One simple way to find evidence of the effect of resource dependence on longevity can be found at the population level of analysis: if resource dependence is important to agents in a landscape in terms of longevity, then the less munificent the landscape, the less surviving agents there will be at the end of the simulation. This result has been observed for ANOVA tests of differences between landscapes (Figure 12), and will be discussed in more detail below, as these results are primarily a validation of the importance of the contingency theory perspective in the baseline simulation.

Contingency Theory

This view associates organizational performance with a fit between the organization's internal structure and its environment. In our case, we would expect to observe different characteristics, on average, for surviving agents in different landscapes. To validate the contingency theory perspective, it first must be established that the three dimensions of munificence, dynamism, and complexity are significant and independently operable variables across the simulated landscapes. Then, ANOVA tests will be used to observe significant differences between surviving agents in different environments.

To verify that each environmental setting is distinct and significant at the end-state of the simulation (at initialization conditions were set up as distinct, but it must be verified that the distinctness at setup was carried through to the end-state condition), two-way ANOVA tests have been conducted at the landscape level of analysis and are shown in Figures 12, 13 and 14. In these tests, the first factor (rows) is the combined effect of two environmental variables, while the second factor (columns) is our variable of interest. Thus, the first factor is treated as a "nuisance" and controlling for it allows us to test for significant differences in one environmental variable at a time. Figures 12, 13, and 14 study the variables munificence, dynamism, and complexity, respectively. Each variable (identified as *i*, *j*, and *k*, respectively in the simulation code and in the figures) is given three levels of magnitude (1, 2, and 3), according to the values assigned to that landscape by Algorithm 1.1 above. Figure 12 validates the differences in average munificence across all landscapes by testing the averages of the total resources on the landscape at termination across nine landscapes at each level of magnitude ($i = 1, 2, \text{ and } 3$). The *p*-value of the average differences is significant (at 0.0226; but the reader is reminded that this value is inflated due to unequal variances, and the *p*-value resulting from transformed data is

0.0021), and the direction of munificence increase is as expected (from which the averages change from 424 to 654 to 911 resource units for munificence = 1, 2, and 3, respectively). Thus, we can say that the munificence when $i = 1$ is lower than the munificence when $i = 2$, which is lower than when $i = 3$, for any given landscape in the simulation (on average).

Figure 13 investigates the significance of the dynamism dimension by testing differences of average total resources across the “j” dimension (in Figure 12, the average differences across the “i” dimension were tested). The reasoning here is that an environment that is more dynamic should be a harsher environment, with shifting peaks across the landscape and appearing under agents at random, thus preventing any agents or agent-chains from controlling access to resource peaks. The two-way ANOVA across all three columns were highly significantly different, with a p-value of 1.68×10^{-5} (see Figure 13), but the change in total resource averages were not in the desired direction. It seems that, at some high reset frequency, the total resources in a landscape increase markedly. Thus, at $j = 3$, the environment seemed to be least, rather than most, harsh. The problem here is that dynamism really implies movement of a landscape away from the agents so that at any given iteration any agent may find that it is suddenly off the landscape and can no longer participate in industry activity until it moves back onto the landscape. If this feature were added to the landscape resetting code, perhaps $j = 3$ would have been most harsh. As it is, however, the $j = 3$ landscapes reset so frequently that all any agent had to do was wait until the next peak came around to avail themselves of more resources. Rather than attempt to deal with the considerably more complicated change in code needed to model the movement of the landscape away from the agents, it was decided to test $j = 1$ against $j = 2$ with the idea that perhaps only two levels of dynamism could be used in further analysis, while any landscape with $j = 3$ would be ignored. Figure 13 also shows the two-way ANOVA test for a difference

between $j = 1$ and $j = 2$, and these levels were found to be significantly different with a p-value of 0.0477. Thus, it was decided to henceforth study only the 18 environments which did not include $j = 3$ when studying dynamism effects. This important finding will be carried through the remainder of this study.

Complexity, the third environmental dimension, was validated in two different ways in Figure 14. First, the average number of agents alive at termination was ANOVA tested across increasing levels of complexity. Next, since the number of agents alive at termination is directly a function of how many agents began the simulation in each landscape (as determined by k), the average number of deaths, was also ANOVA tested. Thus, the first test regarded the end-state consistency of the input parameters of the simulation code across all simulation iterations, while the second test dealt with end-state differences in environmental harshness across k . Both two-way ANOVA tests were found to be highly significant, with averages increasing for increasing k , as expected. This finding indicates that, with increasing levels of complexity, there are more agents on the landscape (and therefore more alternatives that agents need to choose from in deciding on transaction partners), and there are also more agent deaths, making $k = 3$ the harshest environment, with $k = 1$ the least harsh.

Having found all of the environmental dimensions except $j = 3$ to be significant and distinct, a second type of contingency validation must be undertaken. It is not sufficient to merely determine distinctness of environments; it also must be established that the differences in environments have an effect on the characteristics of the successful agents: what works well in some environments will work less well in others and vice versa. To that end, we will look for differences in characteristics of surviving agents between most harsh ($i = 1 \ \& \ 2; j = 2; k = 2 \ \& \ 3$) and least harsh ($i = 2 \ \& \ 3; j = 1; k = 1 \ \& \ 2$) landscapes using one-way ANOVA tests for the same

16 variables as tested in Table XXI for comparing early dead and survived agents. The results are shown in Table XXII, and exhibit four significantly different variables at a 0.03 individual level of significance (the individual level of significance can be increased because fewer variables were found to be simultaneously significant): STATUS, DIE, TERRITSETUP, and MOVE adj. The effect of the environment on agent characteristics, then, are apparently that in simple, munificent, and slowly changing environments STATUS is much easier to obtain, agents DIE slower, have more balanced supply chains (rather than retailer-concentrated), are more free to set up territories in more stable fertile areas and therefore have no need to move as far or as often. An industry of this fashion would have been what some early authors (David, 1997; Phillips, 1960; Henderson, 1954; Wilcox, 1950) might have identified as a linked oligopoly: a complex, localized version of the oligopoly concept, where there are few (local) industry members, which appear to collude locally as evidenced by an industry-wide reduction in competitive behavior. Therefore, since enough variables show significant differences between extreme environmental types in order for us to recognize familiar properties, our baseline simulation is strongly validated at the agent level of analysis. Taken together with the strong results from the landscape-level of analysis, we have found rather comprehensive validation of the contingency perspective in our simulation. Different findings in the two subsequent extensions when compared to differences observed in Table XXII should enable us to develop a meaningful contingency theory of diversification and executive compensation. We turn now to those results, beginning with a validation of transaction cost economics based on the success observed in the vertical integration strategy.

Diversification Extension

Results of the diversification extension are shown in Tables XXIII-XXVI and Figures 15-22. The diversification results are analyzed as follows: comparison to baseline results, transaction cost economics perspective validation, and an analysis of best and worst performing agents between different and most/least harsh landscapes.

Comparison to Baseline Results

Death curves are shown in Figure 15, and appear similar to the baseline death curves (Figure 8), except that there is no dramatic drop in the number of agents alive for environments 333 and 312, as in the baseline simulation. Landscapes 323 and 332 appear to exhibit relatively high death rates, but this result is expected of the relatively harsh and populous Landscape 323, while Landscape 332 was not used in subsequent analysis along with other high-dynamism landscapes. All landscapes that began with the same population of agents remained distinct from the landscapes with different populations of agents. We can say, even more confidently than in our analysis of the baseline simulation results in Figure 8, that complexity differences are retained throughout the 50 iterations of the simulation.

Regression results of the baseline variables, shown in Figures 9 and 10, indicate a lessening of the association with profitability, but little change with respect to longevity. More specifically, only STATUS, DIE, and AVERSION were significantly associated with PROFIT in the diversification extension results, with Markup and Markup² notable but not significant (Figure 16), while six variables were significant in the baseline results, with one more variable notable but not significant (Figure 9). Interestingly, the variable AVERSION, which was not significant in the baseline regression, was significant and positively related to PROFIT in the

diversification extension. This implies that, in an environment where diversification is allowed, agents are more profitable when they move toward higher resources and less profitable when they try to maneuver into a niche. Moreover, territories are no longer profitable in a diversification-allowed landscape. It seems that in such landscapes, it does not pay to isolate oneself from one's competitors, perhaps because horizontal integration is now a more profitable option (discussed below). A second unexpected result was a jump in the diversification extension model's sharp increase in the coefficient of determination, R^2 , from 4% to 21%. This sharp increase is probably mostly due to the much higher significance of the STATUS variable, as indicated by the t-test statistic rise from 8.9 to 46.1. It suggests that STATUS is an increasingly important determinant of profitability when diversification is allowed. In contrast, the regression models with Longevity as the dependent variable are quite similar with the exception that MOVE adj was found to no longer be significant in the diversification extension regression model (Figure 17). Taken together, and given a few exceptions, one might expect diversification to have a much greater impact on profitability than on longevity. If not (i.e., if the diversification variables, when added to the model with PROFIT as the dependent variable, are found to not be significant), then a viable explanation is the reduction in the significance of the theoretical perspectives used to construct the baseline model, making it of little use with regard to the study of diversification. An alternative explanation might be that diversification renders the theoretical perspectives useless. Fortunately, the alternative explanation was not the case, as two diversification variables were found to be strongly significant, as discussed in the diversification analysis below. For now, it is an important finding to conclude that the perspectives which were used to construct the baseline simulation and validated above are

carried through to the diversification extension, although diversification certainly has an effect on agent profitability, and to a lesser extent, longevity.

Similarly, contingency theory was found to be at least as valid in the diversification extension as it was in the baseline simulation, as exhibited in the two-way ANOVA results shown in Figures 18, 19, and 20. The ANOVA table in Figure 18 finds significant differences in total resources found on landscapes at diversification extension termination, with a p-value of 0.03 and averages increasing with increasing munificence, as expected. Results are quite similar to the baseline results, shown in Figure 12, although total resources had decreased somewhat for each munificence level. The tests for differences across different levels of dynamism, shown in Figure 19, result in nearly identical results, so that the same discussion that applied to the baseline validation above applies to the diversification extension, in particular that the nine landscapes with dynamism = 3 must be excluded from subsequent analysis, but that there is a significant difference (p-value = 0.019) in the expected direction between $j = 1$ and $j = 2$. Finally, results of the tests for differences in average number of agents left alive and those dead by termination across different levels of complexity are shown in Figure 20, and are similar to the baseline results shown in Figure 14. Specifically, the averages of dead and alive at termination are highly significantly different, in the expected directions (increasing with k), across all three levels of complexity. Based on the results in Figures 18, 19, and 20, then, one can conclude that the diversification extension is at least as valid as the baseline for studying differences in agent characteristics across 18 different landscapes (with $j = 3$ landscapes excluded); our pursuit of a contingency theory of diversification is warranted.

Transaction Cost Economics Validation

This perspective has not yet been validated, as its importance is made most prominent in environments where vertical integration is allowed. This perspective states that an organization's size and vertical scope is always a result of the lowest transaction cost between independent businesses/dependent divisions: in a market where information is freely available and spot transactions are efficient, organizations are not vertically integrated; in a market where the causes of pricing can be hidden by suppliers (leaving room for the inevitable rise in prices from dishonest suppliers), transactions become inefficient and vertical integration occurs (buyers buy suppliers) to counter the inefficiency. In the baseline code, transaction inefficiency is programmed directly as a transaction cost that decreases linearly with every repeated transaction. When vertical integration occurs in the diversification extension, transaction efficiency is immediately maximized as consistent with the TCE perspective. Thus, the diversification assumes market failure, the mechanism that motivates vertical integration, at the outset, making vertical integration a generally profitable strategy. We would expect, then, for validation of this perspective, that among all of the diversification strategies, vertical integration should be among the most profitable. This expectation is exactly what is observed in Table XXV: in 4 out of 8 environments, vertical integration was among the two most profitable diversification strategies. Of course, transaction efficiency is not the only reason for vertical integration, and vertical integration is not even often the most profitable diversification strategy in the real world, but this diversification extension was programmed to incorporate the perspective of TCE, and the results in Table XXV (discussed more in depth in the following section) validate the influence of this perspective on the simulation results.

Diversification Extension Results

There are two general types of results that will be considered here. First, we investigate what effects diversification has on the overall profitability and longevity of landscapes. Next, we conduct a finer-grained investigation as to which diversification strategies perform better than others.

The activity of mergers and acquisitions affects industry dynamics. Early American economists were concerned that mergers and acquisitions would result in the formation of only a few large organizations which would then collude (tacitly) on prices and reduce competition. Wilcox (1950) described this threat to capitalism as urgent because of the assumed prevalence of such non-competitive industries, though she questioned its prevalence in her own anecdotal observations. It would be interesting to see if the present diversification extension simulation tends toward oligopoly, and what are the industry-level effects in the diversification extension as compared to the baseline. One immediately apparent effect is the reduction in average profit from 1.27 to -0.9 for surviving agents, but an increase in the corresponding variance of PROFIT from 11.11 to 137. Thus, diversification apparently caused the agents in the diversification extension to become less profitable, on average, but enabled some agents to become substantially more (and less) profitable. Another corresponding result is that profits are strongly and negatively associated with diversification, as shown in Figure 21 in terms of how many strategic business units (SBUs) that the CEO agent acquires and an agent's diversification status in general. Clearly, higher profitability is associated with no diversification at all. On the other hand, a conservative diversification strategy (toward lower numbers of PROPENDDIVERS, and toward a low probability of accepting an offer of acquisition) is associated with greater Longevity, as shown in Figure 22. Table XXIII confirms these results (except for

ACQRACCEPT) with highly significant differences, in the averages of NumSBUs, DIVERSIFIED, PROPENDDIVERS and THRESHDIVFY; in particular, a greater proportion of surviving agents were diversified than had died early (0.65 compared to 0.49). Clearly, there are some significant advantages to any diversification strategy, but these advantages are more closely related with longevity than with profitability. This is consistent with what the liability of newness and liability of smallness principles would have predicted in the population ecology perspective with regard to longevity on the one hand, and the empirical findings of Amihud & Lev (1981) that diversification is accompanied by both risk reduction and lower profits (consistent with agency theory) on the other. However, the increase in the variance of profits suggests that there are some occasions in which some diversification strategies, in particular, might be profitable, thus justifying a contingency approach within the strategic management perspective, as discussed next.

Does the choice of any diversification matter with regard to the harshness of the environment? Apparently yes, as the proportion of diversified agents was much higher (0.73) in the most harsh environments as compared to that at least harsh environments (0.64), as shown in Table XXIV. However, this table does not show any differences among the remaining four diversification variables. Furthermore, this difference in DIVERSIFIED may be more a matter of strategy implementability than longevity or profitability: in a more simple environment, there are less agents to interact with, and consequently less agents to merge with or acquire. However, DIVERSIFIED also counts the number of agents acquired through an unrelated strategy involving agents outside the acquiring agent's (simple) landscape, which will doubtless include more complex and populous landscapes. Thus, opportunity to diversify does not fully explain

the significant difference in DIVERSIFIED. This shortfall allows for the possibility that agents use diversification more frequently as a way to cope with more harsh environments.

While diversification is apparently more prevalent in more harsh environments, this finding does not inform us as to which diversification strategies are more and less successful in which environments. To address this contingency question, a series of two-sample difference tests were conducted across different environmental extremes, for each diversification strategy, as shown in Table XXV, where generally the two best and two worst strategies were determined by ranking the average PROFIT among agents of different diversification strategies, and then testing (with a two-sample t-test for PROFIT in Table XXV; and a Wilcoxon rank sum test for Longevity in Table XXVI) for a significant difference between the highest-averaging “Worst” strategy and the lowest-averaging “Best” strategy. Since Unrelated Passive and Acquisitive Conglomerate were always the least profitable strategies, a third-worst strategy was identified in the table if the p-value between lowest-best and highest-worst strategies appeared reasonable. Thus, the highest p-value was 0.059 (low dynamism) because Dominant-Linked was added as a third-worst strategy. The Related-Constrained strategy appeared to be the most profitable overall, as it appeared in the top two best strategies in 5 out of 8 environmental conditions, but generally under low-harshness conditions (with the exception of “best” under low munificence), although it showed up as a third-worst strategy under most-harsh conditions, so there is apparently some risk associated with this strategy. The Related-Linked strategy also appeared to be most profitable under low-harshness conditions, and was associated with less risk than Related-Constrained. Vertical Integration, Single Business, and Dominant-Linked appeared to be among the most profitable choice under harsh conditions. The most middle-of-the-road strategy appeared to be Dominant-Constrained, as it was among the best strategies under high-

dynamism conditions, but was neither best nor worst under all other environmental conditions. Generally, there seemed to be a tendency for the most profitable agents to choose a very conservative strategy under high-harshness conditions, and a moderate strategy under low-harshness conditions; the most aggressive strategies always resulted in lowest profits.

Average Longevities were compared for different diversification strategies across different environmental conditions, and the results are shown in Table XXVI. This table yielded similar results in that Unrelated Passive and Acquisitive Conglomerate always yielded the worst results (in this case, shortest average longevity), except that Acquisitive conglomerate was not worst under conditions of high munificence or low complexity. Note that the not-worst conditions are immaterial to the poor results for Acquisitive Conglomerate; once a strategy is “worst” for both low and high conditions of the same environmental category, it is seen as a consistently poor strategy regardless of performance under the other environmental extremes. Similarly, and more surprisingly, Single Business exhibited lowest Longevity under both extremes of munificence and complexity; apparently, while the Single Business strategy may sometimes result in higher profits, this strategy always resulted in relatively low longevity. Conversely, Vertical Integration seems to consistently have resulted in longer life; Related Linked resulted in highest longevity under both high and low munificence, but resulted in third-lowest Longevity for the most-harsh environmental condition. Generally, Dominant-Constrained appeared to be a high-longevity strategy for harsh environments, while Related-Constrained appeared to be a high-longevity strategy for benevolent environments. The general conclusion with regard to Longevity (Table XXVI) is not the same as the conclusion reached for PROFIT (Table XXV). With regard to the maximization of Longevity, agents should avoid both aggressive and conservative extremes, perhaps favoring either Vertical Integration or Related

Linked as a safe, “all conditions” strategy, while also considering a Dominant strategy under more harsh conditions or Related Constrained under benevolent conditions. If an agent were to attempt to simultaneously maximize PROFIT and Longevity, it might choose a Related strategy under benevolent conditions and a Dominant strategy (or Vertical Integration) under more harsh conditions. Perhaps the “best” strategy under changing environmental conditions would be to switch between a dominant and related strategy contingent on updated environmental searches.

Results from CEO Compensation Extensions

We consider herein the results from two CEO compensation extensions, one in which the payrule proportions were set as permanent, unchanging characteristics of each agent, and a second in which agents were allowed to change their payrule proportions based on a rudimentary algorithm that searches for new payrule proportions associated with higher PROFITS.

The results from the first CEO compensation extension (or “CEO extension”) are shown in Figures 23-32 and Tables XXVII-XXVIII. The results will be discussed first with respect to the baseline simulation validation (using the first CEO extension), then the shortcomings of the first CEO extension are addressed, and finally the results of the second CEO extension are evaluated.

The baseline validation appears to carry over to the first CEO extension. First, Figure 23 shows that the number of agents alive are reasonably distinct and separate, according to the original complexity setting for each landscape, across all iterations. As in the diversification extension, landscape 323 approaches the next-lower population landscapes, but this is again the harshest landscape at the high-population setting, so the death rate for this population is expected to be high. Second, 3 out of 6 of the baseline simulation’s significant variables were associated

with PROFIT (when comparing Figure 9 with Figure 24), while 7 out of 8 of the baseline simulation's significant variables were associated with Longevity (when comparing Figure 10 with Figure 25). There appear to be some interesting differences, however, such as higher R^2 terms and a number of additionally significant variables, especially in the model with Longevity as the dependent variable (Figure 25), but these are related to CEO behavior and are discussed below. Third, the ANOVA tests for the significance of different environmental conditions, shown in Figures 26 through 28, are quite similar to those shown for the baseline and diversification extension results. Consequently, the conclusions are identical as were made with regard to the diversification extension, that the CEO extension is at least as valid as the baseline.

The first CEO extension bears some quite interesting results that most likely are related to CEO behavior programmed into the payrule code. With regard to the baseline variables, the variable "ReactTime*Mag*Prob", a measure of an agent's aggressiveness toward nearby competitors, was significant for the first time in this study. As this variable's coefficient was positive, and its squared term was significant and negative, it seems that a level of aggressiveness existed that was associated with a maximum of Longevity. SEARCHLAND and its squared term were also strongly significant and also suggested a maximum, although this value appeared to be less than 1; an oddity when the first 8 squares are searched without cost. The variable Change was also found to be quite significant – more so than in any previous models – and in opposing directions: when PROFIT was used as the dependent variable (Figure 24), the Change coefficient was strongly negative; when Longevity was used as the dependent variable (Figure 25), the Change coefficient was strongly positive. This is a curious result, suggesting that the more frequently an agent changes its characteristics, the longer it can live, but at a lower cumulative PROFIT. Furthermore, the same behavior can be said for MOVE adj,

where lower PROFITS but higher Longevity is associated with more movement. Since all that was added to the CEO extension code was a number of executive payrules, these changes must have been due to that code extension and can be explained in that context. For example, CEOs paid by the agency payrule were considered to be “highly motivated” and were allowed to search more extensively and move more quickly. Also, the Change variable can be explained by the strategic fit payrule: when an agent changes to the PROPENDDIVERS setting with the greatest success in a given landscape, it compensates its CEO highest (reducing PROFIT) and its environmental fit enables it to increase its Longevity. It is more difficult to explain how a low level of aggressiveness can be associated with greater Longevity, however, since all of the payrules were constructed to directly affect PROFIT. Perhaps aggressiveness at a low level could be seen as a way to “buy” STATUS from a competitor through association, which would then be disseminated throughout the agent’s supply chain through transactions, thus increasing the longevity of the entire value chain; because of the Stakeholder payrule, however, any benefits in terms of profitability might be erased. However, this does not explain why aggressiveness had not appeared as a significant variable in any previous model in this study. It is enough, perhaps, to say that the significance of aggressiveness is the results of a highly complex influence of the payrules on an already complex simulation environment.

Figures 29 and 30 exhibit a sort of hierarchical regression procedure where first the diversification variables, then the payrule proportions, are added to the baseline regression model with PROFIT as the dependent variable (DV); Figures 31 and 32 follow the same procedure with Longevity as the DV. When the diversification variables were added, the R^2 increased by 22.1% for the PROFIT-as-DV model (Figure 29) and 3.26% in the Longevity-as-DV model. Clearly, the effects of diversification are carried through to the CEO compensation extension. When the

payrule proportions are added to the model however (Figures 30 and 32), R^2 only increased 2.13% and 0.32% for the PROFIT-as-DV model and Longevity-as-DV model, respectively. While 4 out of 6 of the payrule terms were found to be significant in the PROFIT-as-DV model (Figure 30), none of the payrule variables were found to be significant in the Longevity-as-DV model (Figure 32). Thus, while the CEO payrules appeared to significantly effect changes in the way some baseline variables were significantly associated with Longevity (discussed above), the payrule proportions themselves had no direct association with Longevity. We are led therefore to study payrules directly only in terms of their association with PROFIT. To this end, turning to Figure 30, the most interesting and surprising result is the significant interaction between agency and stakeholder payrule proportions. To illustrate this interaction effect, a conditional effects plot is shown in Figure 33. This plot illustrates that a high proportion of agency pay increases the strength of the relationship between stakeholder pay proportion and PROFIT. Thus, an agent with a high stakeholder pay proportion would be able to name a higher PROFIT if it also had a higher agency pay proportion; conversely, if an agent had a low agency and stakeholder pay proportions, its expected PROFIT would be higher than if it had a low-high mix of agency and stakeholder proportions, respectively. To reiterate: the best case is if the agent's proportions are both high; a second-best case occurs if there is a low-high mix; third-best is a low-low mix, and worst case is a high-low mix (of agency pay and stakeholder proportions, respectively).

The interaction between payrules increases the difficulty in studying results at the landscape level of analysis in order to identify contingencies; one would have to show conditional effects plots for each environmental condition and point out significant differences between slopes in different plots. In an effort to take a simpler approach, a second CEO compensation extension was written in which the agents were allowed to modify their payrules

in the direction of higher profits. It was decided to allow agents to conduct a basic Tabu-type search, because of its efficient and humanistic style of search (David, 1997; Battiti, 1996; Glover, 1990). If an agent realizes a profit after using a particular payrule, it increases the proportion of that payrule, which then becomes its “best” proportion, until it realizes a higher profit, when it reacts by increasing the appropriate payrule. The Tabu-type nature of the search occurs when each agent keeps a list of proportions tried, and never returns to that proportion if it realizes a higher profit at a different proportion. For the purpose of analysis, simple frequency histograms are used which are expected to display high-profit peaks for each type of extreme environment (munificence, dynamism, complexity, and harshness). Observed shifts of the peaks between landscapes are expected to suggest differences in high-profitability proportions across different environmental conditions.

Figures 33-40 show frequency histogram results across all extreme environmental conditions; Figures 33-36 show all agents, while Figures 37-40 show only survived agents. Note that, in the first CEO extension, these histograms, if plotted, would have appeared flat, characteristic of a uniform distribution, since that was the distribution used to assign pay proportions in the simulation initialization. The least-harsh, Agency payrule histogram shown in Figure 37 appears to be relatively flat, at least in the range 0.35 to 0.80, as might be expected from a least-harsh environment: it matters little what the proportion for the agency rule is in such an environment; any payrule will yield an equally high profit (except for very low and very high proportions). The remainder of the histograms do not appear to be flat but exhibit at least two peaks per histogram, suggesting that higher profits have been found by agents at those pay proportion peaks. The peaks observed from these figures are summarized in Table XXIX for

more convenient comparison. Since this is an initial, exploratory study, only the most obvious and extensive shifts in peaks will be discussed (highlighted in bold in Table XXIX).

With regard to the agency/stewardship payrule, few clear differences were observed across extremes of individual environmental variables. A secondary peak changed from 0.45 to 0.70 when comparing all-agent results to survivors under the condition of high munificence, but this switch in second-highest peak is probably due to the relative flatness of these histograms than any substantive effect. One interesting, but expected, difference between the less harsh environments (high munificence, low dynamism and low complexity) and their more harsh counterparts was not the position of the peaks but the steepness of the peak shapes when the environment becomes more harsh. The clearest example of a more pronounced peak, and the only example of a primary peak shift under the agency payrule, is found between the least-harsh and most-harsh histograms for survivors (Figure 41), where the primary peak shifted from 0.35 (least harsh) to 0.60 (most harsh). Apparently, when environments are most harsh, it pays to increase the frequency of the agency payrule. Conversely, the stewardship payrule frequency may be increased in least-harsh conditions.

Much more can be said about the Stakeholder/Fit payrule frequency proportion changes across environments, especially among survivors. First, the primary peak shifts from 0.35 to 0.65 from low to high munificence conditions (see Figure 38). Both the 0.35 and 0.65 peaks can be found on both histograms, but it is clear that many more agents gravitate around the peak at 0.35 under low munificence than those agents in the corresponding high-munificence peak. An increased stakeholder payrule frequency may therefore be more profitable under high-munificence conditions. A second interesting finding was among the secondary peaks in the low compared to high dynamism conditions, shown in Figure 38. A secondary peak appears in the

low-dynamism histogram at 0.90 which completely disappears in the high-dynamism histogram, and even turns into a minimum. Thus, it may pay to reduce the frequency of the use of the stakeholder payrule under increasingly dynamic conditions. A third difference can be observed in the shift of secondary peaks in the extremes of the complexity condition, and this shift can be observed in both the all-agents (Figure 36) and survivors-only (Figure 40) histograms: more agents seemed to favor the higher proportion of 0.65 under high-complexity conditions, but the primary peak remained unchanged. Thus, like the high-dynamism condition, more agents moved away from a high proportion usage of the stakeholder payrule, but the move was toward a more moderate proportion somewhat greater than 0.5. This cumulative effect appears most dramatically in Figure 41, when comparing least-harsh to most-harsh histograms. In the least-harsh environments, there is clearly a peak at 0.90, which subsequently disappears in the most-harsh histogram and is replaced by a (secondary) minimum. Thus, under any more harsh condition, it can be concluded that profit-seeking agents should move away from a high-stakeholder proportion and toward a more moderate proportion. Conversely, it apparently pays to incorporate a higher proportion of fit-based pay when conditions faced by the agent are more difficult.

Comparison of CEO Extension #1 to CEO Extension #2

The finding in the results from CEO Extension #1 of interacting payrule proportions should serve to temper the findings in CEO Extension #2. The above analysis of the second extension assumed that agency and stakeholder payrules were independent, which allowed us to consider the environmental effects of one proportion at a time; however, the payrules are not independent. Note also, however, that the second extension's findings should serve to temper

the results of the first in that the first extension assumed linear relationships with PROFIT and therefore oversimplifies the results. Neither can the first extension be “fixed” by applying nonlinear regression techniques (the second extension’s results suggest that there may be step functions and discontinuities involved), nor can the second be “fixed” by reporting histograms of multiplied payrules (it is not clear at all that different combinations of proportions will yield the same profit level if, when multiplied, they result in the same number). The results from each extension are intended to complement each other, as the interaction effect between payrule proportions is a strong and significant finding, but there are also clear differences across different environmental conditions that must be acknowledged.

The next chapter will attempt to generalize the findings discussed here into a series of hypotheses about the real world in a way that might be useful for both practitioners and researchers.

CHAPTER 8. DISCUSSION

It has been the intent until now to carefully refer to any observed results as restricted to the findings in the simulation, but the purpose of the simulation was to be able to make predictions about real-world contingencies. The caution with approaching the real world is emphasized in this discussion by formulating hypotheses about the real world; thus the assumption is made that any findings in the simulation must first be verified with real-world data before it can be considered a contribution to the advance of the field through the scientific method. However, because of the complexity of the simulation, more can be presumed about the real world than mere propositions, which are merely based on a theorist's understanding and synthesis of progress in one or more fields to that point. Thus, our simulation allows us to be more confident than a theorist that makes mere propositions, but somewhat less confident than the scientist who tests hypotheses using real-world data. Hypotheses are formulated below from discussion over the findings observed in the baseline, diversification, and CEO compensation extensions, in turn.

Organizational Characteristics: Baseline Simulation

While not the focus of this study, the analysis conducted on the baseline simulation for the purpose of validation can also be used to hypothesize some organizational characteristics. For example, hypercompetition (D'Aveni, 1994) claims that environments are increasingly becoming more harsh, at an increasing rate. One might, then, ask what effect hypercompetition has on agent characteristics. To address this question, in the simulation results, one might observe agent characteristic changes when an agent changes from least to most harsh conditions (Table XXII). While this might not indicate all of the conditions of hypercompetition, which

indeed could and should be studied by its own simulation extension with switching arenas of competition, one can at least note the effects of increasing competition on agent characteristics and generalize the observations to say something about the real world:

Hypothesis 1.1: Organizations in environments with increasing harshness will, on average, exhibit lower reputations, be less tolerant of loss periods, and be associated with higher price markups for same-value products, less territoriality, and more agility in altering their competitive positions.

Hypothesis 1.1 might be operational in the real world for the following reasons. First, in a more competitive environment, attacks and counterattacks will be more frequent; each attack is more likely to contain an assault on the competitor's reputation, thus reducing the reputation of, perhaps, both participants. Second, periods of contiguous losses will be tolerated less because investors will be less tolerable in a more risky environment. Third, organizations will move across their parameters of competition faster to find a niche in the competitive landscape, following Porter's (1980) method of avoiding direct competition, but once that niche is found, it creates a micro-monopoly of sorts which allows the firm to mark up its prices more than otherwise, albeit for a shorter period of time; but since there are more firms behaving in this manner, markups industry-wide will increase somewhat. Note that this last argument runs counter to the popular economics idea that competition increases industry efficiency and reduces profit margins; however, this economics view does not take into account industry dynamics and regional inefficiencies created by Porter's micro-monopoly creation strategy. In the real world, no "perfect competition" really exists, but while increasing competition may root out organizations with poor characteristics and result in overall average efficiency, increased competition may also result in decreased efficiencies with regard to pricing markups.

One way the above hypothesis might be used in a practical manner might be as a way to identify more and less harsh environments, assuming that firms with higher-risk are generally those firms found in more harsh environments. For example, if an organization finds itself in a competitive environment and wants to diversify its risk by acquiring an unrelated organization in a less harsh environment, it might measure reputations, loss tolerance, price markups, territoriality, and agility in its own industry and compare the measures with those of other industries. Acquisition candidates might then be chosen from industries with lower average scores when compared with the firm's industry. Alternatively, one could develop a risk-controlled portfolio of stocks based on designing stock purchases which would result in a wide variance of industry average scores. In other words, the characteristics in Hypothesis 1.1 might be used to construct a sort of measure of industry risk.

The concept of the liability of newness in OT certainly involves finer-grained elements, but it has until now received a black-box sort of treatment; much more can and should be done in real-world studies to identify more detailed characteristics of this liability. Certainly, the success rate of entrepreneurial ventures is characteristically low, and on one hand this is because risk has been encouraged by state laws, in part evidenced by the growing popularity of both the state-by-state availability of limited-liability corporations (LLCs) which protects the property of proprietors from debt reclamation, and on the other hand because not enough entrepreneurs engage in well-deliberated strategic plans. Suppose, however, that an entrepreneur has set up an LLC and has expertly written a business plan which she fully intends to carry out, what then? What characteristics, at that point, could her organization exhibit which might reduce the firm's liability of newness? Hypothesis 1.2, derived from Table XXI, offers some suggestions:

Hypothesis 1.2: Organizations will live longer if they are more profitable, have a higher reputation, tolerate longer periods of losses, search their environments somewhat less, change in characteristics more frequently, markup prices higher, and set up territorial areas for launching attacks against competitors.

Of course, the “finding” that more profitable organizations live longer is simply a repeat of the strategic management perspective of organizations, and the idea that higher-reputation organizations live longer is an observation central to institutional theory. However, in the present study, it must be noted that these findings, while obvious in retrospect, were falsifiable in that survived agents need not have exhibited these different characteristics. It therefore stands as a confirmation of both the strategic management perspective and institutional theory. The prediction that a longer-lasting organization will tolerate longer periods of losses is also an unsurprising result, as for example it is widely known that, given time, an organization will uncover and exploit a niche, and perhaps a propitious niche which will grow at the rate of the company’s capability for growth, but that it has until it burns through its present store of cash to unearth this situation. More cash buys more time for an organization to find a profitable, survivable place in its environment because, during the time that it is burning through its cash stores and spending it on operations, it is operating at a loss. Finally, firms having shorter “memories” are willing to forgive blacklisted interaction agents and be more skeptical of whitelisted agents, while organizations which search their environments somewhat less extensively are able to make faster, cheaper decisions, and those firms which set up territorial areas and attack intruders are more apt to live longer because of their established revenue stream (in effect, they have found a reliable niche). Thus, firms oriented toward longer life are not merely those which make higher profits and are able to garner higher reputations.

It could be argued that a lower risk is associated with a firm which lives longer, on average. Therefore, Hypothesis 1.2, like Hypothesis 1.1, could be used to aid the investment or acquisition decision, but in this case, the organization's score could be compared to the industry average. When Hypotheses 1.1 and 1.2 are combined, they might be especially useful for investors/acquirers interested in finding, say, a relatively lower-risk organization in a lower-risk industry, or hedging one's investment in a high-risk industry by investing in/acquiring a lower-risk organization in that industry.

Perhaps an important contribution of this study is toward the advancement of contingency theory itself. The traditional independent variables of age, size, change in size (Baker & Cullen, 1993), as well as structural characteristics such as formalism, centralization, and specialization (Blau & Shoenherr, 1971), may be just the tip of the proverbial iceberg with regard to the number of actual organization-level characteristics that may be contingent on environmental conditions. Other fields have advanced this additional-characteristics idea. For example, operations management research has extended the idea of contingency toward the success of flexibility (Ketokivi, 2006) and integration (Koufteros, Vonderembse, & Jayaram, 2005) strategies, negotiation strategies have been considered contingent on the nature of an international conflict in the field of public relations (Zhang, Qiu, & Cameron, 2004), and predicting whether CEOs have chief operating officers was found to be contingent on the CEO's experience, but lower performance ensues (Hambrick & Cannella, 2004). In management theory, the use of additional independent and dependent variables toward the further development of contingency theory has been surprisingly sparse. Recently, post-bankruptcy strategic change was found to be contingent on the type of CEO successor choice (Brockmann, Hoffman, & Dawley, 2006), and the success of structural adaptation was theorized to be

contingent on rhetorical congruence (Sillince, 2005). Certainly, organization theories themselves suggest many more basic contingency variables, and a few of them have been proposed here. Perhaps this study will influence the further development of contingency theory as the association between specific organizational characteristics and specific environmental conditions.

Limitations of the Baseline Simulation

A key limitation of the baseline simulation is that it is based in only eight perspectives of how organizations are expected to act. Surely, there are more perspectives within organization theory and strategic management that could be incorporated and modeled, such as multiple arenas of competition (D'Aveni, 1994), negotiations (Denis, Denis, & Sarin,), organizational structures (Galbraith, 1973), organizational climate and culture, innovation, etc. While the objective was to develop a basic model of what virtually all organizational researchers might accept as how organizations actually function, the conclusions of this study must be qualified within the context of the eight perspectives modeled.

Within the eight perspectives on organizations, there is the possibility that these perspectives have been incompletely or incorrectly modeled. This limitation is due to the fact that real-world data was not used in the simulation creation. However, as detailed in the COT literature review above, the approach taken in this study follows the norm of the field rather than the exception; thus, it is a “weakness” of virtually all COT studies that have been published. The proper way to curtail the conclusion based on this limitation is to develop hypotheses that are intended as input to real-world studies (Carley, 1999), as have been done in this work.

The baseline simulation, as modeled, makes at least two assumptions with regard to operations research issues. First, manufacturing process time is not modeled because the

baseline model considers the “product” to be a commodity with basically equal manufacturing times for each simulated organization. In other words, manufacturing equipment can be readily acquired off-the-shelf and relatively costlessly integrated into an existing manufacturing line. Manufacturing times were made constant because this study was intended to be concerned with corporate diversification and executive behavior; it is not a study on operations, so certain operations factors may be held constant (such as manufacturing time) without a significant loss in generality. Note that operations research studies usually do just the opposite in that they observe operations conditions while holding constant factors such as diversification conditions and executive behavior. A second operations research issue that is assumed for this study is that no advance orders are placed (and no backorders accumulated) with manufacturers (or harvesters) for their finished inventories. This, again, is a simplification of the real-world operations condition, which can admittedly be very complicated, but is allowed here because operations was not an area of focus for this study.

Further Study: Using the Baseline to Study Issues in OT

The baseline simulation could be extended to further study organizational characteristics, without application to strategic management. One extension of the baseline could model more or all of the environmental differences as described in Table III, rather than modeling just one element of each environmental dimension as conducted in the baseline simulation. For example, the effect of sales concentration could be modeled by superimposing a sales matrix that varies geographically, analogous to the resource landscape, to further model the effects of environmental complexity. It may well be that different aspects of the same environmental dimension may have different, if not opposing, effects on agent profitability and longevity. In

other words, it may well be that “customer dependence” may oppose, or alter, the effects of resource dependence.

At issue in any future study on environmental effects is the issue of modeling environmental dynamism. Perhaps shifting landscapes could be modeled (landscapes that move independently under their agents), but an interesting project might first be to examine the limit of RESETFREQ at which dynamism, as-written, begins to decrease rather than increase agent death rates. This is an interesting phenomenon which might occur in the real world; perhaps the fashion industry might serve as an example, as some popular fashions are termed “retro” because they return to the popularity of prior styles; clothing companies, or retailers, might do well to specialize in one or two particular styles and realize high profits whenever a style their company specializes in returns to popularity. Alternatively, the airlines industry might also be an example, as airlines generally make little profits when the price of oil is high, but high profits when the price of oil is low; it is the high variance of the price of oil that allows an airlines industry to exist at all, and also probably keeps the threat of entrants low. As it appears that the high-price period of the oil price cycles are getting longer, how long can those loss cycles go before all of the airlines companies are run out of business?

A third area that holds potential for future research is in the sensitivity of environmental and other variables used in this study. Whereas, in this exploratory study, differences between environments was considered sufficient, what remains to be studied is how sensitive agents are to changes in the simulation settings. Landscape characteristics could be changed, such as PEAKS, MAXPEAK and RESETFREQ, as well as changing the steepness of resource peaks, to discover the robustness of resource dependence and environmentally-contingent agent

characteristics. These and additional ideas than might be investigated in a sensitivity analysis are exhibited in Table XXX, and indicates a logical next step for further study.

Diversification

General Effects

A central objective of this study was to develop a contingency theory of diversification strategy. Extant literature has suggested, but never directly studied, environmental contingencies at the organizational level of analysis. Instead, much of the literature (for example, in Berry, 1974) has been spent on determining if diversification has an effect on the environment, especially diversification's effects on competition. To that literature, the present study suggests that the carrying capacity of environments increases when diversification is allowed; more carrying capacity indicates that higher populations can exist, which further suggests that diversification can have a positive influence on the potential for more competition, but the landscape's now higher population and higher potential for competition does not overcome the increased cooperation between organizations, with overall diversification rates of 50% or more. Thus, cooperation does indeed reduce competition, and also overall industry profits, and increases the carrying capacities of environments. However, diversification decreased the average markup of survivors from 5.66 (Table XXI) to 5.06 (Table XXIII), so apparently cooperation can increase supply-chain efficiencies, which should be a benefit to consumers. Less competition between firms does not, therefore, always imply less efficiency.

A further question is, "Does diversification increase or reduce overall industry profitability?" Comparing survivor profitability in the baseline results of 1.27 (Table XXI) to survivor profitability in the diversification extension of -0.90 (Table XXIII), it would seem that

when diversification is allowed, average profitability drops significantly. Even when diversified survivors were compared to single-business strategy survivors, -3.14 compared to 1.28 respectively, a non-single business diversification strategy seems to be a choice associated with poor profitability.

Why, then, should a firm ever consider a diversification strategy? The results of this study (for example, Figure 22) suggest that diversification may at least increase firm longevity, on average. This phenomenon may be true in the real world because a firm that acquires a smaller firm may, after some time, improve its financial position by later divesting that firm; the firm might end up in a worse position than it started, but it may have broken up a series of contiguous losses such that it might survive for a longer period of time, albeit with worst performance. Some research on diversification has noticed this behavior among diversifiers (Porter, 1987), where a corporation acquires, and then later divests the same entity (Porter found such behavior in $\frac{1}{3}$ to $\frac{1}{2}$ of his sample of 33 firms over the years 1950 to 1986). These acquisitions-then-divestments were considered failures, since divestment is usually conducted as a result of poor performance, but the present study suggests that such behavior may have had a positive effect on longevity of the acquirer, and so managers of these firms may have seen the acquisition-then-divestment as a general success after all. Thus, the effects of diversification are mixed; one cannot conclude that diversification is generally a positive or negative activity, but only that various tradeoffs are involved.

Hypothesis 2.1: Diversification in general reduces industry competition and profitability, but increases industry efficiency and firm longevity.

What can be said, then, about the single business strategy? If diversification generally has a negative effect on diversification, can one conclude the opposite about the single business

strategy? Were the stricter antitrust laws that were enforced before the early 1980s justified?

The results indicate mixed benefits; the single business is apparently not a panacea because of its relatively short longevity. In terms of profitability, the single business strategy performed poorly under the condition of low complexity, but was among the two most profitable under high-complexity and most-harsh conditions.

Hypothesis 2.2: The single business strategy is relatively unprofitable under conditions of low complexity, but relatively profitable under conditions of high complexity and high harshness.

Why might the single-business strategy be among the most profitable under high-harshness and high-complexity conditions? It may be that single businesses are more decentralized in that they make all of their decisions at the business level; in a linked organization, efforts are made to standardize organizational characteristics according to the HQBU (which in turn copies from among the most successful in its industry), but a related-linked strategy might create certain characteristics that are beneficial to some agents in some areas of the landscape when it is integrated with a particular supply chain (for example, one constructed of organizations with a supply-chain focus), but are instead detrimental to other linked organizations when integrated into a different sort of supply chain (for example, one constructed of organizations with a lowest-cost focus). In a relatively harsh environment, especially one which involves a level of complexity where there are many other firms willing to step in as a new supply-chain partner, the single business can integrate more easily, while the related-linked strategy can result in weak links.

Even though single businesses may be more profitable under more harsh conditions, there is still the liability of smallness that these organizations must face, as confirmed by the results observed in this study:

Hypothesis 2.3: The single business strategy is associated with relatively low longevity under all conditions of munificence and complexity.

Clearly, the liability of smallness is evident from this study, but it is curious as to why this liability was not evident under any conditions of dynamism; this “neutral” effect must have been quite strong, as no evidence of smallness liability was observed under any conditions of harshness. Perhaps under conditions of dynamism, organizations, whether existing as a division under a larger corporation or as a single business, have as one of their only responses the ability to move across the competitive landscape to adjust to changes in supplies and customer needs, and the decision as to the competitive positioning of the business is made at the business level, regardless of whether that business is connected to any larger corporation or not. Thus, the liability of smallness is related only to munificence and complexity, which one can be explained using the usual ecological reasons such as relative (financial) weakness.

If validated by real-world studies, hypotheses 2.2 and 2.3 might serve to shed some light on the “combination” debate in the early 20th century, for example with respect to Dewing’s 1911 investigation of the failure of the U.S. Leather Company: in a harshly competitive and complex international market, the U.S. Leather Company took U.S. companies away from the most profitable single-business strategy and into what one could argue was a related-linked strategy in that the linkages were across geographic regions. This strategy (discussed below), while also profitable as indicated in Table XXV, also exhibited the third-shortest longevity among the nine available strategies. Thus, one might say that even though the U.S. Leather

company could have remained profitable, it was selected out of its environment for other reasons that are common to selection “rules” in a high-harshness environment. U.S. Leather’s mismanagement, which was identified by Dewing (1911) as the cause of its downfall, can be reinterpreted by the present study as a failure to realize that a related-linked does not last long in a high-harshness environment, and that the single-business strategy would have served efficiency best, given its environment.

Related vs. Unrelated Diversification Strategies

Which strategy performs better, related or unrelated diversification? Most research has sided with findings such as Chatterjee and Wernerfelt (1991) and Rumelt (1974) that related diversification performs better, as explained by the resource-based view; in particular, when specialized resources are used to diversify relatedly, more efficiencies and synergy can be realized than when only unspecialized resources (i.e. cash) are used to diversify (Chatterjee & Wernerfelt, 1991). However, Reed and Luffman (1986) found unrelated diversifiers more profitable, and explained their findings as contingency-related: Luffman and Reed’s dataset was British, and conditions in Britain were harsh such that it might benefit those firms to diversify outside Great Britain into less harsh environments (such as the United States). In comparison, the current work finds with surprising decisiveness that, no matter what the environment, unrelated diversifiers performed much worse than related diversifiers or single businesses, but also that acquisitive conglomerates performed much worse than unrelated passive diversifiers.

Hypothesis 2.4: Unrelated diversification results in poor profitability as compared to related diversifiers and single businesses. In particular, acquisitive conglomerates are generally less profitable than unrelated passive diversifiers.

In terms of longevity, however, acquisitive conglomerates were not significantly worse than any other strategy under conditions of high munificence and low complexity (Table XXVI), the only two conditions where one strategy was no less profitable than any other, on average.

Hypothesis 2.5: The acquisitive conglomerate strategy is not associated with a significantly shorter life than any other diversified or single-business firm in high-munificence and low-complexity conditions; under every other environmental condition, the acquisitive conglomerate strategy, and under all conditions for the passive unrelated strategy, firms live significantly shorter than in any other diversification strategy.

Taken together, Hypotheses 2.2 and 2.3 leave very little question as to whether unrelated diversification is in the interest of shareholders or not: it is most likely, on average, not. If anything, the acquisitive conglomerate strategy sometimes results in higher longevity than a single business or unrelated passive diversifier under conditions of high munificence or low complexity, but even these minor exceptions might benefit management more than shareholders, as the longer the organization survives, the longer management gets to keep their jobs; yet the unprofitability continues. In other words, with respect to unrelated diversification as a competitive strategy, this work agrees with Amihud and Lev (1981) among others in that unrelated diversification can be explained only as an agency cost that results in larger organizations and more pay for the CEO, but also in some environments (high munificence and low complexity), this strategy has served to reduce the effects of the market for corporate control, an important control mechanism in agency theory (Fama, 1980). But there are severe environmental limits to the agency theory perspective; in most environments, neither the unrelated passive nor the acquisitive conglomerate strategies are effective or efficient; they are simply inferior strategies with few benefits when compared to related diversification. Thus,

based on the findings in this study, neither portfolio risk nor agency cost is a satisfactory explanation for the popularity of the unrelated diversification strategy. We must traverse beyond the perspectives used herein to develop the simulation to explain this popularity; perhaps it is a temporary popularity itself that is the benefit gained from unrelated diversification, or perhaps there is always a related element to unrelated diversification, such as management expertise. In any case, more theoretical work must be done to explain the benefits of unrelated diversification.

Dominant and Related Strategies

If the single-business strategy is unreliable and low-longevity, and the unrelated strategy is consistently unprofitable, then the best of all worlds must be found in the in-between strategies of dominant-constrained, dominant-linked, related-constrained, and related-linked. The dominant-constrained strategy, a very conservative strategy in which only 5% to 30% of sales are derived from related operations while the rest is generated from the organization's core business, performed particularly well in highly dynamic conditions in terms of profitability, and high-dynamism, high-complexity, and high-harshness conditions in terms of longevity. The dominant-linked strategy also performed well under high-harshness conditions: high dynamism and complexity in terms of profitability, and high dynamism in terms of longevity. However, the dominant-linked strategy also performed well under low harshness and high munificence conditions in terms of longevity. The only "worst" performance for either of the dominant strategies was the dominant-linked strategy under low dynamism for profitability. It seems there was little downside to either of these conservative strategies, a finding which strongly supports the views of Penrose (1969), Hosskisson and Hitt (1990) and Lubatkin and Chatterjee (1994), among others: not only is unrelated diversification a poor choice of strategy (Hypotheses 2.4 and 2.5), but strongly related diversification is apparently one of the best choices for most conditions:

Hypothesis 2.6: The dominant strategy, whether linked or related, is among the best strategies under conditions of high dynamism with respect to either profitability or longevity, but the dominant-related strategy is a poor choice under conditions of low dynamism.

Hypothesis 2.7: The dominant-constrained strategy is among the best choices under conditions of high complexity and high harshness in terms of longevity.

Hypothesis 2.8: The dominant-linked strategy is among the best choices under conditions of high complexity (for profitability), and low harshness and high munificence (for longevity).

Again, it is difficult here to develop some simple explanation of these three hypotheses because it is based on the results of a rather complex simulation. It must be noted here that the dominant-constrained strategy, the most conservative of all of the diversification strategies, was the only diversification strategy that was not a worst performer in at least one of the environmental conditions. In short, one cannot go wrong with the choice of a dominant-constrained diversification strategy. However, one rarely does well either, especially in terms of profitability. In other words, it is the lowest-risk strategy of all the diversification strategies considered in this study; an organization oriented toward a dominant-constrained strategy is different enough from the single business structure so that it loses its liability of smallness, yet its conservative approach to acquiring only nearby organizations in its own industry seems to separate itself far enough away from the unrelated diversification strategies that seem to perform so poorly.

Related strategies, however, while somewhat more risky, were also most consistently among the most profitable. For example, while the dominant strategies garnered three best-

strategies for profitability (two for the high-dynamism condition), the related strategies received eight best-strategies for profitability, and another 5 best-strategies for longevity. In addition, 9 out of 13 of these best-strategies fell into the high-benevolence conditions:

Hypothesis 2.9: The related strategies are overall the most profitable, especially under conditions of high benevolence. However, under most-harsh conditions, the related-constrained strategy is among the lowest in terms of profitability.

Hypothesis 2.10: The related strategies are among the most profitable under conditions of low munificence, but not under the other low-benevolence condition of high-dynamism and high-complexity.

Taken together, if Hypotheses 2.9 and 2.10 can be validated by real-world studies, and there are no such studies to date that have approached anything like the contingent relationships suggested here, then following is suggested for practicing managers: when in a low-benevolence environment, choose a more conservative dominant type of diversification strategy, except under conditions of only low-munificence; when in a high-benevolence environment or a low-munificence-only environment, choose a more aggressive related type of diversification strategy.

Vertical Integration

While it would amount to circular logic to compare vertical integration to the other diversification strategies' performance results, as substantial advantages to vertical integration were programmed into the simulation at the outset, it is interesting to note and discuss the performance of vertical integration relative to itself across different environmental conditions. In particular, why was vertical integration not among the "best" strategies for every environmental condition? Even with its built-in advantages, vertical integration was not substantially better

than the other strategies under conditions of low munificence, high dynamism, low complexity, and low harshness in terms of profitability, and under any conditions of munificence and high dynamism in terms of longevity. It may be that organizational characteristics cannot be standardized up and down a value chain; certain organizational characteristics might be efficient or effective in some parts of the value chain while it might be detrimental in other parts.

Hypothesis 2.11: Vertical integration strategy generally performs well under the relatively benevolent conditions of high-munificence and low dynamism, and under the relatively harsh conditions of high-complexity and high-harshness. Otherwise, vertical integration is rarely among the most profitable strategies.

It is interesting to observe that Williamson's (1975) transaction cost economics could not have been used to predict the vertical integration strategy results. In essence, Williamson's (1975) transaction cost economics theory is a contingency theory, as it predicts certain environmental conditions under which a vertical integration becomes more efficient than other strategies. Since market failure was an initial assumption condition, and programmed into the simulation, TCE theory would have predicted that vertical integrators should perform well under any environmental conditions. Furthermore, the conditions that vertical integration performed well (and also for those conditions for which vertical integration did no better) were not consistently harsh or benevolent conditions; for example, vertical integration was a most-profitable strategy under the benevolent conditions of high munificence and low dynamism, but it was also most profitable for the harsh conditions of high complexity and high harshness. This suggests that vertical integration's success operates under a far more complex set of contingencies than Williamson (1975) had considered. For example, under conditions of high complexity, it might be beneficial to acquire a supplier and impute to it a number of desirable organizational

characteristics rather than put the time and effort into choosing from a wide array of potential, independent suppliers; under conditions of high munificence, it might be beneficial for a supplier to be acquired by its buyer because under those conditions, with more units processed per organization, economies of scale are more directly realized through transaction cost reductions. Thus, more work can and should be done in the area of vertical integration and related contingencies in future studies, as discussed below in the Future Study section.

Limitations of the Diversification Extension

The weakest part of the diversification extension is most likely the modeling of the vertical integration strategy. Actually, the transaction cost rationale, or the effort to reduce opportunism, is only one of three recent rationales given for diversification (Barney & Hesterly, 2006), although the TCE rationale, the means to reduce seller opportunism, was referred to as one of the “best known explanations” (p. 183) of vertical integration. The two additional rationales given were to vertically integrate into resources that might lead to competitive advantage according to the RBV, and for the purpose of increased strategic flexibility. This much more complex reason for vertical integration explains the lower profitability observed by diversification researchers such as Rumelt (1974) and Luffman and Reed (1984), since only the first reason would lead to higher profitability, might lead to a separate simulation study on vertical integration in order to better understand, and model, this necessary and interesting diversification strategy before it can be placed next to the other diversification strategies in proper context. Thus, this “weakness” might lead to an entirely new and interesting study.

Another weakness might be that not all diversification strategies have been modeled, or that real-world diversification strategists see their alternatives in a different way, such as

concentrically-related according to Ansoff's (1965) somewhat different perspective, or more simply, such as the four-category categorization used by Rumelt (1974) and Luffman and Reed (1984), among others. The significance of this diversification study may therefore fall short in two ways. On the one hand, real-world practitioners may have in mind a different set of diversification strategy alternatives or understand their environmental parameters differently and perhaps idiosyncratically, while real-world researchers might find it difficult to measure diversification strategies in a way that confidently tests the hypotheses contained herein. However, the diversification strategy alternatives were developed from the categorization of real-world corporate annual reports, and the major strength of a simulation study is to proceed through to the development of theory unhindered by real-world measurement problems. Stated more simply, it is expected that many real-world diversification strategists actually do see organizations in terms of Rumelt's eight alternative strategies, and real-world researchers are expected to develop increasingly more sophisticated and creative measurement techniques that will eventually result in sufficiently consistent tests of the hypotheses contained herein. Perhaps more work should be done in terms of a survey design after Nayyar (1992), but more generally rather than service-industry specific, and including specific questions as to the organization's forward-looking diversification strategy. To date, no study has included such a survey.

A final weakness of the diversification extension discussed here is the inability of single-agents to offer more than one type of product at a time. In one sense, this weakness could be accommodated for by simply making one of the generalized landscape dimensions something like "extensiveness of product line" an use that as the relevant competitive variable; in another sense, it points out that, while growth was modeled by external means, internal growth means such as the creation of new entities by some parent organization was not modeled. But this

weakness really addresses a further question that is considered outside the scope of the present study: In which environment is which mode of growth, growth by internal or external means, more appropriate? This question was not considered here because it was also outside the scope of existing studies on diversification (e.g., Chandler, 1962; Rumelt, 1974; Luffman & Reed, 1984; Hoskisson & Hitt, 1990; Chatterjee & Wernerfelt, 1991), and this diversification extension's purpose was to contribute to the diversification literature. The growth question is, of course an interesting one and growth-from-within could be modeled in a separate study with an additional extension of the diversification extension used herein.

Future Study Opportunities in Diversification

In addition to a vertical integration and growth studies discussed above, it might be interesting to directly test Reed and Luffman's (1986) conjecture, that international diversification's success is contingent on the level of benevolence of involved countries, with its own simulation extension. This could be done by setting up only two landscapes, one harsh and one benevolent, and allow unrelated diversifiers to acquire agents only from the other landscape. In other words, simulate international diversification between two countries which exist under different environments; however, if a firm can diversify relatedly overseas as well as unrelatedly, then conditions are little different from the present study, and related strategies should also exhibit higher profits and longevities. The simulation might be made more interesting and relevant to the field of international strategy if agents were allowed to adopt different types of multinational strategies, such as global, multifocal, multidomestic, and transnational strategies (Bartlett & Ghoshal, 1987).

In another further study, it may be interesting to vary the extent of centralization in diversified organizations. In the present study, what has been modeled is a reasonable shift in centralization (e.g., subsidiaries should be able to position themselves in their industry autonomously, while their existence is ultimately decided by the corporate headquarters) and consistency of shift among all agents (i.e., centralization is held “constant”), but linked agents belonging to different supply chains, as well as linked-related agents in harsh environments, may require more centralization than was modeled for diversified organizations. This would be an interesting progression of research: this study applied organization theory to the study of diversification, while the proposed future study would apply diversification to the study of a well-known quantity in organization theory.

A final area of investigation that might be conducted, though this list of future studies is by no means exhaustive, involves cooperative strategy. There are certainly a number of cooperative strategies that could serve as alternatives to, and fall short of, acquisition, as outlined by Brandenberger and Nalebuff (1996). Certainly, different types of joint ventures, for example, could be modeled in a separate study on the success of joint ventures with respect to different environmental conditions. The assumption that diversification reduces competition is no longer adequate, as internal division managers often compete against each other, while independent competitors often cooperate to the benefit of each. Perhaps a competition score of sorts could be developed in an effort to measure actual industry-wide competition in an effort to develop a contingency theory of competition in a simulation that models both internal competition and external cooperation.

CEO Compensation

Agency and Stewardship Payrules

It is a curious observation that, while in the diversification extension the unrelated strategy could be explained as an agency cost and was hypothesized to always be detrimental to organizational profitability, the use of the agency payrule may actually increase organizational profitability under some environmental conditions. Specifically:

Hypothesis 3.1: Under most-harsh environmental conditions, organizations become more profitable if they increase the frequency of the use of the agency payrule and decrease the frequency of the application of the stewardship payrule, and *vice-versa*, when compensating executives.

Thus, increasing competition can actually have the effect of increasing the use of agency theory with regard to CEO pay to profitable effect. This finding is interesting especially in light of the notion that this payrule will be especially costly for unrelated diversifiers, which are already unprofitable as stated by Hypothesis 2.4. It sounds counter-intuitive at first, but this study actually offers the recommendation that, for a large, unrelatedly-diversified organization, one way to move toward higher profits is the increased frequency of use of the agency payrule. The reason may be that, since agency pay may motivate corporate executives to search their environments more extensively, attack competitors more aggressively, and move more quickly across the competitive landscape, any increased motivation that an organization can elicit out of its organization's members under such difficult conditions could lead to a competitive advantage, even if that advantage comes at a cost. Of course, what is assumed here is that agency-paid executives actually are more motivated to add value to their organizations and that the pay, while always at an increase, is still within reasonable bounds. There are some real-world situations

where agency pay may result in executives engaging in corruption, profit-taking, balance-sheet management, or celebrity-seeking behaviors which do not result in appreciable added value to their organizations. These alternative behaviors were not modeled in the present study, but they could become topics of future studies as discussed below. In any case, with the present assumptions in place, the suggestion here is to pay the agency-costing conglomerate executive more frequently according to the agency payrule, if the organization faces a harsh environment. However, this increased frequency stands at only 60%, with 40% of the stewardship payrule still used; this still-high stewardship payrule frequency is probably far more than what many for-profit, hypercompetitive firms and their boards of directors are using today, so this study still recommends a decrease in the frequency of the use of the agency payrule for those organizations.

Stakeholder and Fit Payrules

The stakeholder payrule was observed to shift from moderate to high proportions among proportion-optimizing agents under increasingly benevolent conditions. Apparently, stakeholder reasoning is easier to justify under more benevolent conditions, while under increasingly harsh conditions, organizations can only afford to look after their own welfare.

Hypothesis 3.2: Under increasingly harsh environmental conditions, organizations become more profitable if they increase the frequency of the use of the fit payrule from moderate to high and correspondingly decrease the frequency of the application of the stakeholder payrule, and *vice-versa*, when compensating executives.

This hypothesis is consistent with stakeholder theory (Mitchell, Agle, & Wood, 1997) if the increasingly harsh environment itself becomes a stakeholder that grows more powerful, urgent, and legitimate, and if the needs of this stakeholder are answered by focusing more on

strategic fit, and ignoring supply-chain stakeholders. Note that for high profitability, use of the stakeholder payrule should at least be moderate; in other words, profitable organizations pay a great deal of attention to their supply chain's profit.

Agency-Stakeholder Interaction

To the above discussion, it must be added that those agents which increased both their agency and stakeholder payrules were even more profitable than those that only increased one or the other of the payrules. When integrated with the above discussion, we arrive at the following:

Hypothesis 3.3: Under increasingly harsh environmental conditions, organizations become most profitable if they simultaneously increase the frequency of the use of both the agency and stakeholder payrules, and *vice-versa*, when compensating executives.

Note that the regressions in this study were not weighted by landscape, so one arrives at Hypothesis 3.3 when one assumes that the higher populations of the more harsh environments brought out the conditions in the regression model that are reflected by Hypotheses 3.1 and 3.2. In any case, it is an important finding of this study that agency and stakeholder payrules are dependent, and when agency reasoning is increased, so should stakeholder reasoning. Members of boards of directors should keep in mind that agency reasoning must be accommodated by stakeholder types of reasoning if any reasonable and profitable balance in terms of compensation is to be found. With regard to stewardship, it was found not to be a panacea, or an antidote, for the agency perspective, but under even harsh conditions it should influence about 35% of executive pay, which is probably far less than real-world directors employ this reasoning today. Under benevolent environmental conditions, however, stewardship thinking should be more frequent than agency thinking; under such conditions, however, strategic fit should also be

increased at the expense of stakeholder reasoning. Thus, there is room for all four types of reasoning for the profit-oriented firm, even though only Stewardship reasoning actually directly bases executive pay on firm profitability. This places Friedmanian economics into a new light.

For example, consider the following quote (Friedman, 1963):

“There is one and only one social responsibility for business – to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deceit or fraud” (p. 133).

The current work does not disagree with Friedman, but it finds that satisfying the seemingly unprofitable concerns of executives’ wants for more pay and supply-chain profitability does, at times and in the proper proportion which is contingent on environmental conditions, have a place toward the pursuit of higher profits. Furthermore, this study suggests that the maximization of competition might not be in the best interest of consumers or economies in general.

Limitations of the CEO Compensation

This study was limited by the number of payrules modeled, and it is possible that there are more payrules that could have been modeled. Unfortunately, no study has been conducted which actually surveys executives or directors to determine which payrules actually exist. The balanced scorecard has apparently often been used to pay executives along four dimensions: financial, customer, internal operations efficiency and effectiveness, and innovation and learning (Wheelan & Hunger, 2004). While the first two dimensions could be considered stewardship and stakeholder perspectives, the latter two were not considered for the present study; this is

because the governance literature, to which I was writing, is distinct from the balanced scorecard literature. It would be useful and interesting to model the balanced scorecard with a separate CEO compensation extension, however, since there is no indication in this body of literature as to what exact the proportion from each of the four elements should be (the “balance” is assumed to be equal).

In the real world, the most rational course of action when considering executive pay might be to assess the quality and results of the executive’s decisions that were made over the relevant pay period. The current model of executive pay is limited in that it did not directly evaluate the quality of executive decisions that were made, except for in the choice of diversification strategy which was used in the fit payrule. However, as in the real world, the exact level of success of specific decisions is ambiguous, and any measures of decision quality would have been unreliable, and just as one might do in the real world, in the current study I have resorted to simple heuristic rules for compensation seem reasonable enough. Thus, this “weakness” is one that actually exists in the real world, and may constitute an important step toward reality taken by the simulations used in this study.

A third weakness of this study was the scarcity of some of the observations used to construct the ranking of the FIT array. Considering the poor performance of the unrelated strategies in general, the ranking of these strategies in the FIT array was probably reasonably reliable, but the relative ranking of, say, the profitability of the related-linked strategy as compared to that of the dominant-constrained strategy was unreliable; using different random number seeds in the diversification extension, different rankings could have been possible. However, the data used to construct the rankings for each landscape were all that was available, and increasing the number of observations by increasing landscape sizes just so that a more

reliable ranking could be made would have demanded an unreasonable amount of computation time (such as one week) and effort, if it even would be at all possible given the limitations of the computer equipment used in this study. In any case, the improvement to the CEO extensions would have been incremental, as the ranking as-coded was considered to be generally and reasonably reliable.

Future Study Opportunities in CEO Compensation

In addition to a balanced scorecard study discussed above, one could study the environmental conditions under which market for corporate control mechanism, among other control mechanisms, is broken down, as it was noted in the discussion of the results of the diversification extension that the mechanism of corporate control could have been usurped under two environmental conditions under which the acquisitive conglomerate was worst in profitability but not worst in longevity. More specifically, an extension of a diversification extension could be written that explicitly models the mechanisms of corporate control under one payrule, the agency payrule. This extension could also model CEOs as separate agents with their own separate characteristics, which are hired and fired by organizations. This additional layer of complexity might, however, have to wait a year or two until computer technology can accommodate the complexity without adding to the computation times of the simulations conducted in this study. However, once individual CEO behavior can be modeled, so can the (un)ethical behavior, so not only is the potential contribution to agency theory, but it also might contribute to the ethics literature on CEO behavior as follows. Certainly, there are unethical responses that each CEO might have after being rewarded under any of the four payrules modeled in this study. CEOs could be identified as “unethical” or “ethical” according to one of

each CEO's characteristics, with the "unethical" CEOs coded to behave in a different way from the "ethical" CEOs according to different rationales. Alternatively, or additionally, CEOs could be programmed to follow different modes of ethical development, such as the application of the golden rule, or objectivist learning. Industry effects and changes in agent successfulness could be observed and compared across different environments.

CHAPTER 9. SUMMARY AND CONCLUSION

This paper contributes to a number of fields in a number of ways. First, it contributes to the field of COT by suggesting that the modeling of organizations in this field have been needlessly simple, and that computer simulation can contribute more to the real world when these simulations are more complex, even if the rules programmed remain simple. Further, it demonstrates that studies rooted in COT can contribute to OT once the analysis is made simple and relevant to issues prevalent in OT. Second, this study contributes to the field of OT by broadening and extending the concept of contingency to include any organizational characteristic, by identifying certain trends in organizational characteristic under more harsh environments, and by proposing a number of antecedents to organizational longevity. Third, this study contributes to the field of strategic management by developing a contingency theory of diversification, by siding with those researchers who have observed and theorized that related diversification performs better than unrelated diversification, and justifying the recent loosening of securities regulations by finding that economies do better with related diversifiers than with only single businesses. Finally, this work contributes to the field of corporate governance by developing a contingency theory for the emphasis of agency and stakeholder payrules as compared to stakeholder and strategic fit payrules which suggests that agency and stakeholder perspectives might be increased somewhat under harsher environmental conditions.

This work suggests a direction of future research that combines the fruit of computational studies with that of real-world studies. It contends that the scientific method cannot proceed readily enough without the combined efforts of computational and real-world researchers. In the scientific method, a field of research proceeds by the preponderance of tested hypotheses by real-world researchers, but that testing cannot be performed on hypotheses that are not known; such

hypotheses can be developed by the computational researcher, given that she creates sufficiently complex models and sufficiently simple analyses to make her results reasonably interesting and relevant to her real-world counterparts. It is hoped that this work revitalizes the connection between computational and real-world research which has been used too sparsely in the fields of strategic management and organization theory.

GLOSSARY OF TERMS

Agent

Used in Computational Organization Theory, the decision-making object in the computer simulation; this approach to simulating organizations is termed “multi-agent simulation,” where each simulation-world “agent” represents a real-world organization.

Agency

The perspective from the fields of economics and strategic management that assumes a separation between corporate owner (the “principal”) and management (the “agent”). In order to avoid confusion with the term “agent” used in “multi-agent simulation” (see “agent” term above), the term “agency,” but never “agent,” has been used in reference to the agency theory perspective.

Agency Payrule

The CEO payrule that is based on the Agency perspective and on the principle of the pay package point drift. If this rule is used, then the CEO receives a random increase in pay over the previous period.

Baseline

Used in COT, the baseline is a skeleton of code upon which extensions are built. A common approach to meaningful research in COT is to first construct a validated baseline, and then extend it to study some organizational problem. This is the approach taken in this study.

Benevolence

Used in OT, it describes an environment that is relatively easy to survive in, along all three environmental dimensions of munificence, dynamism, and complexity. Thus, a

benevolent environment is one that is simultaneously high in munificence and low in dynamism and complexity. This term is equivalent to the term “least harsh” which has been used frequently in the Results and Analysis section.

Bias

A term used in the enactment perspective, generally refers to the inherent, psychological bias that organizational members possess with regard to their functional background and also toward searching their environments.

Contingency

A term used in OT which suggests that structural organizational variables such as formalism, centralization, and specialization adjust to environmental conditions, such as dynamism, complexity and munificence, at multiple levels of analysis, such as departmental, divisional, and organizational. This study liberalizes the use of the term toward the adjustment of any organizational characteristics, and considers adjustments of these characteristics only at the organizational and divisional levels of analysis.

Diversification

Used in Strategic Management, it describes the growth of a firm by internal growth, merger or acquisition. Diversification in the simulation has been restricted to the acquisition of one firm by another. Simulation rules for different diversification strategies are outlined in Algorithm 2.1.

Early Dead

Those agents which have died within the first 30 iterations of the simulation. In the Results and Analysis section, the early dead are compared with survivors in order to study ecological effects on simulation variables for different environments.

Equilibrium

Used in COT, it is the point at which further iterations are no longer necessary. Some COT simulations are terminated (and data is taken) only when the condition of the simulated agents has, on average, not changed appreciably. In the present study, equilibrium must be approximately reached before the simulation can be taken, and it was determined that at least 30 simulations were required before equilibrium was reached.

Extension

A term used in this study which is implied by much COT research, the extension is added to the baseline in order to study an organizational problem. The baseline is common to numerous studies while an extension is specific to a particular study.

Firm

A strategic management term used to refer to a for-profit oriented organization.

Fit

The perspective in Population Ecology which states that only the most “fit” organizations survive was modified by Strategic Choice advocates (in the field of Strategic Management), such as Aldrich (1979), who suggested that managers might change the fate of their organizations by making choices toward positioning their organizations so that their organizations might be selected for survival.

Fit Payrule

The CEO payrule that is based on the Fit perspective; if this rule is used, then the CEO receives an amount of pay in proportion to the relative success of the diversification strategy for that landscape as determined by the prior diversification strategy.

HQBU

Acronym for the “headquarters business unit.” This is an agent which, during simulation, acquires other agents to form a multidivisional organization. HQBUs are allowed to acquire up to 30 agents and treat them as “subsidiaries.”

Harshness

Used in OT, it is opposite in meaning from benevolence and describes an environment that is relatively difficult to survive in, along all three environmental dimensions of munificence, dynamism, and complexity. Thus, a harsh environment is one that is simultaneously low in munificence and high in dynamism and complexity.

Iteration

A COT term which refers to the number of cycles that a simulation is run through. The study herein used 50 iterations of each simulation program.

i, j, and k

Simulation variables which, in combination set a unique environment for each simulated landscape. Each variable had a range of only 3 numbers, 1 (the low condition), 2 (the moderate condition), and 3 (the high condition). The variable “i” was used for the munificence setting, “j” for the dynamism setting, and “k” for the complexity setting.

Landscape

The modeled “space” in this simulation study upon which agents were placed. This study used 27 landscapes with different combinations of environmental parameters, each consisting of a “chessboard” with 22x22 squares. Landscape rules are (1) that only one agent can occupy any single location at any time, and (2) agents cannot move off the landscape. The landscape in the simulation world can be seen as an industry in the real

world, where industry members have been mapped according to two industry-idiosyncratic dimensions that all members use to compete against each other, after Porter (1985).

m

Simulation counting variable which counts through the number of agents in the landscape. Thus, many loops in the simulation code include i, j, k (counts through landscapes), and m (counts through agents), and many agent characteristic variables are referenced with these four variables; for example, MOVE[i,j,k,m] is the MOVE characteristic of Agent m on landscape i,j,k, and its value in this case is 0, 1, or 2 (see MOVE below).

Organization

An OT term, like a “firm”, but also includes not-for-profit organizations.

Pay Package Point Drift

The idea developed in this work that a stable package point position cannot be assumed under agency theory.

Payrule Proportion

In the CEO compensation extension, in each iteration, each agent pays its CEO according to a payrule. The Payrule Proportion is the proportion of iterations with which a particular CEO payrule is used. There are two proportions, one assigned to both the agency and stewardship payrules (the agency proportion = 1 – the stewardship proportion) and one assigned to both the stakeholder and fit payrules (the stakeholder proportion = 1 – the fit proportion).

Performance

The apparent goal of a for-profit organization (firm). In the simulation, performance is measured by the amount of PROFIT has been gained or lost by the agents at the end of the simulation.

RAND

Refers to a function in the algorithms which represent the generation of a random number. Among other things, random numbers are used to create variability among agent characteristics at simulation initialization. All random numbers were generated according to a uniform distribution (continuous or discrete, as needed) in order to maximize variability of agent characteristics. Other uses were for the resolution of moving to one of two equally-desirable squares across a landscape, and for the resolution of ranking two equally-desirable interaction (buying or selling) candidates.

SBU

Acronym standing for “strategic business unit.” While this is a real-world term referring to the divisions of a multi-divisional organizational structure, each with its own independent strategy and managed by a reasonably autonomous division leader, it is also used here as a simulation term that refers to an agent that has been acquired by an HQBU.

Simulation

A COT term that refers to a computer-run code for the purpose of studying real-world phenomena. In COT, simulations are applied to the study of organizations. Note that the type of simulation conducted in this study is of the type that does not entail human interaction; another type of simulation that has been conducted in COT is the type that requires human interaction in every iteration.

Stakeholder

The perspective in Strategic Management which claims that profit maximization is not the sole objective of the firm. Instead, profit may be forgone in order to satisfy the interests of stakeholders, especially those which are simultaneously powerful, urgent, and legitimate.

Stakeholder Payrule

The CEO payrule that is based on the Stakeholder perspective; if this rule is used, then the CEO receives an amount of pay in proportion to the average PROFIT of all the agents interacting with that agent during the iteration.

Stewardship

A perspective in corporate governance (strategic management) which assumes that managers feel responsible for stakeholder interests and thus there is no separation of interest between corporate ownership and management.

Stewardship Payrule

The CEO payrule that is based on the Stewardship perspective; if this rule is used, then the CEO receives an amount of pay in proportion to the agent's PROFIT gained in that iteration.

Survivors

Those agents which have not died before the final iteration of the simulation. In the Results and Analysis section, survivors are compared with the early dead in order to study ecological effects on simulation variables for different environments.

REFERENCES

- Agrawal, A., & Mandelker, G. N. (1987). Managerial incentives and corporate investment and financing decisions. Journal of Finance, 42(4), 823-837.
- Alchain, A. A. (1950). Uncertainty, evolution, and economic theory. Journal of Political Economy, 58(6), 211-221.
- Alderfer, C. P. (1972). Existence, relatedness, and growth: Human needs in organizational settings. New York, NY: Free Press.
- Aldrich, H. E. (1979). Organizations and Environments. Englewood Cliffs, NJ: Prentice-Hall.
- Aldrich, H. E., & Pfeffer, J. (1976). Environments of organizations. Annual Review of Sociology, 2, 79-105.
- Amburgey, T. L., Kelly, D., & Barnett, W. P. (1993). Resetting the clock: The dynamics of organizational change and failure. Administrative Science Quarterly, 38(1), 51-73.
- Amburgey, T. L., & Rao, H. (1996). Organizational ecology: Past, present, and future directions. Academy of Management Journal, 39(5), 1265-1286.
- Amihud, Y., & Lev, B. (1981). Risk reduction as a managerial motive for conglomerate mergers. Bell Journal of Economics, 12(2), 605-617.
- Amihud, Y., & Lev, B. (1999). Does corporate ownership structure affect its strategy towards diversification? Strategic Management Journal, 20(11), 1063-1069.
- Ansoff, I. (1965). Corporate Strategy. New York, NY: McGraw Hill.
- Aragon-Correa, J. A., & Sharma, S. (2003). A contingent resource-based view of proactive corporate environmental strategy. Academy of Management Review, 28(1), 71-88.
- Arrow, K. (1963). Research in management controls: A critical synthesis. C. Bonini, R. Jaediche, & H. Wagner (Eds.), Management controls: New directions in Basic Research

- (pp. 317-327). New York, NY: McGraw-Hill.
- Axelrod, R. (1980a). Effective choice in the prisoner's dilemma. Journal of Conflict Resolution, 24(1), 3-25.
- Axelrod, R. (1980b). More effective choice in the prisoner's dilemma. Journal of Conflict Resolution, 24(3), 379-403.
- Axelrod, R. (1987). The evolution of strategies in the iterated prisoner's dilemma. L. Davis (Ed.), Genetic algorithms and simulated annealing (pp. 32-41). Los Altos, CA: Morgan Kaufman.
- Bak, R. (2003). Henry and Edsel: The Creation of the Ford Empire. Hoboken, NJ: John Wiley & Sons.
- Baker, D. D., & Cullen, J. B. (1993). Administrative reorganization and configurational context: The contingent effects of age, size, and change in size. Academy of Management Journal, 36(6), 1251-1277.
- Barnard, C. I. (1938). The Functions of the Executive. Cambridge, MA: Harvard University Press.
- Barney, J. B., & Hesterly, W. S. (2006). Strategic Management and Competitive Advantage. Upper Saddle River, NJ: Pearson Prentice Hall.
- Barron, D. N. (2000). Simulating the dynamics of organizational populations: A comparison of three models of organizational entry, exit, and growth. A. Lomi, & E. R. Larsen Dynamics of organizations: Computational modeling and organization theories (pp. 209-242). Menlo Park, CA: AAAI Press/The MIT Press.
- Bartlett, C. A., & Ghoshal, S. (1987). Managing across borders: New strategic requirements. Sloan Management Review, 28(4), 7-17.

- Battiti, R. (1996). Reactive search: Toward self-tuning heuristics. V. J. Rayward-Smith, I. H. Osman, C. R. Reeves, & G. D. Smith (Editor), Modern Heuristic Search Methods (pp. 61-83). Chichester, West Sussex, England: Wiley.
- Baum, J. A. C., & Oliver, C. (1996). Toward an institutional ecology of organizational founding. Academy of Management Journal, 39(5), 1378-1427.
- Baum, J. A. C., & Singh, J. V. (Eds.). (1994). Evolutionary dynamics of organizations. New York, NY: Oxford University Press.
- Berle, A., & Means, G. (1932). The modern corporation and private property. Chicago, IL : Commerce Clearing House.
- Berry, C. H. (1975). Corporate growth and diversification. Princeton, NJ: Princeton University Press.
- Bettis, R. A. (1981). Performance differences in related and unrelated diversified firms. Strategic Management Journal, 2(4), 379-393.
- Bettis, R. A., & Hall, E. H. (1982). Diversification strategy, accounting determined risk, and accounting determined return. Academy of Management Journal, 25(2), 254-264.
- Bettis, R. A., Hall, E. H., & Prahalad, C. K. (1978). Diversity and performance in the multibusiness firm. National proceedings of the American Institute for Decision Sciences (pp. 210-212). American Institute for Decision Sciences.
- Bettis, R. A., & Mahajan, V. (1985). Risk/return performance of diversified firms. Management Science, 31 (7), 785-813.
- Bettis, R. A., & Prahalad, C. K. (1995). The dominant logic: Retrospective and extension. Strategic Management Journal, 16(1), 5-14.
- Birkinshaw, J., & Gibson, C. B. (2004). Building ambidexterity into an organization. MIT Sloan

Management Review, 45(4), 47-55.

Blair, M. M. (1995). Ownership and control. Washington, D.C.: The Brookings Institution .

Blau, P. M. (1956). Bureaucracy in Modern Society. New York, NY: Random House.

Blau, P. M., & Meyer, M. W. (1971). Bureaucracy in Modern Society. 3rd ed.,). New York, NY: Random House.

Blau, P. M., & Shoenherr, R. A. (1971). The Structure of Organizations. New York, NY: Basic Books.

Bonini, C. P. (1963). Simulation of information and decision systems in the firm. Englewood Cliffs, NJ: Prentice-Hall.

Bothner, M. S., & White, H. C. (2000). Market orientation and monopoly power. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational modeling and organization theories (pp. 181-208). Menlo Park, CA: AAAI Press/ The MIT Press.

Boulding, K. E. (1950). A Reconstruction of Economics. New York, NY: Wiley & Sons.

Bourgeois, L. J. I. (1985). Strategic goals, perceived uncertainty, and economic performance in volatile environments. Academy of Management Journal, 28(3), 548-573.

Bowman, E. H., & Helfat, C. E. (2001). Does Corporate Strategy Matter? Strategic Management Journal, 22(1), 1-23.

Boyd, B. K., Gove, S., & Hitt, M. A. (2005). Consequences of measurement problems in strategic management research: The case of Amihud and Lev. Strategic Management Journal, 26(4), 267-375.

Brandeis, L. D. (Statement). (1911). Statement of Louis D. Brandeis, Esq., Attorney at Law, of Boston, Mass. Committee on Interstate Commerce, 62nd Congress of the United States Senate.

- Brandenburger, A. M., & Nalebuff, B. J. (1996). Co-opetition. New York, NY: Doubleday.
- Brockmann, E. N., Hoffman, J. J., & Dawley, D. D. (2006). A contingency theory of CEO successor choice and post-bankruptcy strategic change. Journal of Managerial Issues, 18(2), 213-233.
- Brown, G., Lawrence, T. B., & Robinson, S. L. (2005). Territoriality in organizations. Academy of Management Review, 30(3), 577-594.
- Brown, S. L., & Eisenhardt, K. M. (1998). Competing on the edge. Boston, MA: Harvard Business School Press.
- Bruderer, E., & Singh, J. V. (1996). Organizational evolution, learning, and selection: A genetic algorithm-based model. Academy of Management Journal, 39(5), 1322-1349.
- Bryce, R. (2003). Pipe dreams and the death of Enron. New York: Public Affairs.
- Burns, T., & Stalker, G. M. (1961). The Management of Innovation. Oxford, England: Oxford University Press.
- Burton, R. M. (2000). Afterword. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational modeling and organization theories (pp. 439-444). Menlo Park, CA: AAI Press/ The MIT Press.
- Busija, E. C., O'Neill, H. M., & Zeithaml, C. P. (1997). Diversification strategy, entry mode, and performance: Evidence of choice and constraints. Strategic Management Journal, 18(4), 321-327.
- Carley, K. M. (1996). A comparison of artificial and human organizations. Journal of Economic Behavior & Organization, 31, 175-191.
- Carley, K. M. (1999). On generating hypotheses using computer simulations. Systems Engineering, 2(2), 69-77.

- Carley, K. M. (2000). Organizational adaptation in volatile environments. D. R. Ilgen, & C. L. Hulin (Eds.), Computational modeling of behavior in organizations: The third scientific discipline (pp. 241-268). Washington, DC: American Psychological Association.
- Carley, K. M., & Prietula, M. J. (1998). WebBots, trust, and organizational science. M. J. Prietula, K. M. Carley, & L. Gasser (Eds.), Simulating Organizations: Computational models of institutions and groups (pp. 3-22). Menlo Park, CA: AAAI Press/ The MIT Press.
- Castrogiovanni, G. J. (1991). Environmental munificence: A theoretical assessment. Academy of Management Review, 16(3), 542-565.
- Chandler, A. D. (1962). Strategy and structure: Chapters in the history of the industrial enterprise. Cambridge, MA: MIT Press.
- Channon, D. F. (1975). The strategy and structure of British enterprise. London: Macmillan.
- Chatterjee, S. (1986). Types of synergy and economic value: The impact of acquisitions on merging and rival firms. Strategic Management Journal, 7(2), 119-139.
- Chatterjee, S., & Wernerfelt, B. (1991). The link between resources and the type of diversification: Theory and evidence. Strategic Management Journal, 12(1), 33-48.
- Chen, B., & Munson, C. L. (2004). Resource allocation with lumpy demand: To speed or not to speed? Naval Research Logistics, 51(3), 363-385.
- Chen, M. J. (1996). Competitor analysis and interfirm rivalry: Toward a theoretical integration. Academy of Management Review, 21(1), 100-134.
- Chen, M. J., & Miller, D. (1994). Competitive attack, retaliation, and performance. Strategic Management Journal, 15(2), 85-102.
- Child, J. (1972). Organizational structure, environment, and performance: The role of strategic

- choice. Sociology, 6, 2-22.
- Child, J. (1974). Managerial and organizational factors associated with company performance - Part I. Journal of Management Studies, 11, 175-189.
- Child, J. (1975). Managerial and organizational factors associated with company performance - Part II. Journal of Management Studies, 12, 12-27.
- Cohen, J. (1992). A power primer. Psychological Bulletin, 112(1), 155-159.
- Conger, J., Lawler, E., & Finegold, D. (2001). Corporate boards. San-Francisco, CA: Jossey-Bass.
- Corimer, S., & Hagman, J. (1987). Transfer of learning: Contemporary research and applications. San Deigo, CA: Academic Press.
- Cyert, R. M., Feigenbaum, E. A., & March, J. G. (1971). Models in a behavioral theory of the firm. J. M. Dutton, & W. H. Starbuck (Eds.), Computer simulation of human behavior (pp. 246-259). New York, NY: John Wiley & Sons.
- Cyert, R. M., Kang, S., & Kumar, P. (2002). Corporate governance, takeovers, and top-management compensation: Theory and evidence. Management Science, 48(4), 453-469.
- Cyert, R. M., & March, J. G. (1963). A Behavioral Theory of the Firm. Englewood Cliffs, NJ: Prentice-Hall.
- Cyert, R. M., March, J. G., & Moore, C. G. (1971). Price and output determination in a retail department store. J. M. Dutton, & W. H. Starbuck (Eds.), Computer simulation of human behavior (pp. 194-208). John Wiley & Sons.
- D'Aveni, R. A. (1994). Hypercompetitive rivalries: Competing in highly dynamic environments. New York, NY: Free Press.
- Dacin, T. M., Goodstein, J., & Scott, R. W. (2002). Institutional theory and institutional change:

- Introduction to the special research forum. Academy of Management Journal, 45(1), 45-57.
- Daily, C. M., Dalton, D. R., & Cannella, A. A. (2003). Corporate governance: Decades of dialogue and data. Academy of Management Review, 28(3), 317-382.
- Danneels, E. (2003). Tight-loose coupling with customers: The enactment of customer orientation. Strategic Management Journal, 24(6), 559-576.
- David, F. R. (1997). Strategic Management. Upper Saddle River, NJ: Prentice Hall.
- Davis, J. H., Schoorman, F. D., & Donaldson, L. (1997). Toward a stewardship theory of management. Academy of Management Review, 22(1), 20-47.
- Dean, A., & Voss, D. (1999). Design and Analysis of Experiments. New York, NY: Springer-Verlag.
- Deephouse, D. L. (1996). Does isomorphism legitimate? Academy of Management Journal, 39(4), 1024-1039.
- Delacroix, J., & Swaminathan, A. (1991). Cosmetic, speculative, and adaptive organizational change in the wine industry: A longitudinal study. Administrative Science Quarterly, 36(4), 631-660.
- Denis, D. D., Denis, D. K., & Sarin, A. (1999). Agency theory and the influence of equity ownership structure on corporate diversification strategies. Strategic Management Journal, 20(11), 1071-1076.
- Denis, D. J., Denis, D. K., & Sarin, A. (1997). Agency problems, equity ownership, and corporate diversification. Journal of Finance, 52(1), 135-160.
- Dess, G. G., & Beard, D. W. (1984). Dimensions of organizational task environments. Administrative Science Quarterly, 29(1), 52-73.

- Dewing, A. S. (1911). The United States Leather Company and its reorganization. Quarterly Journal of Economics, 26(1), 68-104.
- Dewing, A. S. (1917). The law of balanced return. The American Economic Review, 7(4), 755-771.
- Dewing, A. S. (1921). A statistical test of the success of consolidations. Quarterly Journal of Economics, 36(1), 84-101.
- Dill, W. R. (1958). Environments as an influence on managerial autonomy. Administrative Science Quarterly, 2, 409-443.
- Dimaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American Sociological Review, 48, 147-160.
- Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. Academy of Management Review, 20(1), 65-91.
- Drazin, R., & Van de Ven, A. H. (1985). Alternative forms of fit in contingency theory. Administrative Science Quarterly, 30, 514-539.
- Dubin, R. (1978). Theory Development. New York, NY: Free Press.
- Duncan, R. B. (1972). Characteristics of organizational environments and perceived environmental uncertainty. Administrative Science Quarterly, 17, 313-327.
- Dutton, J. M., & Starbuck, W. H. (1971a). Computer Simulation of Human Behavior. New York, NY: John Wiley & Sons.
- Dutton, J. M., & Starbuck, W. H. (1971b). The plan of the book. J. M. Dutton, & W. H. Starbuck (Eds.), Computer Simulation of Human Behavior (pp. 3-8). New York, NY: John Wiley & Sons.

- Edmonds, B. (1998). Modeling socially intelligent agents. Applied Artificial Intelligence, 12, 677-699.
- Eisenhardt, K. M. (1989). Agency theory: An assessment and a review. Academy of Management Review, 14(1), 57-74.
- Elgers, P. T., & Clark, J. J. (1980). Merger types and shareholder returns: Additional evidence. Financial Management, 9(2), 66-72.
- Elloumi, F., & Gueyié, J. P. (2001). CEO compensation, IOS and the role of corporate governance. Corporate Governance, 1(2), 23-33.
- Emery, F. E., & Trist, E. (1965). The causal texture of organizational environments. Human Relations, 18, 21-31.
- Epstein, J. M., & Axtell, R. (1996). Growing artificial societies: Social science from the bottom up. Washington, D.C.: Prookings Institutions Press.
- Eslick, D. F. (Statement). (1970). The Conglomerate Merger Problem. 91st U.S. Congress, Senate Committee on the Judiciary 2d sess: Antitrust and Monopoly.
- Fama, E. F. (1980). Agency problems and the theory of the firm. The Journal of Political Economy, 88(2), 288-307.
- Farjoun, M. (2002). Towards an organic perspective on strategy. Strategic Management Journal, 23(7), 561-594.
- Fayol, H. (1949). General and Industrial Management (First English Edition). London: Sir Isaac Pitman & Sons.
- Federico, P. A., & Figliozzi, P. W. (1981). Computer-simulation of social systems. Sociological Methods and Research, 9(4), 513-533.
- Finkelstein, S., & D'Aveni, R. A. (1994). CEO duality as a double-edged sword: How boards of

- directors balance entrenchment avoidance and unity of command. Academy of Management Journal, 37(5), 1079-1108.
- Finkelstein, S., & Halebian, J. (2002). Understanding acquisition performance: The role of transfer effects. Organization Science, 13(1), 36-47.
- Frankforter, S. A., Berman, S. L., & Jones, T. M. (2000). Boards of directors and shark repellants: Assessing the value of an agency theory perspective. Journal of Management Studies, 37(3), 321-348.
- Friedman, M. (1963). Capitalism and Freedom. Chicago, IL: University of Chicago Press.
- Galbraith, J. (1973). Designing Complex Organizations. Reading, MA: Addison-Wesley.
- Gibson, C. B., & Birkinshaw, J. (2004). The antecedents, consequences, and mediating role of organizational ambidexterity. Academy of Management Journal, 47(2), 209-226.
- Gilbert, N., & Troitzsch, K. G. (Eds.). (1999). Simulation for the social scientist. Philadelphia, PA: Open University Press.
- Gilbreth, F. B., & Gilbreth, L. M. (1917). Applied Motion Study. New York, NY: Sturgis and Walton Co.
- Ginsberg, A. (1990). Connecting diversification to performance. Academy of Management Review, 15(3), 514-535.
- Glover, F. (1990). Tabu search: A tutorial. Interfaces, 20(4), 74-94.
- Golden, B. R., & Zajac, E. J. (2001). When will boards influence strategy? Inclination x power = strategic change. Strategic Management Journal, 22(12), 1087-1111.
- Goodstein, J. D. (2002). An integrity-based perspective on corporate boards. Working Paper.
- Gort, M. (1962). Diversification and integration in American Industry. Princeton, NJ: Princeton University Press.

- Grant, R. M., Jammine, A. P., & Thomas, H. (1988). Diversity, diversification, and profitability among British manufacturing companies, 1972-84. Academy of Management Journal, 31(4), 771-801.
- Griffin, J. M., & Wiggins, S. N. (1992). Takeovers: Managerial incompetence or managerial shirking? Economic Inquiry, 30(2), 355-371.
- Hall, E. H., St. John, & Caron H. (1994). A methodological note on diversity measurement. Strategic Management Journal, 15(2), 153-168.
- Hambrick, D. C., & Cannella, A. A. (2004). CEOs who have COOs: Contingency analysis of an unexplored structural form. Strategic Management Journal, 25(10), 959-979.
- Hambrick, D. C., & Mason, P. A. (1984). Upper echelons: The organization as a reflection of its top managers. Academy of Management Review, 9(2), 193-206.
- Hannan, M. T., & Freeman, J. H. (1977). The population ecology of organizations. American Sociological Review, 82, 929-964.
- Hannan, M. T., & Freeman, J. H. (1984). Structural inertia and organizational change. American Sociological Review, 49, 149-164.
- Hannan, M. T., & Freeman, J. H. (1989). Organizational ecology. Cambridge, MA: Cambridge University Press.
- Harrison, J. R., & Carroll, G. R. (1991). Keeping the faith: A model of cultural transmission in formal organizations. Administrative Science Quarterly, 36(4), 552-582.
- Harrison, J. R., & Carroll, G. R. (2000). Modeling culture in organizations: Formulation and extension to ecological issues. A. Lomi, & E. R. Larsen (Eds.), Dynamics of Organizations: Computational Modeling and Organization Theories (pp. 37-62). Menlo Park, CA: AAAI Press/ The MIT Press.

- Hawks, T. E. (1984). Strategic diversification and economic performance: An empirical examination of security market determined measures of performance. Strategic Management Society Annual Conference.
- Hayashi, A. M. (2001). When to trust your gut. Harvard Business Review, 79(2), 59-65.
- He, Z.-L., & Wong, P.-K. (2004). Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. Organization Science, 15(4).
- Helfat, C. E., & Eisenhardt, K. M. (2004). Inter-temporal economies of scope, organizational modularity, and the dynamics of diversification. Strategic Management Journal, 25(13), 1217-1232.
- Henderson, A. (1954). The theory of duopoly. The Quarterly Journal of Economics, 68(4), 565-584.
- Henderson, B. (1970). The Product Portfolio. Boston, MA: Boston Consulting Group.
- Henderson, B. (1979). Henderson on Corporate Strategy. New York, NY: New American Library.
- Hickson, D. J., Hinings, C. R., Lee, C. A., Schneck, R. E., & Pennings, J. M. (1971). A strategic contingencies theory of intraorganizational power. Administrative Science Quarterly, 16, 216-229.
- Hirsch, P. M. (1975). Organizational effectiveness and the institutional environment. Administrative Science Quarterly, 20(3), 327-344.
- Hitt, M. A., Hoskisson, R. E., & Kim, H. (1997). International diversification: Effects on innovation and firm performance in product-diversified firms. Academy of Management Journal, 40(4), 767-798.
- Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2005). Strategic Management: Competitiveness

- and Globalization. Mason, OH: South-Western.
- Hofer, C. W., & Schendel, D. (1978). Strategy Formulation: Analytical Concepts. St. Paul, MN: West.
- Holland, J. H. (1975). Adaptation in Natural and Artificial Systems. Ann Arbor, MI: University of Michigan Press.
- Holmstrom, B., & Tirole, J. (1994). Financial intermediation, loanable funds, and the real sector. The Journal of Political Economy, 112(3), 663-692.
- Hoskisson, R. E., & Hitt, M. A. (1990). Antecedents and performance outcomes of diversification: A review and critique of theoretical perspectives. Journal of Management, 16(2), 461-509.
- Hoskisson, R. E., Hitt, M. A., Johnson, R. A., & Moesel, D. D. (1993). Construct validity of an objective (entropy) categoric measure of diversification strategy. Strategic Management Journal, 14(3), 215-235.
- Hough, J. R., & White, M. A. (2003). Environmental dynamism and strategic decision-making rationality: An examination at the decision level. Strategic Management Journal, 24(5), 481-489.
- Hough, J. R., & White, M. A. (2004). Scanning actions and environmental dynamism: Gathering information for strategic decision making. Management Decision, 42(6), 781-793.
- Ingram, P., & Silverman, B. S. (2002). The New Institutionalism in Strategic Management. P. Ingram, & B. S. Silverman (Eds.), The New Institutionalism in Strategic Management (Vol. 19pp. 1-32). Greenwich, CT: JAI Press.
- Ireland, R. D., & Miller, C. C. (2004). Decision-making and firm success. Academy of Management Executive, 18(4), 8-12.

- Jacquemin, A. P., & Berry, C. H. (1979). Entropy measure of diversification and corporate growth. Journal of Industrial Economics, 27(4), 359-369.
- Janney, J. J., & Dess, G. G. (2004). Can real-options analysis improve decision-making? Promises and pitfalls. Academy of Management Executive, 18(4), 60-75.
- Jeffries, F. L., & Reed, R. (2000). Trust and adaptation in relational contracting. Academy of Management Review, 25(4), 873-883.
- Jensen, M. (1993). The modern industrial revolution, exit, and the failure of internal control systems. Journal of Finance, 48(3), 831-880.
- Jensen, M., & Zajac, E. J. (2004). Corporate elites and corporate strategy: How demographic preferences and structural position shape the scope of the firm. Strategic Management Journal, 25(6), 507-524.
- Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. American Economic Review, 76(2), 323-329.
- Jensen, M. C., & Meckling, W. (1976). Theory of the firm: Managerial behavior, agency costs, and ownership structure. Journal of Financial Economics, 3, 305-360.
- Johnson, D. R., & Hoopes, D. G. (2003). Managerial cognition, sunk costs, and the evolution of industry structure. Strategic Management Journal, 24(10), 1057-1068.
- Jones, M. T. (2003). AI Application Programming. Hingham, MA: Charles River Media.
- Jose, M. L., Nichols, L. M., & Stevens, J. L. (1986). Contributions of diversification, promotion, and R&D to the value of multiproduct firms: A Tobin's q approach. Financial Management, 15(4), 33-42.
- Jurkovich, R. (1974). A core typology of organizational environments. Administrative Science Quarterly, 19, 380-394.

- Ketchen, D. J., Snow, C. C., & Street, V. L. (2004). Improving firm performance by matching atrategic decision-making processes to competitive dynamics. Academy of Management Executive, 18(4), 29-43.
- Ketokivi, M. (2006). Elaborating the contingency theory of organizations: The case of manufacturing flexibility strategies. Production and Operations Management, 15(2), 215-218.
- King, D. R., Covin, J. G., & Hegarty, W. H. (2003). Complementary resources and the exploitation of technological innovations. Journal of Management, 29(4), 589-606.
- King, D. R., Dalton, D. R., Daily, C. M., & Covin, J. G. (2004). Meta-analysis of post-acquisition performance: Indications of unidentified moderators. Strategic Management Journal, 25(2), 187-200.
- Koberg, C. S. (1987). Resource scarcity, environmental uncertainty, and adaptive organizational behavior. Academy of Management Journal, 30(4), 798-807.
- Kogut, B., Walker, G., & Anand, J. (2002). Agency and institutions: National divergences in diversification behavior. Organization Science, 13(2), 162-178.
- Kosnik, R. (1987). Greenmail: A study in board performance in corporate governance. Administrative Science Quarterly, 32(2), 163-185.
- Koufteros, X., Vonderembse, M., & Jayaram, J. (2005). Internal and external integration for product development: The contingency effects of uncertainty, equivocality, and platform strategy. Decision Sciences, 36(1), 97-133.
- Kraatz, M. S., & Moore, J. H. (2002). Executive migration and institutional change. Academy of Management Journal, 45(1), 120-143.
- Krackhardt, D. (2000a). Comment: Modeling structures of organizations. D. R. Ilgen, & C. L.

- Hulin (Eds.), Computational Modeling of Behavior in Organizations: The Third Scientific Discipline (pp. 269-273). Washington, DC: American Psychological Association.
- Krackhardt, D. (2000b). Viscosity models and the diffusion of controversial innovation. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational Modeling and Organization Theories (pp. 243-267). Menlo Park, CA: AAAI Press/ The MIT Press.
- Kuhn, T. S. (1996). The structure of scientific revolutions (3rd ed.). Chicago, IL: The University of Chicago Press.
- Kulik, B. W. (2005). Agency theory, reasoning, and culture: In search of a solution. Journal of Business Ethics, 59(4), 347-360.
- Laffont, J. J., & Martimort, D. (2002). The theory of incentives: The principal-agent model. Princeton, NJ: Princeton University Press.
- Lane, P. J., Cannella, A. A., & Lubatkin, M. (1998). Agency problems as antecedents to unrelated mergers and diversification: Amihud and Lev reconsidered. Strategic Management Journal, 19(6), 555-578.
- Lane, P. J., Cannella, A. A., & Lubatkin, M. (1999). Ownership structure and corporate strategy: One question viewed from two different worlds. Strategic Management Journal, 20(11), 1077-1086.
- Law, A. M., & Kelton, W. D. (2000). Simulation modeling and analysis. (3rd ed.). New York, NY: McGraw Hill.
- Lawrence, P. R., & Lorsch, J. W. (1967). Organization and Environment: Managing Differentiation and Integration. Boston, MA: Harvard Business School Press.
- Lee, J., Lee, K., & Rho, S. (2002). An evolutionary perspective on strategic group emergence: A

- genetic algorithm-based model. Strategic Management Journal, 23(8), 727-746.
- Lee, J., Lee, J., & Lee, H. (2003). Exploration and exploitation in the presence of network externalities. Management Science, 49(4), 553-570.
- Levinthal, D. (1994). Surviving Schumpeterian environments: An evolutionary perspective. J. A. C. Baum, & J. V. Singh (Eds.), The evolution of evolution (pp. 167-178). New York, NY: Oxford University Press.
- Levinthal, D. A. (2000). Modeling adaptation on rugged landscapes. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational modeling and organization theories (pp. 329-348). Menlo Park, CA: AAAI Press/ The MIT Press.
- Lewandowsky, S. (1993). The rewards and hazards of computer simulations. Psychological Science, 4(4), 236-243.
- Liebeskind, J. P. (2000). Internal capital markets: Benefits, costs, and organizational arrangements. Organization Science, 11(1), 58-76.
- Lin, Z. (1998). The choice between accuracy and errors: A contingency analysis of external conditions and organizational decision making performance. M. J. Prietula, K. M. Carley, & L. Gasser (Eds.), Simulating Organizations: Computational models of institutions and groups (pp. 67-87). Menlo Park, CA: AAAI Press/ The MIT Press.
- Lipsett, S. M., Trow, M., & Coleman, J. S. (1956). Union democracy. Glencoe: Free Press.
- Livermore, S. (1935). The success of industrial mergers. Quarterly Journal of Economics, 50(1), 68-96.
- Loch, C. H., Huberman, B. A., & Ulku, S. (2000). Multi-dimensional status competition and group performance. A. Lomi, & E. R. Larsen (Eds.), Dynamics of Organizations: Computational Modeling and Organization Theories (pp. 119-140). Menlo Park, CA:

AAAI Press/ The MIT Press.

Lomi, A., & Larsen, E. R. (1996). Interacting locally and evolving globally: A computational approach to the dynamics of organizational populations. Academy of Management Journal, 39(4), 1287-1321.

Lomi, A., & Larsen, E. R. (Eds.). (2000a). Dynamics of Organizations: Computational Modeling and Organization Theories. Menlo Park, CA: AAAI Press/ The MIT Press.

Lomi, A., & Larsen, E. R. (2000b). Failure as a structural concept: A computational perspective on age dependence in organizational mortality rates. A. Lomi, & E. R. Larsen (Eds.), Dynamics of Organizations: Computational Modeling and Organization Theories (pp. 269-303). Menlo Park, CA: AAAI Press/ The MIT Press.

Lubatkin, M. (1987). Merger strategies and stockholder value. Strategic Management Journal, 8(1), 39-59.

Lubatkin, M., & Chatterjee, S. (1991). The strategy-shareholder value relationship: Testing temporal stability across market cycles. Strategic Management Journal, 12(4), 251-270.

Lubatkin, M., & Chatterjee, S. (1994). Extending modern portfolio theory into the domain of corporate diversification: Does it apply? Academy of Management Journal, 37(1), 109-136.

Lubatkin, M., & Rogers, R. C. (1989). Diversification, systematic risk, and shareholder return: A capital market extension of Rumelt's study. Academy of Management Journal, 32(2), 454-465.

Luffman, G. A., & Reed, R. (1982). Diversification in British Industry in the 1970s. Strategic Management Journal, 3(4), 303-314.

Luffman, G. A., & Reed, R. (1984). The Strategy and Performance of British Industry, 1970-80.

- New York, NY: St. Martin's Press.
- Macy, M. W., & Strang, D. (2000). Dedicated followers of success: A computational model of fashionable innovation. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational modeling and organization theories (pp. 93-117). Menlo Park, CA: AAAI Press/ The MIT Press.
- Malerba, F., Nelson, R., Orsenigo, L., & Winter, S. (2000). Product diversification in a "history friendly" model of the evolution of computer industry. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational modeling and organization theories (pp. 350-375). Menlo Park, CA: AAAI Press/ The MIT Press.
- March, J. G. (1994). The evolution of evolution. J. A. C. Baum, & J. V. Singh (Eds.), Evolutionary Dynamics of Organizations (pp. 39-49). New York, NY: Oxford University Press.
- March, J. G. (2000). Foreword. A. Lomi, & E. R. Larsen (Eds.), Dynamics of Organizations: Computational Modeling and Organization Theories (p. ix-xvii). Menlo Park, CA: AAAI Press/ The MIT Press.
- March, J. G., & Simon, H. (1958). Organizations. Cambridge, MA: Blackwell.
- March, J. G., & Simon, H. (1993). Organizations. (2nd ed.). Cambridge, MA: Blackwell.
- Markides, C. C. (1995). Diversification, restructuring and economic performance. Strategic Management Journal, 16(2), 101-118.
- Markides, C. C., & Williamson, P. J. (1994). Related diversification, core competencies and corporate performance. Strategic Management Journal, 15(Special Issue), 149-165.
- Maslow, A. H. (1970). Motivation and Personality. New York, NY: Harper and Row.
- May, D. O. (1995). Do managerial motives influence firm risk reduction strategies? Journal of

- Finance, 50 (4), 1291-1308.
- Mayer, M., & Whittington, R. (2003). Diversification in context: A cross-national and cross-temporal extension. Strategic Management Journal, 24(8), 773-781.
- McClelland, D. C. (1975). Power: The inner experience. New York: Irvington.
- McGregor, D. (1966). Leadership and motivation. Cambridge, MA: MIT Press.
- Mezias, S. J., & Lant, T. K. (1994). Mimetic learning and the evolution of organizational populations. J. A. C. Baum, & J. V. Singh (Eds.), (pp. 179-198). New York, NY: Oxford University Press.
- Michel, A., & Shaked, I. (1989). Does business diversification affect performance? Financial Management, 13(4), 18-25.
- Miles, R. E., & Snow, C. C. (1978). Organizational Strategy, Structure, and Process. Stanford, CA: Stanford University Press.
- Miller, D. J. (2004). Firms' technological resources and the performance effects of diversification: A longitudinal study. Strategic Management Journal, 25(11), 1097-1119.
- Miller, J. H. (2000). Evolving information processing organizations. A. Lomi, & E. R. Larsen (Eds.), Dynamics of Organizations: Computational Modeling and Organization Theories (pp. 307-327). Menlo Park, CA: AAAI Press/ The MIT Press.
- Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. Academy of Management Review, 22(4), 853-886.
- Molden, D. C., & Higgins, E. T. (2004). Categorization under uncertainty: Resolving vagueness and ambiguity with eager versus vigilant strategies. Social Cognition, 22(2), 248-277.
- Montgomery, C. A. (1982). The measurement of firm diversification: Some new empirical

- evidence. Academy of Management Journal, 25(2), 299-307.
- Montgomery, C. A., & Hariharan, S. (1991). Diversified expansion by large established firms. Journal of Economic Behavior, 15(1), 71-89.
- Montgomery, C. A., & Wernerfelt, B. (1988). Diversification, Ricardian rents, and Tobin's q. RAND Journal of Economics, 19(4), 623-632.
- Mueller, D. C. (1977). The effects of conglomerate mergers: A survey of the empirical evidence. Journal of Banking and Finance, 1(4), 315-347.
- Nayyar, P. R. (1992). On the measurement of corporate diversification strategy: Evidence from large U.S. service firms. Strategic Management Journal, 13(3), 219-235.
- Nelson, R. R., & Winter, S. G. (1982). An Evolutionary Theory of Economic Change. Cambridge, MA: Harvard University Press.
- Nottenburg, G., & Fedor, D. B. (1983). Scarcity in the environment: Organizational perceptions, interpretations and responses. Organization Studies, 4(4), 317-337.
- Nutt, P. C. (1998). Evaluating complex strategic choices. Management Science, 44(8), 1148-1166.
- Nutt, P. C. (2004). Expanding the search for alternatives during strategic decision-making. Academy of Management Executive, 18(4), 13-28.
- Oliver, C. (1992). The antecedents of deinstitutionalization. Organization Studies, 13, 563-588.
- Oliver, C. (1997a). The influence of institutional task environment relationships on organizational performance: The Canadian construction industry. Journal of Management Studies, 34(1), 99-124.
- Oliver, C. (1997b). Sustainable competitive advantage: Combining institutional and resource-based views. Strategic Management Journal, 18(9), 697-713.

- Palepu, K. (1985). Diversification strategy, profit performance and the entropy measure. Strategic Management Journal, 6(3), 239-255.
- Palich, L. E., Cardinal Laura B., & Miller, C. C. (2000). Curvilinearity in the diversification-performance linkage: An examination of over three decades of research. Strategic Management Journal, 21(2), 155-174.
- Parikh, J. (1994). Intuition: The New Frontier of Management. Oxford: Blackwell Business.
- Parsons, T. (1956). Suggestions for a sociological approach to the theory of organizations. Administrative Science Quarterly, 1(1), 63-85.
- Penrose, E. T. (1952). Biological analogies in the theory of the firm. The American Economic Review, 62(5), 804-819.
- Penrose, E. T. (1959). The Theory of the Growth of the Firm. Oxford, England: Oxford University Press.
- Penrose, E. T. (1995). Foreword to the third edition. The Theory of the Growth of the Firm (3rd ed.). Oxford: Oxford University Press.
- Perrow, C. (1986). Complex Organizations: A Critical Essay. (3rd ed.). New York, NY: McGraw-Hill.
- Peters, T. J., & Waterman, R. H. (1982). In Search of Excellence. New York, NY: Harper and Row.
- Pfeffer, J. (1972). Merger as a response to organizational interdependence. Administrative Science Quarterly, 17, 382-394.
- Pfeffer, J., & Salancik, G. R. (1978). The External Control of Organizations: A Resource Dependence Perspective. Stanford, CA: Stanford University Press.
- Phillips, A. (1960). A theory of interfirm organization. The Quarterly Journal of Economics,

- 74(4), 602-613.
- Porter, M. E. (1980). Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York, NY: The Free Press.
- Porter, M. E. (1987). From competitive advantage to corporate strategy. Harvard Business Review, 65(3), 43-59.
- Powell, W. W. (1991). Expanding the scope of institutional analysis. P. J. DiMaggio, & W. W. Powell (Eds.), The New Institutionalism in Organizational Analysis (pp. 183-203). Chicago, IL: University of Chicago Press.
- Powell, W. W., & DiMaggio, P. J. (1991). Introduction. W. W. Powell, & P. J. DiMaggio (Eds.), The New Institutionalism in Organizational Analysis (pp. 1-38). Chicago, IL: University of Chicago Press.
- Prahalad, C. K., & Bettis, R. A. (1986). The dominant logic: A new linkage between diversity and performance. Strategic Management Journal, 7(6), 485-501.
- Prahalad, C. K., & Hamel, G. (1990). Core competencies of the corporation. Harvard Business Review, 68(3), 79-91.
- Prietula, M. J. (2000). Advice, trust and gossip among artificial agents. A. Lomi, & E. R. Larsen (Eds.), Dynamics of Organizations: Computational Modeling and Organization Theories (pp. 141-177). Menlo Park, CA: AAAI Press/ The MIT Press.
- Prietula, M. J., Carley, K. M., & Gasser, L. (1998a). A computational approach to organizations and organizing. M. J. Preitula, K. M. Carley, & L. Gasser (Eds), Simulating Organizations: Computational Models of Institutions and Groups (p. xiii-xix). Menlo Park, CA: AIAA Press/ The MIT Press.
- Prietula, M. J., Carley, K. M., & Gasser, L. (Eds.). (1998b). Simulating Organizations:

Computational Models of Institutions and Groups. Menlo Park, CA: AAAI Press/The MIT Press.

- Prietula, M. J., & Watson, H. S. (2000). Extending the Cyert-March duopoly model: Organizational and economic insights. Organization Science, 11(5), 565-585.
- Quinn, D. P., & Jones, T. M. (1995). An agent morality view of business policy. Academy of Management Review, 20(1), 22-42.
- Rajagopalan, S., & Harrigan, K. R. (1986). Diversification and market performance: In defense of the unrelated diversification strategy. 46th Academy of Management annual conference .
- Randolph, W. A., & Dess, G. G. (1984). The congruence perspective of organization design: A conceptual model and multivariate research approach. Academy of Management Review, 9(1), 114-127.
- Rediker, K. J., & Seth, A. (1995). Boards of directors and substitution effects of alternative governance mechanisms. Strategic Management Journal, 16(2), 85-99.
- Reed, R. (1991). Bimodality in diversification: An efficiency and effectiveness rationale. Managerial and Decision Economics, 12(1), 57-66.
- Reed, R., & Luffman, G. A. (1982). Diversification in British industries in the 1970s. Strategic Management Journal, 3(4), 303-314.
- Reed, R., & Luffman, G. A. (1986). Diversification: The growing confusion. Strategic Management Journal, 7(1), 29-35.
- Reed, R., & Sharp, J. A. (1987). Confirmation of the specialization ratio. Applied Economics, 19(3), 393-405.
- Robins, J. A., & Wiersema, M. F. (2003). The measurement of corporate portfolio strategy:

- Analysis of the content validity of related diversification indexes. Strategic Management Journal, 24(1), 39-59.
- Rosen, S. (1982). Authority, control, and the distribution of earnings. Bell Journal of Economics, 13(2), 311-323.
- Rosetti, C., & Choi, T. Y. (2005). On the dark side of strategic sourcing: Experience from the aerospace industry. Academy of Management Executive, 19(1), 46-60.
- Roy, S. (2004). Introduction of independent players in a centrally planned market: Decision support by long-term production costing. IEEE Transactions on Systems, Man, and Cybernetics, 34(3), 245-256.
- Rumelt, R. P. (1974). Strategy, Structure, and Economic Performance. Cambridge, MA: Harvard University Press.
- Rumelt, R. P. (1982). Diversification strategy and profitability. Strategic Management Journal, 3(4), 359-369.
- Sadler-Smith, E., & Shefy, E. (2004). The intuitive executive: Understanding and applying 'gut feel' in decision-making. Academy of Management Executive, 18(4), 76-91.
- Sastry, M. A. (2000). Understanding dynamic complexity in organizational evolution. A. Lomi, & E. R. Larsen (Eds.), Dynamics of organizations: Computational modeling and organization theories (pp. 378-404). Menlo Park, CA: AAAI Press/ The MIT Press.
- Scherer, F. M. (1971). Industrial market structure and economic performance. Chicago, IL: Rand McNally.
- Schmalensee, R. (1985). Do markets differ much? American Economic Review, 75(3), 341-351.
- Schoar, A. (2002). Effects of corporate diversification on productivity. The Journal of Finance, 57(6), 2379-2403.

- Schoonhoven, C. B. (1981). Problems with contingency theory: Testing assumptions hidden within the language of contingency "theory". Administrative Science Quarterly, *26*, 349-377.
- Scott, W. R. (1995). Symbols and organizations: From Barnard to the institutionalists. O. E. Williamson (Editor), Organization Theory (2nd ed., pp. 38-55). New York, NY: Oxford University Press.
- Scott, W. R., & Meyer, J. W. (1983). The organization of societal sectors. J. W. Meyer, & W. R. Scott (Eds.), Organizational environments: Ritual and rationality . Beverly Hills, CA: Sage.
- Selznick, P. (1957). Leadership in Administration: A Sociological Interpretation. Berkeley, CA: University of California Press.
- Shimizu, K., & Hitt, M. A. (2004). Strategic flexibility: Organizational preparedness to reverse ineffective strategic decisions. Academy of Management Executive, *18*(4), 44-59.
- Shin, H.-H., & Stulz, R. M. (1998). Are internal capital markets efficient? Quarterly Journal of Economics, *113*(2), 531-552.
- Siggelkow, N. (2002). Evolution toward fit. Administrative Science Quarterly, *47*(1), 125-159.
- Sillince, J. A. A. (2005). A contingency theory of rhetorical congruence. Academy of Management Review, *30*(3), 608-621.
- Simon, H. A. (1945). Administrative Behavior. 4th ed.,). New York, NY: The Free Press.
- Simon, J. L. (1969). Basic research methods in science. New York, NY: Random House.
- Singh, H., & Harianto, F. (1989). Management-board relationships, takeover risk, and the adoption of golden parachutes: An empirical investigation. Academy of Management Journal, *32*(1), 7-25.

- Singh, J. V. (Ed.). (1990). Organizational Evolution: New Directions. Newbury Park, CA: Sage.
- Singh, J. V., House, R. J., & Tucker, D. J. (1986). Organizational change and organizational mortality. Administrative Science Quarterly, *31*(4), 587-611.
- Starbuck, W. H. (1976). Organizations and their environments. M. D. Dunnette (Editor), Handbook of Industrial and Organizational Psychology (pp. 1069-1123). Chicago, IL: Rand-McNally.
- Starbuck, W. H., & Dutton, J. M. (1971). The history of simulation models. J. M. Dutton, & W. H. Starbuck (Eds.), Computer Simulation of Human Behavior (pp. 9-102). New York, NY: John Wiley & Sons.
- Staw, B. M., & Sz wajkowski, E. (1975). The scarcity-munificence of organizational environments and the commission of illegal acts. Administrative Science Quarterly, *20*(3), 345-354.
- Stern, I., & Henderson, A. D. (2004). Within-business diversification in technology-intensive industries. Strategic Management Journal, *25*(5), 487-505.
- Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. Academy of Management Review, *20*(3), 571-609.
- Tan, J., & Peng, M. W. (2003). Organizational slack and firm performance during economic transitions: Two studies from an emerging economy. Strategic Management Journal, *24*(13), 1249-1263.
- Taylor, F. W. (1911). The Principles of Scientific Management. Toronto, Ontario, Canada: Dover Publications.
- Teece, D., Rumelt, R., Dosi, G., & Winter, S. (1994). Understanding corporate coherence: Theory and evidence. Journal of Economic Behavior and Organization, *23*(1), 1-30.

- Terreberry, S. (1968). The evolution of organizational environments. Administrative Science Quarterly, 12(3), 590-613.
- Thompson, J. D. (1967). Organizations in Action. New Brunswick, NJ: McGraw-Hill.
- Tosi, H., Aldag, R., & Storey, R. (1973). On the measurement of the environment: An assessment of the Lawrence and Lorsch environmental uncertainty subscale. Administrative Science Quarterly, 18(1), 27-36.
- Townley, B. (2002). The role of competing rationalities in institutional change. Academy of Management Journal, 45(1), 163-179.
- Tung, R. L. (1979). Dimensions of organizational environments: An exploratory study of their impact on organization structure. Academy of Management Journal, 22(4), 672-693.
- Tushman, M. L., & Romanelli, E. (1985). Organizational evolution: A metamorphosis model of convergence and reorientation. B. M. Staw, & L. L. Cummings (Eds.), Research in Organizational Behavior (Vol. 7pp. 171-222). Greenwich, CT: JAI Press.
- Usher, J. M., & Evans, M. T. (1996). Life and death along Gasoline Alley: Darwinian and Lamarckian processes in a differentiating population. Academy of Management Journal, 39(5), 1428-1466.
- Varadarajan, P. R. (1986). Product diversity and firm performance: An empirical investigation. Journal of Marketing, 50(3), 43-57.
- Varadarajan, P. R., & Ramanujam, V. (1987). Diversification and performance: A reexamination using a new two-dimensional conceptualization of diversity in firms. Academy of Management Journal, 30(2), 380-393.
- Venkatraman, N. (1989). The concept of fit in strategy research: Toward verbal and statistical correspondence. Academy of Management Review, 14(3), 423-444.

- Verdin, P. J., & Williamson, P. J. (1994). Core competences, market analysis and competitive advantage: Forging the links. G. Hamel, & A. Heene (Eds.), Sustainable competitive advantage through core competence . New York, NY: Wiley.
- Walking, R., & Long, M. (1984). Agency theory, managerial welfare, and takeover bid resistance. RAND Journal of Economics, 15, 54-68.
- Warfield, T. D., Wild, J. J., & Wild, K. L. (1995). Managerial ownership, accounting choices, and informativeness of earnings. Journal of Accounting and Economics, 20(1), 1995.
- Washington, M., & Zajac, E. J. (2005). Status evolution and competition: Theory and evidence. Academy of Management Journal, 48(2), 282-296.
- Weick, K. (1969). The social psychology of organizing. Reading, MA: Addison-Wesley.
- Weick, K. (1979). The social psychology of organizing. 2nd ed.,). Reading, MA: Addison-Wesley.
- Wernerfelt, B., & Montgomery, C. A. (1988). Tobin's q and the importance of focus in firm performance. American Economic Review, 78(1), 246-450.
- Wheelan, T. L., & Hunger, D. J. (2004). Strategic Management and Business Policy. Upper Saddle River, NJ: Pearson Prentice Hall.
- Wilcox, C. (1950). On the alleged ubiquity of oligopoly. American Economic Review, 40(2), 67-73.
- Williamson, O. (1975). Markets and Hierarchies: Analysis and Antitrust Implications. New York, NY: Free Press.
- Woodward, J. (1958). Management and Technology. London: Her Majesty's Stationery Office.
- Wren, D. A. (1994). The Evolution of Management Thought. New York, NY: John Wiley & Sons.

- Wrigley, L. (1970). Divisional autonomy and diversification. Unpublished doctoral dissertation, Harvard Business School, Cambridge, MA.
- Zhang, G. (1997). Moral hazard in corporate investment and the disciplinary role of voluntary capital rationing. Management Science, 43(6), 737-750.
- Zhang, J., Qiu, Q., & Cameron, G. T. (2004). A contingency approach to the Sino-U.S. conflict resolution. Public Relations Review, 30(4), 391-399.
- Zilber, T. (2002). Institutionalization as an interplay between action meanings, and actors: The case of a rape crisis center in Israel. Academy of Management Journal, 45(1), 234-254.

APPENDIX

TABLES

Table I. Simulation Guidelines Derived from Extant Literature

Citation(s)	Topic	Conclusions	Simulation Guideline
Simon (1945); March & Simon (1958); Cyert & March (1963)	Bounded & Adaptive Rationality	Mgrs are limited in their ability to scan the environment; Managers make decisions sequentially.	Agent scans only adjacent cells & makes decisions of “fit” based on info from that scan
Blau (1956);	Powerful vs. Powerless	Powerful orgs influence their environ’s; powerless orgs are influenced	Highest-profitable & highest-market share agents are copied by troubled & small firms
Selznick (1957)	Role Taking	Orgs take on roles in order to “fit” in society	Agents move around a landscape & transact with nearby agents
Simon & March (1995 [1958])	Organization Studies	Org studies can be split into org-env interaction & internal org’n studies	Simulate organizations as autonomous agents
Cyert & March (1963)	Environmental Munificence	Orgs shore up resources during periods of relative munificence	Agents measure their munificence & “save” resources accordingly
	Computer Simulation	Firm behavior can be translated into simple decision rules	Computer simulation of firm behavior may be simplified without loss of generality
Burns & Stalker (1961); Thompson (1967)	Contingency Theory	Firms are successful by different means, depending on environmental conditions	Discrete environ’s can be simulated by varying degrees of (multidimen’l) uncertainty
Thompson (1967)	Environments	Focused on task environments	A baseline simulation of task environments is sufficient
Lawrence & Lorsch (1967)	Environmental Uncertainty	Magnitude of difference of uncertainty between subunits	Assign a coordination cost to each agent when input & outcome uncertainty differences observed
Weick (1969); Weick (1979)	Environmental Enactment	Mgrs are influenced by their biases when influencing, then making sense of, their environ’s	Local scanning of information biased by agent’s profile/background
Hickson, Hinings et al. (1971)	Subunit Power & Uncertainty	Subunits which have more power are those that process the most uncertainty	Give priorities to some decisions over others to simulate power asymmetry
Duncan (1972)	Perceived Uncertainty	Uncertainty variables operate under 2 diff. dimensions: perceived & actual	Keep track of & measure both perceived & actual uncertainty
		Perceived uncertainty is reasonably homogeneous within subunits	Perceived uncertainty of agent can represent subunit uncertainty
	Environmental Munificence	In high-mun.-env., firms concentrate on perf.; low munif. => survival.	Success measure contingent on level of perceived munificence.
Staw & Sz wajkowski (1975)	Environmental Munificence	Scarce environment: survival may be more important than performance	Measure both survival rates and performance.
Williamson (1975)	TCE	Conditions of bounded rationality, small numbers, environmental uncertainty, vert. integration	These conditions must exist simultaneously in order for firms to grow beyond single unit
Aldrich & Pfeffer (1976)	Nat. Selection & Resource Dependence	Incorporate planned variation & possibility of organizations influencing their environments	Planned variation modeled by randomization of profile at initialization & each iteration; successful org’s influence others
	Empirical Studies	Should be longitudinal to account for processes in nat. selection & res. dep.	Time should be modeled with simulation iterations
	Levels of Analysis	Within-organization decision level & aggregate industry level measures	Incorporate aggregate measures for the study of industries.

Table I. Simulation Guidelines Derived from Extant Literature (continued)

Citation(s)	Topic	Conclusions	Simulation Guideline
Penrose (1952); Starbuck (1976)	Organizational Boundaries	Must be clearly defined	Clearly define organizational and environmental boundaries
Miles & Snow (1978)	Fit strategies	Firms make decisions based on a profile of characteristics	Program agents with a wide variety of characteristics at initialization & observe outcomes
Pfeffer and Salancik (1978)	Environmental Uncertainty	The more organizations in the task environment, the more uncertainty	Environmental density is an element of env'l uncertainty
		The more connected task env. members are, the more the uncertainty	Network tie density is an element of env'l uncertainty
	Decision Making	Decisions about present and future demands are based on past data	Resource, demand, and production needs are based on calculations of historical data
Aldrich (1979)	Population Ecology	Selection need not be accidental	Constrained choice: limited landscape movement & transact only with nearby agents
	Environment: 5 Dimensions	Degrees of homogeneity, stability, concentration, domain consensus, turbulence	Domain consensus: one agent per spot; landscape resource gatherers may/may not access resources from adjacent spots
	Fine-grained/ Coarse-grained	Many short-term changes in fine- grained environment	Additional environ'l variable: landscape reset frequency
Schoonhoven (1981)	Contingency Theory	Nonmonotonic contingencies uncovered	Suggests a new method of hypothesis generation for org's which are complex systems
Perrow (1986)	Org'l and Theoretical Complexity	Org. theories are simplified ideas w/some aspects ignored (but addressed by other theories)	Since theories operate simultaneously, simulation is methodology is relevant
Porter (1980)	Landscape Perspective	Organizations compete against each other on a "landscape" of the two most important dimensions	Justifies a landscape-type simulation with generic dimensions
Randolph & Dess (1984); Porter (1980)	Strategic Process	Strategic and minimum strategic processes identified	Basic & extended decision processes for simulated agents
Dess & Beard (1984)	Uncertainty: 3 Dimensions	Munificence, complexity & market dynamism (empirically validated)	Provides a way to model & measure environ'l uncertainty
Bourgeois (1985)	Perceptual Acuity	Successful managers' perceptions of uncertainty close to actual	Need to measure both & test hypothesis in simulation
Tushman & Romanelli (1985);	Punctuated Equilibrium	Org's encounter long periods of stability punctuated by short periods of instability & change	Agents are modeled with profiles that enable them to make decisions in certain ways; re- creation & reorganization represented by randomized replacement of profile
Prahalad & Bettis (1986); Bettis & Prahalad (1995)	Dominant Logic	Organizations make decisions based on a narrow conceptualization of the world which resists change	
Hambrick & Mason (1984); Jensen & Zajac, 2004	Upper Echelons Theory	A CEO's life experience creates bias in taking action & making decisions	Agents have simulated CEOs with "background" in either buying, production, or sales
Blau (1956); DiMaggio & Powell (1983)	Institutional Theory	Coercive, mimetic, and normative isomorphism	Agents replace elements of their profiles with those of nearby & best agents

Table II. Eight Fundamental Organization Theories

Theory/Approach	Description/Claim	Relevant Citations
Institutional Theory	Pressures from government, society, professional organizations, and other organizations in the task environment constrain managerial choice in ways that are both irrational (institutionalization) and rational (neo-institutionalization).	(Dimaggio & Powell, 1983; Hirsch, 1975; Blau & Meyer, 1971; Selznick, 1957; Parsons, 1956; Blau, 1956)
Behavioral Decision Theory	Managerial choice is limited due their bounded rationality which results in decisions based on feasibility rather than optimality, past experience in making similar decisions, and routines that develop to solve recurring problems.	(Cyert & March, 1963; March & Simon, 1958; Simon, 1945)
Enactment	Managers scanning the environment are biased, so these scans result in self-confirmation or pre-conceived notions for the organization; meanwhile, the environment is influenced by the organization's attentional biases.	(Weick, 1979; Weick, 1969)
Strategic Management	Though constrained, the variance of managerial choice across organizations is nonetheless considerable. Managers choose strategies that guide their organizations' behavior during competition with other organizations.	(Porter, 1980; Miles & Snow, 1978; Aldrich & Pfeffer, 1976; Child, 1975; Child, 1972; Ansoff, 1965)
Resource Dependence	Organizations depend mostly on important, scarce resources to survive. Therefore, much attention in organizations is given to the management of these resources, resulting in firm behavior that would otherwise appear irrational.	(Pfeffer & Salancik, 1978; Aldrich & Pfeffer, 1976)
Contingency Theory	An organization's internal configuration (structure) is "contingent" on (i.e. correlated with or caused by, depending on the particular author) conditions of environmental uncertainty.	(Venkatraman, 1989; Aldrich & Pfeffer, 1976; Staw & Szwejkowski, 1975; Jurkovich, 1974; Tosi, Aldag, & Storey, 1973; Duncan, 1972; Hickson et al., 1971; Lawrence & Lorsch, 1967; Thompson, 1967; Emery & Trist, 1965; Burns & Stalker, 1961; Woodward, 1958; Dill, 1958)
Transaction Cost Economics	The efficiency of transactions between organizations determines an organization's size in such a way that an organization's size is always the result of the most efficient configuration of transactions.	(Perrow, 1986; Williamson, 1975)
Population Ecology	Organizational environments are analogous to biological systems in that variation, selection, and retention mechanisms determine population composition and firm survival, thus limiting the relevance of managerial choice.	(Aldrich, 1979; Hannan & Freeman, 1977; Aldrich & Pfeffer, 1976; Alchain, 1950; Boulding, 1950)

Table III. Dimensions of the Environment as determined by Dess & Beard (1984), after Randolph & Dess (1984)

Dimension	Variables	Definition Quoted from Randolph & Dess, 1984, p. 121		Supporting Citations
Environmental Munificence	<i>Growth</i> in: Sales, price-cost margin, total empl., value added, # of establish's	The extent to which the industry can support present organizations, enable the present organizations to grow and prosper, and enable new organizations to gain entrance into the industry.		(Aldrich, 1979; Hirsch, 1975; Child, 1975; Staw & Sz wajkowski, 1975; Scherer, 1971)
Environmental Dynamism	Specialization ratio; <i>Instability</i> in: Sales, value added, total employment, # of establishments	The degree of change that characterizes environmental activities relevant to an organization's operations.		(Tung, 1979; Child, 1974; Tosi et al., 1973; Child, 1972; Duncan, 1972; Thompson, 1967)
		3 major components	<ul style="list-style-type: none"> a. frequency of changes in relevant environmental activities b. degree of differences c. degree of irregularity in the overall pattern of change; the variability of change 	
Environmental Complexity	<i>Geographical concentration:</i> Sales, value added, total employment, # of establishments	The heterogeneity of and range of environmental activities that are relevant to an organization's activities.		(Tung, 1979; Jurkovich, 1974; Child, 1972; Duncan, 1972; Thompson, 1967; Dill, 1958)

Table IV. Simulation Guidelines Derived from Recent Literature

Theory/Approach	Citation(s)	Topic	Simulation Guideline
Environmental Dimensions	Brown, Lawrence & Robinson (2005)	Consensus/Dissensus	Include mechanisms for territoriality/mobility barriers
	Rosetti & Choi (2005)	Supply-chain tactics	Agents offer high-prices that decrease over time, or low prices that increase
	Castrogiovanni (1991)	Munificence	Measured by minimum facing organization; 3 dimensions
	Tan & Peng (2003)	Uncertainty & slack	Separate uncertainty coping from agency action to clarify slack-performance relationship
Institutional Theory	Deephouse (1996)	Legitimacy	Legitimacy points are added and subtracted based on performance and whether copied by others
	Suchman (1995)	Dimensions of legitimacy	Useful iteration range of study will be an intermediate death rate period
		Four organizational archetypes	Follow one archetype identified and model commodity producers
	Oliver (1992)	Deinstitutionalization	Organizations change by shifting from institution to institution over time
	Oliver (1997)	Institutionalization can increase organizational performance	Decision rule for buyers can be legitimacy-based, competition-based, or supply-chain efficiency based
	Dacin, Goodstein & Scott (2002), Kraatz & Moore (2002); Zilber (2002); Townley (2002)	Institutional change	Mimetic isomorphism is consistent (copy profile elements from the same agent until fully isomorphic)
	Washington & Zajac (2005)	Status	Status points determined by resource possession & contagion
Behavioral Decision Theory	Ireland & Miller (2004); Nutt (2004); Ketchen, Snow & Street (2004)	Decision search vs. speed	Four alternative stopping rules for agent search; transaction decisions are sequenced in tiers according to speed; extent of search is expensed
	Shimizu & Hitt (2004)	Strategic flexibility	Profile changes are reversed if threshold poor performance observed
	Ketchen, Snow & Street (2004)	Strategic positioning	Response time to trespassing treated as a random variable; agent movement constrained by nearness to highly competitive agents
	Janney & Dess (2004)	Real Options	Before entering, agents purchase the right to enter an unoccupied area
	Sadler-Smith & Shefy (2004)	Intuition	Use of blacklists & whitelists; copy movement of other identified agents in complex environments according to a variable threshold amount
Enactment	Danneels (2003)	Creeping commitment	Agents are limited in movement across competitive landscape; option to not move at all, accompanied by entrenchment
	Gibson & Birkinshaw (2004); He & Wong (2004)	Ambidexterity	Rate of entrenchment as a random variable in agent's profile

Table IV. Simulation Guidelines Derived from Recent Literature (continued)

Theory/Approach	Citation(s)	Topic	Simulation Guideline
Contingency Theory	Aragon-Correa & Sharma (2003)	Environmental variables as mediators	Adopt this perspective (initially) rather than strategic-management perspective (environmental variables as moderators)
	Hough & White (2003)	Scanning pervasiveness related to decision quality	Baseline simulation validation tools
	Hough & White (2004)	Pervasiveness-environmental dynamism	
Organizational Ecology	March (1994)	Mechanisms of evolutionary inefficiency	Simulated agents must both accommodate for these mechanisms and mitigate the effects in output analysis
	Levinthal (1994)	Survival in Schumpeterian environments	Financial resources: vary failure time to death; learning capacity; vary elements retained in black/whitelists & move in & out by FILO
	Mezias & Lant (1994); Usher & Evans (1996); Bruderer & Singh (1996)	Ecological, institutional & learning mechanisms	Model as simultaneous coexistence

Table V. Agent profile elements

Decision	Profile Element	Properties & Characteristics
Competitive position	Movement across competitive landscape	Threshold quantity (a random variable at setup) of agents scanned determines movement (a) in direction of greater resources; (b) in direction of movement of other agents
	No movement: Sedimentation (0, 1, ...)	The more an agent chooses not the move, the higher the probability it will not move in the future, and the less scanning it conducts
Bias	Background of CEO (0, 1, 2)	CEO's background is in either purchasing, manufacturing, or sales. This profile element helps to prioritize sub-organizational demand.
Quantities to buy & process	Demand (1, 2, 3, ...)	(Available to buy – resource inventory + buffer) determines how much the purchasing department requests from CEO to purchase; (Available to produce – process inventory + buffer) determines how much the selling department requests from CEO to purchase
	Buffer (0, 1, 2, ...)	For use in above request calculations; randomized at initialization
	Res. inventory (0, 1, ...)	Number of unprocessed units accumulated from previous purchasing
	Inventory (0, 1, ...)	Number of unsold processed units accumulated from previous transformations
Attractiveness to buyer	Selling price	Low price offer that increases with each transaction with same buyer, or high price offer that decreases with each transaction
Retaliation	Reaction time	Low for quick reactors
	Magnitude of reaction	High cost for highly reactive agents
	Prob. of retaliation [0,1]	High for aggressive reactors
	Aversion (1,0)	Aversive agents move away from aggressive and quickly reactive agents (trumps above movement rules)
	Territoriality	Defined region of retaliation
Search pervasiveness	Number of landscape elements to scan (8, 9, 10, ...)	Randomly initialized, plus number of immediately preceding contiguous loss periods
	List of agents identified by previous scanning	These agents included in relevant decisions toward attracting buyers and choosing suppliers.
Choice of supplier	Supplier Prioritization (0,1,2)	Based on supply-chain oriented, lowest-price oriented, or highest status
Change of profile	Flexibility Threshold	Profit increase above threshold: add profile change to whitelist; Profit decrease above threshold: add profile change to blacklist and reverse change
	Whitelist, Blacklist (with variable number of elements)	Checked against future proposed changes of profile
	Transformation, incremental (a probability with range [0, 1])	Copy nearby and/or successful organizations; copying terminated by (1) reversion as a result of poor performance, or (2) when all elements in target copied, minus black/whitelisted items
	Transformation, reorganization	Regenerate profile, minus black/whitelisted items
	Recreation/Regeneration	Regenerate profile after clearing black/whitelisted items
	Legitimacy Points (0, 1, ...)	A consequence of mimetic action taken by and of focal agent. Increases the threshold # of contiguous loss periods (below)
	Threshold # of contiguous loss periods	To determine if fundamental transformation/regeneration should occur
	Propensity for change (0, 1)	Determined at random during initialization to determine if fundamental change is by transformation or regeneration

Table VI. Simulation Guidelines Derived from the Diversification Literature

Citation(s)	Topic	Conclusions	Simulation Guideline
(Dewing, 1921; Dewing, 1917; Dewing, 1911; Brandeis, 1911)	Size Limit	There may be a limit to how large organizations can grow	This conclusion can be tested in a simulation
(Chandler, 1962; Penrose, 1959; Livermore, 1935)	No Size Limit	There may only be a limit to how fast firms can grow, not their size	This conclusion is opposite of the above and can be tested for validity as above
(Rumelt, 1974)	Diversification Strategies	Nine diversification strategies explained twice the variance of four strategies (single, dominant, related, unrelated); related exhibited higher performance than unrelated	Each agent can be programmed to explicitly pursue a particular diversification strategy
(Miller, 2004; Ansoff, 1965)	Diversification decision	Diversification is really a managerial choice	An important level of study is at the decision level, perhaps using an event-history method
(Stern & Henderson, 2004; Schoar, 2002)	Business level of analysis	The business level of analysis is important for understanding diversification: acquired firms decline in performance over time	Another important testable question: does performance increase or decrease after a single-business firm is acquired?
(Boyd, Gove, & Hitt, 2005; Robins & Wiersema, 2003; Hall et al., 1994; Hoskisson, Hitt, Johnson, & Moesel, 1993; Nayyar, 1992; Montgomery, 1982; Berry, 1975)	Measures of diversity	Diversity is a difficult strategy to measure effectively and consistency; usually there exists an unresolvable epistemological misfit. At best, SIC-based measures represent a noisy reflection over the “more accurate” categories designed by Rumelt (1974). At worst, SIC-based measures reflect a different phenomenon altogether. Quite often, statistical results may merely represent measurement error.	Simulation can measure diversification both accurately (by programming Rumelt’s characteristics into agent profiles)
Amihud & Lev (1981) and many others	Performance Measures	Diversification is an agency cost; related diversifiers perform better than unrelated diversifiers	This conclusion can also be tested, but only in the second extension to the baseline model (agency-stewardship balance); i.e. this is a separate issue from the performance issue, and it will be tested for separately in this study
(Miller, 2004; Varadarajan & Ramanujam, 1987; Reed & Luffman, 1986; Rumelt, 1974)	Causality	Firms might diversify because they are high performers	Causation can be studied accurately in a simulation because long-term effects can be modeled and pseudo-random numbers can result in a high level of experimental control
(King et al., 2004; Jensen & Zajac, 2004; Hoskisson & Hitt, 1990; Varadarajan & Ramanujam, 1987; Luffman & Reed, 1984)	Influential Moderators	Higher-level moderators affect the diversity-performance linkage	One type of moderator is studied here: the environment (see Table III)
(Boyd et al., 2005; Reed & Sharp, 1987; Luffman & Reed, 1984)	Short time periods and small numbers	Most categorical studies suffer from both short time span of study and small numbers in each category	Simulation is ideally situated to overcome these drawbacks of real-world studies with many iterations and many agents on large landscapes

Table VII. Comparison of Rumelt (1974) and Ansoff (1965) Diversification Strategies

Rumelt Strategy		Description	Related to Ansoff
Single Business		95% of revenues derive from a single business.	Present product & mission
Dominant- (between 70% and 95% revenues derive from a single business)	Vertical	Vertically integrated firms	Present product & mission
	Constrained	Diversification into areas than can all be related to each other, based on a specific central skill or competency	Either : New product, present mission, Or: Present product, new mission (not both)
	Linked	Diversification into areas that can be connected, or linked, into a chain, but areas at opposite ends of the chain appear unrelated	New mission, present product ~ Present mission, new product alternation
	Unrelated	Diversification into areas that are not associated with each other	Diversification
Related- (less than 70% of revenues derive from a single business & largest group of related businesses <i>more</i> than 70% of total revenues)	Constrained	Diversification into areas than can all be related to each other, based on a specific central skill or competency	Either : New product, present mission; Or: Present product, new mission (not both)
	Linked	Diversification into areas that can be connected, or linked, into a chain, but areas at opposite ends of the chain appear unrelated	New mission, present product ~ Present mission, new product alternation
Unrelated (less than 70% of revenues derive from a single business & largest group of related businesses <i>less</i> than 70% of total revenues)	Unrelated-Passive	Diversification into unrelated areas that do not qualify as acquisitive conglomerates (below)	Diversification
	Acquisitive Conglomerate	Must meet all 3 of the following criteria: (1) average growth in earnings per share $\geq 10\%$ per year; (2) at least 5 acquisitions (at least 3 of which are unrelated); (3) issued new equity shares with total mkt. value \geq dividend payout(s) over same period	

Table VIII. Rumelt's (1974) Performance-Diversification Strategy Hypotheses and Results

Theoretical Reason for Diversification	Explanation	Hypotheses Tested	Method Applied	Results
Portfolio Risk	Diversification can reduce total risk or variability in earnings when the diversified corporation sells a range of products that are in different life-cycle stages	Related-Constrained category will exhibit the lowest risk in earnings & have an average rate of return not significantly lower than rates in other categories.	Group by test of significant difference of risk premium ratios (RPRs) among groups	No evidence found to support.
The Escape Paradigm	Corporations can escape declining along with industries they sell in by diversifying into other, more promising industries.	Non-science-based Dominant-Linked, Dominant-Unrelated, and Unrelated-Passive diversification strategies will exhibit lower returns on equity than those firms in the same industries, but having adopted different strategies.	Linear regression of science-based & non-science-based; ROE dependent variable & strategy type as independent variable.	Evidence found; may be difficult to generalize.
Organizational Scale	There is a "close association between research and development intensity, product innovation, the product-division structure, and the degree of direct foreign investment" (Rumelt, 1974, p. 82).	"The effects of the product-division structure on growth and profitability will be more favorable in environments that require or encourage relatively rapid technological change" (Rumelt, 1974, p. 83).	GEPS (growth in earnings per share) and ROE averages compared for prod. division vs. non-product-division	Support for growth; no support for earnings
Systems Effects	Executives in multidivisional-structured firms are more competitive and are rewarded by a uniform standard (return on investment). Growth can be achieved by continuous diversification, while profit may be a more separable goal.	"Among firms with product-division structures, the relationship between growth and return on investment will not be as strong as among other types" (Rumelt, 1974, p. 85).	Linear regression with ROE and PD*ROE as independent variables (PD = 1 for product-division firms; 0 otherwise), growth in sales dependent variable	Evidence found.
Overall Performance	There are special administrative difficulties involved with diversified firms which are "compounded by the conceptual problem of defining suitable criteria for guiding the direction of diversification" (Rumelt, 1974, p. 86).	Related diversification strategy types will exhibit higher profitability, higher rates of growth, and higher price-earnings ratios than other types.	Statistical test of difference between means of Return on Capital (ROC), ROE, Price-Earnings (PE) ratio for performance measures and GSALES (growth in sales) and GEPS (growth in earnings per share) for growth measures	Evidence for performance, not for growth
		Related-Constrained > Related-Linked firms by the same measures above.		
		Divisionalized related firms > functionally-structured firms by measures above.		Little evidence (GSALES only)
Conglomerate Performance	The "bigger fool" theory of common stock valuation: if A buys stock from a merged company that is now a conglomerate (because conglomeration is popular on the stock market), A can sell the stock to the "bigger fool," B, who believes that the stock is even more valuable. In fact, the stock is less valuable than the valuation of either A or B.	"Acquisitive Conglomerates will have price-earnings ratios that are significantly higher than those of other firms, and conglomerate price-earnings ratios will be strongly related to the growth of earnings per share achieved" (Rumelt, 1974, p. 115).	Scatter plot: Acquisitive Conglomerate PE vs. GEPS (percentage) & significance of coefficient of correlation	No evidence.
		"Acquisitive Conglomerates and Unrelated firms will have average returns on capital that are not significantly different from the overall average of other firms" (Rumelt, 1974, p. 115).	Statistical test of diff. bet. Acquisitive Conglomerates, Unrelated-Passives, & other firms in ROC & ROE	Mixed support (Unrelated-Passive had lower ROE)

Table IX. Rumelt's (1974) Results Compared to Luffman and Reed's (1984) Results

Theoretical Reason for Diversification	Hypotheses Tested	Rumelt's (1974) Results	Luffman & Reed's (1984) Method	Luffman & Reed's (1984) Results
Portfolio Risk	Related-Constrained category will exhibit the lowest risk in earnings & have an average rate of return not significantly lower than rates in other categories.	No evidence found to support.	Averages of % growth in shareholder return compared to average share price variance	Opposite results: Lowest return; risk not significantly different.
The Escape Paradigm	Non-science-based Dominant-Linked, Dominant-Unrelated, and Unrelated-Passive diversification strategies will exhibit lower returns on equity than those firms in the same industries, but having adopted different strategies.	Evidence found; may be difficult to generalize.	Averages of % growth in shareholder return	No evidence, but science-based firms not separated out.
Organizational Scale	"The effects of the product-division structure on growth and profitability will be more favorable in environments that require or encourage relatively rapid technological change" (Rumelt, 1974, p. 83).	Support for growth; no support for earnings	--	Not Tested – no structures measured.
Systems Effects	"Among firms with product-division structures, the relationship between growth and return on investment will not be as strong as among other types" (Rumelt, 1974, p. 85).	Evidence found.	--	Not Tested – no structures measured.
Overall Performance	Related diversification strategy types will exhibit higher profitability, higher rates of growth, and higher price-earnings ratios than other types.	Evidence for performance, not for growth	Statistical test of difference between means of % return for shareholders, % growth in sales, % growth in Return on Capital Employed (ROCE)	Little support: ROCE (Related greater than single bus.); growth in sales and % return to shareholders: no differences
	Related-Constrained > Related-Linked firms by the same measures above.			Mixed support: ROCE lower for R-L – opposite of prediction; growth in sales higher for R-L (as predicted)
	Divisionalized related firms > functionally-structured firms by measures above.	Little evidence (GSALES only)	--	Not Tested – no structures measured.
Conglomerate Performance	"Acquisitive Conglomerates will have price-earnings ratios that are significantly higher than those of other firms, and conglomerate price-earnings ratios will be strongly related to the growth of earnings per share achieved" (Rumelt, 1974, p. 115).	No evidence.	--	Not Tested.
	"Acquisitive Conglomerates and Unrelated firms will have average returns on capital that are not significantly different from the overall average of other firms" (Rumelt, 1974, p. 115).	Mixed support (Unrelated-Passive had lower ROE)	Statistical test of difference between Unrelated & other firms in ROCE	Opposite finding: Unrelated diversifiers significantly higher in ROCE.

Table X. Diversification Literature: 1980s to Present

Citation	Journal	Findings	Comments
Mueller (1977)	JBF J. Banking & Finance	Quoted in Amihud & Lev (1981, p. 605): "[T]he empirical literature upon which this survey focuses, draws a surprisingly consistent picture. Whatever the stated or unstated goals of managers are, the mergers they have consummated have on average not generated extra profits for the acquiring firm [and] have not resulted in increased economic efficiency" (p. 344).	
Amihud & Lev (1981)	BJE Bell J. Econ.	Risk reduction resulting from merger benefits the manager, not the shareholder because in the first case, employment risk is decreased and in the second case, no extra profit is generated. This is one example of a case where ex post settling up does not occur (after Fama, 1980). Evidence: (1) manager-controlled firms engaged in more conglomerate acq'ns than owner-controlled firms (after controlling for size); (2) manager-controlled firms were found to be more diversified.	Explains the motive of managers to form conglomerates (Rumelt's findings & herein) through AT. => managerial self-interest should be used to explain conglomerates.
Luffman & Reed (1982)	SMJ Strat. Mgt. J.	Noted a "change in philosophy" among managers toward diversification (in 1980) & away from single business (in 1970). Change adopted (to diversify or stay the same) was found to be independent of size of turnover & (with a few exceptions) industry type. But problems with small numbers in data.	Partial results from Luffman & Reed (1984).
Montgomery (1982)	AMJ Acad. Mgt. J.	The SIC-based measures may be more useful than prev. studies indicated - good for large-sample cross-sect'l (& maybe longitud'l); Rumelt (1974) may be closer tied to perf. Diff's, esp. rel'd vs. unrel'd.	Did not look at (but predicted) performance measures for each measure as did Hall & St. John (1994) - here differences were found.
Rumelt (1982)	SMJ	Same results as 1974, after adjusting for industry - a respnse to Bettis & Hall's (1981, 1982) argument that pharmacies (a particular industry) => sig. ↑ perf. in rel'd div'n group. However, the industry effect observed in the strategies of rel'd-constrained (unexpected) & dom.-vertical (expected) groups. Three conditions must be met in order to realize economies of scope: (1) ↑ returns (or divisibilities) to scale in the use of ≥1 essential prod uction factors ("core factors"); (2) Transaction costs prevent efficient market (& forcing integration); (3) limits to efficiencies by economies of scale. All 3 must be met for economies of scope (& making diversification more efficient).	Biases: 500 largest firms => less diversity & larger clusters of rel'd businesses; we do not know why rel'd-constrained firms are concentrated in high-profit industries.
Luffman & Reed (1984)	Book	Distinction bet. diversity & div'n ; Intermediate levels of div'n obs'd as staging strategy for unrel'd & rel'd div'n. Unrel'd was highest overall performer - high on all 3 meas. of perf. Suggests div'n may be driven by growth in sales (Rumelt's "cash trap"), and that extended div'n can be a profitable end in itself; also largest companies were most efficient (ROCE) - => no limit to size as did Penrose (1959) OR hidden monopoly effects (Brandeis, 1911)	Different results between Britain (this study) & U.S. (Rumelt's study) raises issue of international differences; more work to do in dynamic studies over time; no explanation of why Rumelt (perf. hypothesis) strongly supported so theory should be developed further.
Palepu (1985)	SMJ	Tried to reconcile 2 streams of literature: (1) IO (no sig. relationship exists between div'n & perf. using product counts) & (2) SM (systematic relationship using Rumelt/Wrigley taxonomy). Found no cross-sectional differences between high & low total div'n & unrel'd vs. rel'd; over time, rel'd more profitable than unrel'd; for rel'd, profit growth seems to translate into profitability level over time, but effects not sig. (could need more time) => rel'd div'n seems a profitable long-term strategy.	Flaws of previous studies: did not distinguish between rel'd/unrel'd & were cross-sectional. Demonstrated that carefully/properly constrained div'n index based on SIC → sig. results, so need not sacrifice "objectivity and simplicity" with a Rumelt-like taxonomy.
Prahalad & Bettis (1986)	SMJ	Review of mgt research on div'n-perf. link. Identified 4 streams: (1) Diversification as strategy (Chandler, Ansoff, Rumelt) choice of strategy affects perf.; (2) IO/Econ: structure of industry & competitive position are the key determinants of performance (Porter, Montgomery, PIMS); (3) portfolio management: strategic position => cash flow; div'n => balance of strategic positions (Hofer & Schendel, 1978; BCG matrix); (4) implicit recommendation (Peters & Waterman, 1982: stick to knitting). Since (1) quality of mgt critical factor in explaining perf. (Bettis, Hall, & Prahalad, 1978), (2) general mgt.: distinct skill for diversified firm, (3) mgrs use administrative tools to "shift the strategic direction of a business" (p. 488), TMT (dom. coalition) mindset, or dom. logic, emerges to relate usually less than the 4 streams to solve problems & these evolve by operant conditioning, paradigms, cognitive biases & artificial intelligence.	Limits to div'n are found in the variety of dom. logics required vs. dom. logics that exist in the dom. coalition. The term "rel'dness" might need to be redefined in terms of strategic (not market) similarities.
Reed & Luffman (1986)	SMJ	Strategies are useful for the benefits they offer, but div'n has seen a 'golden egg syndrome' in popular bus. press: the "best performing" div'n strat should be deemphasized while the benefits of ea strat shld be identified; i.e. terms are mixed up & causality reversed. Research should focus on link bet firm's needs & div'n payoffs ("needs": reduce risk, change direction, earnings stability, use spare resources, adapt to customer needs, synergy, growth, etc.).	
Reed & Sharp (1987)	AE Applied Econ.	Bimodality persists (diversified & single) & 4 types confirmed - boundary marks at 96%, 73%, & 36%. Current trend magnified: dom. & single product numbers cut in half before reaching dynamic equilibrium; reducers increased.	It may be that some firms have core competencies as single-business firms and some as diversified enterprises.
Varadarajan & Ramanujam (1987)	AMJ	All performance variables were sig'ly correlated, with high of 0.9 on ROC-ROE. Confirmed Rumelt's findings: rel'd diversifier was high performer, unrel'd was average performer; however, wide variances were observed for perf. measures in each cell, so difficult to generalize (but this suggests causality is reversed again - see Rumelt, 1974).	(1) rel-div'n may be a rel'd but not sufficient condition for perf; (2) though unrel'd ↓ correl w/perf, some individual firms do quite well => antecedents, mediators &/or moderators may be confounding results: ownership control, size, growth rate, etc. - see Hoskisson & Hitt (1990).
Grant, Jammine & Thomas (1988)	AMJ	Rumelt categories not sig., but conclusions based on the "Index of Product Diversity" (PDIV) & PDIV ² similar to Rumelt's; intermediate levels of diversity are optimal for perf. (PDIV = 3.7 is max), so "firms earned higher profit margins on their core activities than on their diversified activities" (p. 789); time lag (4 yrs) provided much better fit. Div'n explained very little of the interfirm variability, so their results might be idiosyncratic differences not picked up in this large-sample study.	Need further investigation of relatedness (strategic "dom. logic - Prahalad & Bettis, 1986), & operations (Rumelt, SIC-based), etc.
Montgomery & Wernerfelt (1988)	RndJE RAND J. Econ.	The more unrel'd a company must go to use their "core factors" (Rumelt, 1984), the less the firm receives in Ricardian rents, assuming that firms choose to diversify into those areas that are expected to be most profitable first.	Provides a continuous-variable theory to explain continuously-variable results; different from Rumelt/Wrigley's categorical measures.
Hoskisson & Hitt (1990)	JOM J. of Mgt.	In order to begin development of a unified theory, summarize 3 theoretical perspectives: (1) assumes mkt perfection: mkt's are relatively perfect & firms homogen's w/in industry (IO/Econ) says only limited div'n is rational: industry structure-conduct-perf paradigm - perf controlled by the mkt (Schmalensee, 1985); div'n strategy is moderator between capital markets & industry structures and perf; (2) mkt & firm imperfections: external incentives (anti-trust, tax laws, mkt failure) compromise the assumptions in (1) & encourage div'n through external influence; capital mkt's. & ind'y structure moderate between div'n strategy & firm perf. (3) there may be internal managerial motives for div'n: agency theory. These 3 perspectives then become 4 antecedents: markets, resources (free cash flows - Jensen, 1986), incentives (low perf., uncertainty, firm risk reduction), managerial motives (agency cost). H&H model: Resources (tangible, intangible, financial) & Incentives (TCs, govt policy, uncertainty of future cash flows, etc.) are antecedents to div'n strategy, while "strategy implementation & issues of fit" (structure, dom. logic, distinctive competence, managerial characteristics, culture) moderates div'n-perf.	

Table X. Diversification Literature: 1980s to Present (continued)

Chatterjee & Wernerfelt (1991)	SMJ	Empirical findings of three types: Agree with Rumelt that rel'd div'n is associated with highest perf.: Montgomery (1979), Bettis (1981), Rumelt (1982), Palepu (1985), Varadarajan (1986), Varadarajan & Ramanujam (1987), Jose, Nichols & Stevens (1986), Lubatkin & Rogers (1989); others find the opposite (rel'd is worse than unrel'd): Michel & Shaked (1989), Rajagopalan & Harrigan (1986), Elgers & Clark (1980), Chatterjee (1986); or no sig. difference: Lubatkin (1987). Pursued the Penrose (1959) idea that "firms diversify in part to utilize productive resources which are surplus to current operations" (p. 33). Most important finding: only high-perf firms use resources as described above (in this case research intensity, advertising intensity & long-term liquidity) were sig. & negative assoc'n w/div'n. Risk was opposite as predicted by AT. "to understand the link bet. div'n & perf. we need to consider the resource profile of the firm" (p. 41) => resource-based theories supported (AT not), especially the intangible & fin'l results - no support for physical, possibly because physical drains debt capacity (upon increasing div'n) while non-phys does not.	Firms need to take stock of their intangibles before deciding to diversify. May have left out meaningful variables: mkt. growth, org'n structure, culture, stock ownership, compensation schemes, nature of managerial expertise (& dom. logic for that matter).
Delacroix & Swaminathan (1991)	ASQ Admin. Sci. Quarterly	Study of wineries in CA with firm survival as DV. 3 models: brand portfolio (size had negative effect on probability of brand change: large more conservative than small, but not older), product change (age & size sign negatively associated), land change (increased w/ more wineries & less demand - defensive move). Disbanding: nothing sig'ly decreased the probability of disbanding - any significance is negative, especially land acq'n (vertical integration). Findings strengthen the structural inertia hypothesis in that "large and older wineries tend to be both conservative & immortal" (p. 656); findings are against the idea that org's can adapt.	First time effectiveness measure was used as a DV with div'n as IV. Combined w/Reed (1991), suggests that multivariate regr'n can be used w/ BOTH effectiveness & efficiency measures used as DV & more traditional meas's as IV - to add one more DV as suggested by King et al. (2004). Div'n may ↓ profitability but ↑ survivability.
Lubatkin & Chatterjee (1991)	SMJ	The best way to protect shareholder value against economic downturns: "put all one's eggs in similar baskets" (i.e. diversify rel'dly). Considered bull/bear/stable market cycles with daily risk-free rate of return data - Rumelt (1974) & Hawks (1984) shown to differ at each date data taken. "Rumelt may have underestimated the value of contr'd div'y in mitigating economic risk" (p. 267).	Portfolio theory only applies in div'n case if businesses are rel'd - against Amihud & Lev (1981, 1999) because in the self-seeking mgr's interest to reduce risk by diversifying rel'dly, which would also be good for shareholders => no agency problem (Luffman & Reed, 1984, found opposite results for SS vs. SD: ↑risk & ↑returns for SD).
Reed (1991)	MDE Managerial & Decision Economics	Rationality offered for the bimodal phenomenon. There is generally a difference between the max. possible diversity (max. possible effectiveness) & the "frontier to maximum efficiency." These two were plotted as lines on a 2-D graph of {total possible div'n - Herfindahl index} vs. {largest % contribution - 1/SR ratio}. Effectiveness line: higher & smooth; efficiency frontier line: lower & stepped. "Reduced levels of diversity are associated with lower costs of control &, therefore, with improved efficiency" (p. 62). Thus, a tradeoff between effectiveness & efficiency, and "the costs of managing separate activities accumulate at a geometric rate." When firms seek to optimize both efficiency & effectiveness, they place themselves closer to the (higher) effectiveness than the efficiency line, so they may decide to overdiversify, and then reduce to an "optimum" level later.	There is an opportunity cost attached to the Dom. strategy; efficiency cost attached to the unrel'd strategy, so bimodal dist'n results. So firms should seek to optimize both efficiency & effectiveness rather than one to the exclusion of the other => the strategy of diversification is multidimensional.
Nayyar (1992)	SMJ	Internal meas sign'ly diff (Entropy: less unrel'd; Rumelt: misclass both rel'd & unrel'd, more rel'd) & explains more than secondary publicly available data bec. potential rel'dness often isn't realized & rel'dness may be externally invisible. Relatedness may always be a moving target as org'l learning may increase relatedness, but there's probably a shorter lag with primary data from CEO than secondary annually published data. Offered numerous reasons why potential is different from actual relatedness: org'l design & HRM involved in processes which precede & follow acq'n can be impediments to integration; org'l difficulties, org'l inertia, intrainfirm exchanges are required over long periods, but cause internal Xaction costs; governance/coordination costs (goal incongruence may lead to competition not coop'n, as the M-form is set up for competition), self-preservation, bureaucratic distortions, accounting conventions, difference in tech xfer.	Showed that internal meas's may be closer to the Ansoff65 as part of an exec's decsn procss, & sugg's lab studies (Ginsberg, 1990) and/or longitudinal clinical studies (Prahallad & Bettis, 1986) to capture social psychological factors involved in the div'n decision (dom. logic, sociocognitive similarities, common managerial capabilities, common routines & repertoires, information asymmetries).
Hoskisson, Hitt, Johnson & Moesel (1993)	SMJ	Convergent validity between a categorical entropy measures (using DR and DU) of diversification & Rumelt's categories - using discriminant validity, about 70% of Rumelt's categories correctly classified. Also found strong relationship between each method & diversification in an SEM model. Tradeoff: Rumelt measure increases precision somewhat, while entropy measure is more objective & can be applied to large datasets.	Found support for SIC code-rel'd measures; explanation for Amihud & Lev (1981) findings difference: div'n rel'd to accounting perf. (ROE, ROS, ROA) but not mkt. perf. (did not use CAPM).
Hall & St. John (1994)	SMJ	Do categorical & continuous methods capture the same diversity measures? (I: continuous vs. strategy types): None of the 3 entropy scores were effective in differentiating rel'd vs. unrel'd; D-R and D-U entropy scores were strong predictors of dom. & rel'd (3 & 4 digit SIC), but could not predict single & unrel'd. (II: continuous-to-categorical): clustering classified most companies as single or dom. => Rumelt categories tend to classify more firms as single business/dom. (III: diversity-perf. link): ANOVA: ROA & ROS sig'ly lower for unrel'd, higher for dom. - but only Rumelt's cat's showed significance.	"a clear p'trn emrgs: cat'l & contin meas's appear to b assoc but they do not capt an undry'g construct w/a specf rel to perf" (p. 163) => "the choice of measurement method influences research conclusions" (p. 165). SIC asms 2- & 4- digit codes are automtically rel'd; 2-digit unrel'd: while it captures only raw material commnalities, not dist'n channel, procurement technology or product commonalities.
Lubatkin & Chatterjee (1994)	AMJ	Test of (and support for) portolio theory, but across limited range: found a u-shaped relationship between div'n (IV) and risk (DV); also, dummy variable vertical integration div'n strategy had greatest ↓ effect on risk (compared to single-business, vertical, & linked, though constrained also sig. & negative effect). However, bull/bear market effects (as moderator) were about the same. Strategy/mkt. cycle was significant & negative (as DV; systematic & unsystematic risk & div'n strategy as IVs).	Advantages of constrained div'n strategy (ow systematic risk & low-cost capital) are more pronounced in bear markets. => results do not support AT as put forth by Amihud & Lev (1981) & Jensen (1986) (but U-shape also implies support for AT at higher levels of div'n).
Markides & Williamson (1994)	SMJ	RBV-based perspective on div'n. Rel'd +correlated w/ROS, so agree with Rumelt, but 5 new categories (along lines of Penrose 1959) correlated stronger. Identified 5 ways that rel'd div'n can result in a competitive advantage: (1) exaggerated relatedness - may appear rel'd but it is non-strategic, so no advantage; (2) economies of scope - what traditional measures detect; (3) catalyst: competence gained in one SBU can help another existing SBU; (4) experience/learning in existing SBU used to create new SBU; (5) asset fission: the new SBU gains a competence to help the older SBU. (1) is nonsystematic bias for traditional measures of div'n which meas. (2), which is acceptable, but (3), (4), & (5) are not measured so there is systematic bias in traditional measures of div'n. 5 broad classes (dimensions) taken from Verdin & Williamson (1994): customer, channel, input, process exp., market knowledge: R ² from 5 cats sig'ly higher (.41 vs .26) than simplified Rumelt - used ROS as DV.	Showed that strategic relatedness is superior to market relatedness - so much for Ansoff. Example given of Canon in laser printers, photocopiers & cameras is a poor example, as the rel'd SIC codes (3827,3861,3577) indicate relatedness more or less to the degree discussed (yet auths claim relatedness would not be measured). Also, since to be rel'd, the measure must be strategically important, we run into circular logic since strategic importance is, by definition, profitable.
Markides (1995)	SMJ	Refocusing among overdiv'd firms generally resulted in higher perf. & it takes time for these effects to be realized (late refocusers did worse) => agrees w/Reed (1991). Also agrees with TCE & Wernerfelt & Montgomery (1988): there's a limit to how much a firm can grow & marg'l returns may decrease as a firm diversifies further from core. 24/25 regression equations supported main thesis of paper (above).	Why have firms div'd in the 1st place (test Reed's 1991 thy)? Entropy meas's use prop'n of sales => high entropy correlates highly with high perf. can ROS be used here? Is logic circular if it is?

Table X. Diversification Literature: 1980s to Present (continued)

Hit Hoskisson & Kim (1997)	AMJ	Product div'n moderates the (nonlinear) relationship between international div'n & perf. Moderate product diversifiers perform well at moderate levels of international div'n; high product diversifiers perform well at high levels of international diversification; single businesses performed best at no international div'n. May help to explain Luffman & Reed's (1984) finding that unrel'd diversifiers performed better than rel'd because these firms were also diversifying internationally (esp'y into healthier economies at the time as Luff & Reed discuss).	Calls for weights by global region. It is important to address how international div'n is implemented, including consideration of org'l & governance structures, modes of entry, application of knowledge & capabilities, etc.
Lane, Cannella & Lubatkin (1998)	SMJ	Response to Amihud & Lev (1981). Authors question the relevance of agency theory (see above: Lubatkin & Chatterjee, 1991). Taking strategic mgt. perspective, authors find no reason to revise conclusion that monitoring by owners affects extent of div'n. Finance field focuses on cash flow correlation with mg'l self-interest; SM more emphasis on mgr'l practice & capturing real-world complexities. "Statistics may appear to be objective, but the methods used to derive them & the nature of the inferences drawn from them tend to be very discipline-specific" (p. 1080) - unrel'd vs. rel'd in finance is a dichotomous variable; continuous/categorical in strategic mgt..	"Our findings add to a growing list of SM studies that provide evidence of AT's limitations" (p. 1084). Finance researchers can learn from a greater awareness of SM literature (e.g. "new" insights/reasons for div'n such as inefficient capital mkts).
Amihud & Lev (1999)	SMJ	Argue as in 1981 that companies with greater ownership concentration are less diversified. Response to Lane, Canella & Lubatkin (1998) who found no relationship. "on average, diversifying mergers & conglomerates decrease shareholder value" (p. 1064). Authors cite evidence to agree with them in LCL (R ² from regression agrees with Amihud & Lev (1981), Warfield, Wild & Wild (1995; mgt. of accounting earnings only for firms with low managerial ownership); Agrawal & Mandelker (1987; "executives' security holdings induce them to make invest. decisions that are in the interest of shareholders", but they did not study div'n); May (1995 - effect of CEO char's on decisions that affect firm-level risk in line with Amihud & Lev, 1981).	Proposes to test more detailed aspects of their hypothesis: perf.-based exec. compensation should be positively correlated w/ lower div'n levels. More study: composition of BOD & involvement of institutional investors correlation w/div'n frequency/propensity. Note: citations to left are from the finance literature & their measures are less direct than, say, Rumelt's; it may take a larger body of evidence to confirm Amihud & Lev (1981).
Denis, Denis & Sarin (1999)	SMJ	Response to Amihud & Lev (1999) and Land, Canella & Lubatkin (1998). Support A&L. Authors above disagree on (1) theoretical relevance of agency theory (AT) & (2) interpretation of existing evidence. AT predicts: mgrs maintain a div'n strategy even when it doesn't benefit shareholders. Strong owner is >30% by one person - this variable does not provide much power in stat'l tests because (1) definition of a 'conglomerate' is subjective; (2) Rumelt-like subsamples have too few firms in each category; (3) no distinction between inside & outside ownership. Denis, Denis & Sarin (1997) used 5 diff measures of div'n & supported Amihud & Lev (1999). "However, unlike Amihud & Lev, we are uncomfortable with concluding that it is the desire for personal risk reduction that drives managers to diversify" (p. 1074) since private benefits to mgrs from risk reduction are likely to increase w/managers' equity stake could have confounded results (unmeasured moderator?).	Need to add managers' equity ownership as a possibly controlling/moderating variable before any conclusions may be made.
Lane, Cannella & Lubatkin (1999)	SMJ	Used Amihud & Lev's (1981) data & more recent data & found that "the relationships between type of ownership structure and type of div'n appears contrary to Amihud & Lev's predictions. Specifically ... almost 40% of the management-controlled firms are constrained diversifiers, the div'n strategy that is associated with the best combination of shareholder return and risk (Bettis & Hall, 1982; Lubatkin & Chatterjee, 1991). Only 12.5% of the mgt-controlled firms are unrel'd diversifiers.... Curiously, weak owner-controlled firms favor unrelated div'n more than mgt-controlled firms" (pp. 564-565).	Started the AT-div'n debate in SMJ. Tobin's q and div'n variable based on proportion of mgt. stock ownership supports AT while regression/chi-square tests using IVs such as Wrigley/Rumelt categories does not support AT.
Liebeskind (2000)	OS Organization Science	Both Williamson (1975; efficiencies from internalization of capital market when one large corporate HQ is replaced by many small ones) & Jensen (1993) (inefficiencies because of agency costs on free cash flows needed for internal investment) arguments are questioned. Author argues that very little generalization can be made one way or the other: when SBU is capital-suff, costs are always likely, but when SBU is capital-constr'd, benefits accrue only if (a) trade secrets involved, (b) when external lenders are poorly informed, (c) business lines sensitive to delay/interruption so that reliability can be incr'd due to capital reliability. Also, comparative benefits can be nontrivial: Costs from centralization, misinvestment from incomplete info, under- & over investment from bureaucratic stickiness (Shin & Stulz, 1998) & investment delay (BCG per Henderson, 1970 & 1979 & agency cost increases imply that "the value of a div'd firm can be sig'ly influenced by the relative efficiency of its internal capital mkt., over & above the presence of other benefits of div'n, such as economies of scope or extension of mkt power" (p. 73). The relative efficiency of interlan capital mkt. can depend partly on its org'n & costs can be mitigated by partnered lending & partial ownership (↑ capital reliability & reduce agency problem).	We must better understand the benefits & costs of div'n - still a critical issue, and little research done on internal capital markets: What is comparative efficiency of internal vs. external capital markets?
Kogut Walker & Anand (2002)	OS	Even by 1970, technical forces alone were not sufficient to Inst'l hyp supported (that countries differ in their pattern of interindustry div'n; no evidence for techn'l hyp (it's industry, not country, that matters & firms tend to div'y along similar techn'l paths - after Teece, Rumelt, Dosi & Winter's (1994) coherence), but could be operable at a lower level of analysis - these auths "assumed that techn'l laws are invariant among all societies" (174); instead, this study found that techn'l & inst'l factors interact & certain inst'ns in certain countries may be fixed over long periods, immune from takeover by institutional forces.	At the macro level, it appears that the technological & institutional sides failed to consider conditions of cognition, agency & entrepreneurship that influence interindustry div'n. The literature seems to be converging on a finer-grained analysis of Ansoff's (1965) div'n decision procedure. We must not ignore the effect & influence of interorganizational networks (i.e. networks of individuals that serve on boards). Institutions matter; org'l patterns are not just the result of an individual's choice.
Finkelstein & Haleblan (2002)	OS	Transfer effects (Corimer & Hagman, 1987) at the individual level hypothesized to exist at the org'nal level & tested by acq'ns. Idea is an extension of Nelson & Winter's (1982) discussion of routinization. Found: acq'n perf. +assoc w/similarity of individual environments with acq'ns & targets; acq'n perf. > 1st acq'n than 2nd. When firm's 2nd target is dissimilar to the 1st, 2nd underperf 1st. Older acq's may impact subsequent acq's. No significance when ROA used as perf. DV instead. Consistent with ind'l level psychology studies where (1) acquirer-to-target dissimilarity ↑ likelihood of positive transfer & (2) target-to-target dissimilarity ↑ likelihood of negative transfer.	Problem that shareholder returns show sig. but not ROA - study might measure only the popularity of acq's (stock's perf.), not <i>bona fide</i> firm perf. But consistent w/the idea that firm's decisions influenced by past actions (Amburgey, Kelly, & Barnett, 1993) & prior acq'n of knowledge misapplied to subsequent target-counterintuitive to org'l learning but consistent w/literature citing prevalence of unsuccessful acq'ns. Need to study the underlying procedures (lab simulation/ case study): nature of knowledge transferred (tacit vs. codified), or procedural vs. declarative; post-acq'n integration on subsequent knowledge transfer; attention reduction bet. 1st & 2nd acq'ns & influence on negative transfer.

Table X. Diversification Literature: 1980s to Present (continued)

Schoar (2002)	JOF J. of Finance	Used plant-level data from the longitudinal Research Database (a unique approach). Found that plants owned by conglomerates (one of three categories studies as comparison between groups: stand-alone, diversified & highly-diversified) are more productive. One reason suggested is that, when a plant is acq'd by a conglomerate, the plant has more access to more capital. However, over time, conglomerates "run their plants down" (p. 2388) as the plants become more inefficient. Additionally, it was found that "diversifying events have a much larger negative effect on the incumbent plants of a firm than expansion into related industries" (p. 2391). In other words, incumbent plants experienced a decrease in perf. when the conglomerate acquires an unrelated plant. Finally, the overall productivity of a diversifying firm declined by about 2% relative to the 3 periods before the div'n.	Findings (poor perf. for diversifying firms) were explained by the managerial neglect of core competencies (Prahalad & Hamel, 1990) and bounded rationality (Rosen, 1982). Author offers her own theory: "conglomerates dissipate higher rents in the form of higher wages" (p. 2379).
Mayer & Whittington (2003)	SMJ	Adds national (generalizability across national boundaries) & temporal (stability over time) contexts to the div'n-performance discussion. Argument across countries is the same as Hitt, Hoskisson & Kim (1997, above): institutional differences (rather than environmental differences, as in Luffman & Reed, 1984). Used Rumelt catogories & found same results as Rumelt at the aggregate level, but different results for some countries at the disaggregate (country) level of analysis (confirms Luffman & Reed, 1986, but had same small sample size problem).	"Time and country can make a difference" (p. 777), although in this research note, no explanations were offered <i>ex ante</i> .
Robins & Wiersema (2003)	SMJ	Concentric index (used by Montgomery & Wernerfelt (1988) & Wernerfelt & Montgomery (1988)); used 2- & 3-digit SIC & sensitive to dominance of main 3-d SIC (div'n max when each 3-d SIC prop'n sales is =), is inversely correlated with the rel'd component of the entropy index (used by Berry (1975), Jacquemin & Berry (1979) & Palepu (1985)), which uses 2- & 4-digit SIC & sensitive to the quantity of 4-digit SICs in a firm. The findings of these classics may actually be at odds.	Article suggests caution; I suggest either a 2-dimensional index or a new index that takes into account 2-3-4-digit SICs simultaneously.
King Dalton Daily & Covin (2004)	SMJ	Post-acq'n perf. is moderated by unspecified variables. ROA sig. for only 1-yr event window (but small: -0.09). Abnormal returns sig. & positive for same-day event window (acquirer, 0.09; acquired, 0.70), but negative for longer event windows. No evidence for moderators found, so moderators remain unidentified.	Need for further moderator development: identifying antecedents/moderators that help predict post acq'n perf. Complementary res's (King, Covin, & Hegarty, 2003) may be a promising theoretical foundation (but complementary resources important when collaboration not integration); also alternate motives beyond org'nal efficiency might be considered (but not managerial opportunism) such as to manage uncertainty, to grow in order to ↓ vulnerability. Methodologically, event studies may be too short term, multiple DVs should be measured (usually just stock mkt. perf.; but not acting perf), calls for replication & use of internal/non-secondary data.
Helfat & Eisenhardt (2004)	SMJ	Proposes inter-temporal economies of scope as an additional potential benefit to related div'n: rather than be simultaneously div'd, the firm may diversify in sequence, or "patching" (Siggelkow, 2002; Brown & Eisenhardt, 1998) that results in an evolving path of related div'n through time" (p. 1218). Economies of scope are thought to be realized because of a firm's inter-temporal path: making product 1 at time 1, then product 2 at time 2 is less costly than making products 1 and 2 at the same time.	Suggests that related diversifiers need not be highly coordinated between business units. Rather, org'l structure can be designed in decentralized modular units.
Jensen & Zajac (2004)	SMJ	Integrated upper echelons theory with & AT to arrive at an explanation as to how individual differences among top managers affect corporate strategy in different ways. In particular, functional background affected the extent of diversification: CEOs with finance backgrounds were found to be managers over firms that were more diversified than CEOs with non-finance backgrounds. However, non-CEO elites with financial backgrounds had the opposite association with div'n: more of these individuals were more associated with related diversifiers than unrelated diversifiers.	Div'n research must focus on both demography and position in studying the influence that corporate elites may have on their firms. Offers evidence that, in general, corporate elites' (biased) preferences do affect corporate strategy.
Miller (2004)	SMJ	Performance of a diversifier is lower in the year prior to diversification because (1) R&D intensity is lower compared to non-diversifying firms and (2) reduced technology breadth. ROA & tobin's q were DVs (calculated separately, each DV yielded the similar results); diversification measures by Herfindahl-type (entropy) index and a new concentric index.	A "div'n discount" (p. 1109) can be realized, where a firm realizes ↑ perf. after div'n because of poor performance in the period just before the div'n event. Supports the idea that resources, mode of diversification (internal growth or acq'n), and strategy type (related vs. unrelated) are linked (Busija, O'Neill, & Zeithaml, 1997).
Stern & Henderson (2004)	SMJ	Entropy measures & diversification may be applied to business-level with sig. results. At the business level of analysis, within-business diversification "has a profound impact" (p. 502) on whether firms survive. This suggests that Christensen's innovator's dilemma of reacting to a threat by spanning the market with products might actually be an effective business-level strategy and that the cases he studied were exceptions. Also supports Aldrich's (1979) argument that after org'ns institutionalize, population ecology persists within org'ns (rather than between org'ns) & the key to success at that point is within-firm variance.	Since authors found sig. differences in div'y w/in & across product lines in the SAME 4-dig business results in tech-intensive industries may not be as mobile as thought. Future: consider other DVs such as profitability (& TMT composition, sole ownership levels to invest AT at this level). Together w/King, Dalton et al. (2004) => probability of survival might be applied at the corporate level DV.
Boyd, Gove & Hitt (2005)	SMJ	Auths contend that change in results between Lane et al. (1998) and Amihud & Lev (1981), using same data, was due to measurement error. Effect is there, but limited in significance (p-value almost .05) and magnitude (-.16). Also "Strong governance constrains div'n in general, but especially unrel'd div'n" (p. 7).	For sig. level .05 & 80% detecting, need n=547 to detect small effect & 76 for moderate (Cohen, 1992) => we can't ignore Type II. Amihud & Lev (1981) supported.

Abbreviaion Key

=>:	"implies"	Div'y:	diversity	Perf.:	performance
↑:	"increase"	Dom.	dominant	Rel'd:	related
↓:	"decrease"	DV:	dependent variable	ROA:	return on Assets
Acq'n:	acquisition	IV:	independent variable	ROE:	return on equity
AT:	agency theory	Mgt.	management	ROS:	return on sales
SM:	strategic management	Mkt.:	market	Sig.:	significant
Div'd:	diversified	Org'n:	organization	Sig'ly	significantly
Div'n:	diversification	Org'l:	organizational	Unrel'd:	unrelated

Table XI. Simulation Guidelines Derived from the Agency and Stewardship Literature

Citation(s)	Topic	Conclusions	Simulation Guideline
(Eisenhardt, 1989; Jensen & Meckling, 1976)	Agency theory	Agency-oriented managers are always trying to increase their remuneration; if it is greater than the firm's profits, the manager diversifies to create further firm profit & personal wealth	Enter agency orientation as a decision rule for deciding the agent's compensation: search is proportional to pay
(Conger et al., 2001; Davis et al., 1997)	Stewardship theory	Managers' and owners' interests may already be aligned to a large extent	Enter stewardship orientation as a decision rule for deciding the agent's compensation: pay is proportional to performance
(Blair, 1995; Quinn & Jones, 1995)	Stakeholder theory	Managers' decisions may be curtailed by other-than-shareholder concerns	Enter stakeholder orientation as a decision rule for setting prices, with pay based on the performance on the supply chain
(Goodstein, 2002; Conger et al., 2001)	Strategic Management & IBV	Managers' interests may be curtailed by strategic concerns	Enter strategy orientation as a decision rule for agent's compensation: pay is proportional to strategic fit

Table XII. Mechanisms that solve the agency problem (after Rediker and Seth, 1995)

<p>Threats (external):</p> <ul style="list-style-type: none"> • Takeover • Competition in product-markets • Competition in managerial labor markets
<p>Monitoring:</p> <ul style="list-style-type: none"> • Outside shareholders • Boards of directors • [also: business press]
<p>Financial Incentives:</p> <ul style="list-style-type: none"> • Stock ownership • Salary & other compensation

Table XIII. Positivist Agency Theory: Empirical Evidence Cited by Eisenhardt (1989)

Author(s)	Sample	Agency Variables	Results
Amihud & Lev (1981)	309 Fortune 500 firms	Manager vs. owner controlled	Support
Walking & Long (1984)	105 U.S. firms	Mgt's equity & options	Support
Wolfson (1985)	39 oil & gas limited partnerships	General partner's track record	Support
Argawal & Mandelker (1987)	209 major corporations	Exec. stock holdings	Support
Kosnik (1987)	110 major corporations	Prop. & equity held by outside dir's; ODs w/exec. experience	Mixed: greenmail: yes; poison pills: no
Barney (1988)	32 Japanese electronics firms	Employee stock ownership	Support
Singh & Harianto (1989)	84 Fortune 500 firms	Managerial stock ownership & takeover threat	Support

Table XIV. Positivist Agency Theory: Empirical Evidence after Eisenhardt (1989)

Author(s)	Sample	Agency Variables	Results
Finklestein & D'Aveni (1994)	Pub. firms: print. & pub.(41), chem.(35), & computer (32) industries	CEO duality (DV), board vigilance, CEO power, CEO shareholdings	Mixed: No: Vigilance ~ -(CEO Duality) Yes: V ~ -(D) ⇒ incr. CEO Power
Frankforter, Berman & Jones (2000)	330 NYSE firms	Shark repellent accept. rate (DV), prop. of inside dir's, CEO comp/TMT comp	Little Support
Rediker & Seth (1995)	81 bank holding companies	Monitoring by large outside shareholders, incentive factors, mutual monitoring	Support
Elloumi & Gueyié (2001)	415 Canadian firms	CEO compensation (DV), investment opportunity set, bd's composition & power	Mixed
Golden & Zajac (2001)	3198 hospitals	Strategic Change (DV), board attention & comprehensiveness of evaluation	Mixed: evidence found for agency, power, & demography

Table XV. Comparison of Simulation Tools

Article	Simulation Tools							
	Simplicity	Hypothesis Development	Pseudorandom # control	Limited Scope	Survival & Evolution	Equilibrium	Extreme Conditions	Data Reproduction
This Study	×	×	×	×	×	×	×	
Axelrod (1980)	×			×			×	
Carley & Prietula (1998)	×	×		×				
Lin (1998)	×			×				
Carley (2000)	×			×			×	
Harrison & Carroll (2000)	×	×		×	×		×	
Carley & Hill (2000)	×	×		×		×		
Macy & Strang (2000)	×			×			×	
Loch, Huberman, et al. (2000)	×	×		×		×		
Prietula (2000)	×			×				
Bothner & White (2000)	×	×		×				
Barron (2000)	×	×		×	×			×
Krackhardt (2000b)	×			×		×	×	
Lomi & Larsen (2000b)	×			×	×		×	
Miller (2000)	×				×		×	
Levinthal (2000)	×			×			×	
Malerba et al. (2000)	×			×				×
Sastry (2000)	×			×		×	×	
Prietula & Watson (2000)	×			×			×	

Table XVI. List of Variables Used in Baseline Validation Study

Variable	Description
PROFIT	Total amount of capital accumulated by an agent.
Longevity	Total life of the agent. If Longevity = 50, then the agent has survived until the end of the simulation.
STATUS	Status at time of death or at the last iteration. Agents with higher status are given priority in interaction and movement.
DIE	Number of contiguous periods of losses before the agent dies. It is generally a characteristic of the tolerance for poor performance.
TYPE	Agent is either a harvester (TYPE=0), manufacturer (TYPE=1), or retailer (TYPE=2).
BUYSELLPREF	Agents choose which candidates to interact with on the basis of candidate's orientation. Used to construct a sorting rule so that candidates with higher desirability are interacted with first. If BUYSELLPREF = 0, agent has a supply-chain orientation; if BUYSELLPREF = 1, agent has a lowest-price buying preference; if BUYSELLPREF = 2, agent prefers to interact with agents of higher STATUS.
AGENTMEM	Number of agents that an agent remembers; i.e. the length of an agent's whitelist, blacklist, INTERACTWITH list, and on an agent's map.
PROPBIAS	CEO's background bias: buying=0; production=1; selling=2. Used as a sorting rule for the disbursement of capital needs. The CEO will satisfy capital needs from his/her own background first.
BIASCHANGE	A number between 0 and 1. If closer to 1.0, the CEO's background bias will change more often, thus representing a more even-handed (& less biased) CEO with regard to the disbursement of capital needs.
Markup	Amount that the agent marks up its price for sale after transforming the unit to a sellable form: $\text{sellprice} = \text{buyprice} + (2 \times \text{Markup})$.
ReactTime*Mag*Prob	Reaction time before an agent attacks a competitor times the magnitude of the attack times the likelihood of attack on any given iteration. The higher this score, the more aggressive toward competitors the agent is expected to be.
TERRITSETUP	If this value is nonzero, it indicates that the agent has set up a stronghold with number equal to the size of the territory.
AVERSION	If AVERSION = 0, the agent moves away from known competitors; if AVERSION = 1, the agent moves toward higher known resources.
MOVE adj	Same as MOVE, but with 0 and 1 switched: when MOVEadj = 0, the agent does not move and tries to set up a stronghold; when MOVEadj = 1, the agent moves a maximum of one square per iteration; when MOVEadj = 2, the agent moves a maximum of two squares per iteration.
Change	Value from 0 to 1. The higher this value is, the more frequently it will change either incrementally or transformationally.
SEARCHLAND	Maximum number of squares searched per iteration, up to what is affordable.
THRESHFLEX	Flexibility threshold: after interaction with agent, if profits > THRESHFLEX, place interacting agents on WHITELIST; if losses are > THRESHFLEX, place interacting agents on BLACKLIST.

Table XVII. Baseline Validation Analysis

Analysis Method:		Intended to Confirm:
Chart of number alive across iterations		Equilibrium state arrived at (number of iterations is sufficient); separation of complexity across simulations; Resource Dependence
Pearson χ^2 contingency table tests or Wilcoxon rank-sum tests on each variable in Table XVI significant differences between surviving agents and those agents that died within the first 30 iterations.		Population Ecology
Regression		
Dependent Variables:	PROFIT	Strategic Choice
	Longevity	Institutional Theory
Independent Variables:	STATUS	Institutional Theory
	AGENTMEM, SearchLand, MOVE, THRESHFLEX	Behavioral Decision Theory; Strategic Choice
	Choice	Strategic Choice <i>and</i> Institutional Theory
	BIASCHANGE	Strategic Choice <i>or</i> Institutional Theory
	Markup, ReactTime*Mag*Prob, AVERSION	Strategic Choice
	PROPBIAS, BUYSELLPREF	Enactment
	All Together	Significance of simulation model
Pearson χ^2 contingency table tests or Wilcoxon rank-sum tests on each variable in Table XVI significant differences between agents in least and most harsh landscapes.		Contingency Theory
2-Way ANOVA on Landscapes		
Main Factor: Munificence	Compare End-of Simulation total resources	Contingency Theory; Resource Dependence
Main Factor: Dynamism	Compare End-of Simulation total resources	
Main Factor: Complexity	Compare End-of Simulation total alive	

Note: TCE efficiency is confirmed in the diversification extension.

Table XVIII. Diversification Extension Analysis.

Analysis Method:		Intended to Study:
Chart of number alive across iterations		Equilibrium state arrived at (number of iterations is sufficient)
Regression		
Dependent Variables:	PROFIT	Compare to baseline validation results
	Longevity	
Independent Variables:	All independent variables listed in Table XVII.	
Student's t-test or Wilcoxon rank sum test for differences between samples		
Munificence: high & low	Compare best vs. worst diversification strategy in terms of profit & longevity	
Dynamism: high & low		
Complexity: high & low		
Environmental Harshness: high & low		

Note: a "CEO agent" is defined as an agent that owns at least one other agent (i.e. NumSBUs > 0).

Table XIX. CEO Payrule Extension Analysis

Analysis Method:		Intended to Study:	
Chart of number alive across iterations		Equilibrium state arrived at (number of iterations is sufficient)	
Regression			
Dependent Variables:	PROFIT	Compare to baseline validation results	
	Longevity		
Independent Variables:	All independent variables listed in Table XVII.		
2-Way ANOVA on Landscapes			
Main Factor: Munificence	Compare end-of-simulation total resources/total alive		
Main Factor: Dynamism			
Main Factor: Complexity			
Student's t-test or Wilcoxon rank sum test for differences between samples (Extension #1)			Contingency Theory of CEO Behavior
Munificence: high & low	Compare best vs. worst payrule in terms of profit & longevity		
Dynamism: high & low			
Complexity: high & low			
Environmental Harshness: high & low			
Frequency Histograms of (CEO Extension #2)			
Main Factor: Munificence	Compare shapes of frequency distributions		
Main Factor: Dynamism			
Main Factor: Complexity			

Table XX. Table of Correlations, Baseline Simulation Variables.

	PROFIT	Longevity	STATUS	DIE	BUYSELLPREF	AGENTMEM	PROPBias	BIASCHANGE	Markup	ReactTime*Mag*Prob	TERRITSETUP	AVERSION	MOVE	adj	Change	SEARCHLAND	THRESHFLEX
PROFIT	1.00																
Longevity	0.26	1.00															
STATUS	0.12	0.33	1.00														
DIE	0.05	0.33	0.16	1.00													
BUYSELLPREF	0.02	-0.01	0.01	-0.01	1.00												
AGENTMEM	-0.03	-0.03	-0.01	-0.01	0.00	1.00											
PROPBias	-0.07	0.00	-0.01	-0.01	0.00	0.00	1.00										
BIASCHANGE	0.00	0.05	0.00	-0.01	0.00	0.01	0.00	1.00									
Markup	0.11	0.17	0.08	0.04	-0.01	-0.02	-0.01	0.00	1.00								
ReactTime*Mag*Prob	0.00	0.00	0.01	0.00	0.01	-0.01	0.00	0.02	0.00	1.00							
TERRITSETUP	-0.04	0.10	-0.02	0.08	-0.01	-0.02	0.00	0.01	-0.03	0.03	1.00						
AVERSION	0.00	-0.01	-0.09	0.00	0.00	0.02	0.02	-0.02	0.01	0.01	0.02	1.00					
MOVE adj	0.04	-0.03	0.03	-0.05	0.01	0.02	0.01	0.00	0.01	-0.01	-0.47	-0.01	1.00				
Change	0.02	0.03	0.02	-0.03	-0.01	-0.02	0.01	0.00	0.04	0.01	-0.01	0.01	-0.01	1.00			
SEARCHLAND	-0.05	-0.06	-0.03	-0.01	0.02	0.01	0.00	0.00	0.01	0.02	-0.10	-0.02	-0.24	0.02	1.00		
THRESHFLEX	0.03	0.01	-0.01	0.00	0.00	-0.01	-0.02	0.00	0.02	0.02	0.01	0.01	-0.01	0.00	-0.02	1.00	

Table XXI. Summary of two-sample difference tests between early dead and survived agents:
Baseline Simulation

Variable	Average, Early Dead (Died within 1 st 30 iterations)	Average, Survived	P-value of ANOVA Test
PROFIT	-0.511	1.27	0.00E+00*
STATUS	66.7	122.0	0.00E+00*
DIE	14.6	17.5	0.00E+00*
TYPE	0.582	1.56	0.00E+00**
BUYSELLPREF	0.985	0.984	0.8744**
AGENTMEM	20.31	19.88	0.0163*
PROPBIAS	0.970	0.970	0.9583**
BIASCHANGE	0.485	0.517	6.35E-06*
Markup	4.56	5.66	0.00E+00*
ReactTime*Mag*Prob	8.14	8.10	0.6833*
TERRITSETUP	1.34	2.56	0.0021*
AVERSION	0.500	0.484	0.2331**
MOVE adj	1.030	1.004	2.24E-08**
Change	0.546	0.579	0.0002*
SEARCHLAND	22.33	21.26	1.30E-07*
THRESHFLEX	4.028	4.067	0.4802*

* p-value for Wilcoxon Rank Sum Test; ** p-value for a Pearson χ^2 contingency table test

Table XXII. Summary of two-sample difference tests between agents in most and least harsh environments: Baseline Simulation

Variable	Average, Least Harsh	Average, Most Harsh	P-value of ANOVA Test
PROFIT	1.18	1.24	0.6761*
STATUS	148.9	70.7	0.00E+00*
DIE	17.9	17.3	0.0260*
TYPE	1.46	1.56	0.0684**
BUYSELLPREF	0.96	0.98	0.4309**
AGENTMEM	20.22	19.98	0.5925*
PROPBIAS	0.92	0.93	0.9517**
BIASCHANGE	0.53	0.52	0.3627*
Markup	5.35	5.66	0.0308*
ReactTime*Mag*Prob	8.40	7.86	0.2694*
TERRITSETUP	4.49	1.63	0.00E+00*
AVERSION	0.52	0.48	0.2369**
MOVE adj	0.95	1.03	5.97E-08**
Change	0.57	0.58	0.8215*
SEARCHLAND	20.54	21.22	0.1603*
THRESHFLEX	4.12	4.07	0.7259*

* p-value for Wilcoxon Rank Sum Test; ** p-value for a Pearson χ^2 contingency table test

Table XXIII. Summary of two-sample difference tests between early dead and survived agents:
Diversification Extension

Variable	Average, Early Dead (Died within 1 st 30 iterations)	Average, Survived	P-value of ANOVA Test
PROFIT	-4.00	-0.90	0.00E+00*
STATUS	53.36	115.7	0.00E+00*
DIE	14.5	17.5	0.00E+00*
TYPE	0.66	1.33	2.26E-265**
BUYSELLPREF	1.01	0.98	0.1759**
AGENTMEM	19.90	20.16	0.1530*
PROPBIA	0.98	0.99	0.0452**
BIASCHANGE	0.49	0.51	0.0006*
Markup	4.46	5.06	0.00E+00*
ReactTime*Mag*Prob	8.34	8.35	0.8575*
TERRITSETUP	1.38	2.71	0.4864*
AVERSION	0.51	0.49	0.1157**
MOVE adj	1.01	1.00	1.09E-05**
Change	0.67	0.87	0.00E+00*
SEARCHLAND	22.00	22.03	0.9244*
THRESHFLEX	4.10	4.06	0.4489*
NumSBUs	0.87	0.32	0.00E+00*
DIVERSIFIED	0.49	0.65	8.80E-198**
PROPENDING	4.89	4.15	1.51E-49**
ACQRACCEPT	0.45	0.45	0.8796*
THRESHDIVFY	16.98	18.00	4.65E-08*

* p-value for Wilcoxon Rank Sum Test; ** p-value for a Pearson χ^2 contingency table test

Table XXIV. Summary of two-sample difference tests between agents in most and least harsh environments: Diversification Extension

Variable	Average, Least Harsh	Average, Most Harsh	Test P-value
PROFIT	-2.64	-3.97	0.0386*
STATUS	128.91	46.60	0.00E+00*
DIE	16.63	16.72	0.6493*
TYPE	1.18	1.12	0.1685**
BUYSELLPREF	1.04	0.97	0.1380**
AGENTMEM	19.83	20.23	0.2079*
PROPBias	0.96	0.995	0.6227**
BIASCHANGE	0.500	0.498	0.8397*
Markup	5.28	5.18	0.3705*
ReactTime*Mag*Prob	8.87	8.24	0.2274*
TERRITSETUP	3.22	1.46	0.00E+00*
AVERSION	0.479	0.488	0.6991**
MOVE adj	1.100	1.017	4.75E-43**
Change	0.799	0.867	0.0012*
SEARCHLAND	22.60	21.86	0.0395*
THRESHFLEX	3.95	4.11	0.0926*
NumSBUs	0.71	0.87	0.4849*
DIVERSIFIED	0.64	0.73	5.27E-08**
PROPENDIVERS	4.44	4.47	0.1007**
ACQRACCEP	0.456	0.450	0.5430*
THRESHDIVFY	17.29	17.60	0.3451*

* p-value for Wilcoxon Rank Sum Test; ** p-value for a Pearson χ^2 contingency table test

Table XXV. Summary of T-Test Difference Tests: PROFIT Averages Compared by Diversification Strategy

Diversification Strategy:	Environment:							
	Munificence		Dynamism		Complexity		Harshness	
	Low (2.76E-8)	High (8.3E-06)	Low (0.0590)	High (4.68E-7)	Low (9.84E-7)	High (2.07E-8)	Least (0.0219)	Most (4.93E-5)
Single Business					Worst [-0.42]	Best [-0.11]		Best [-0.20]
Vertical Integration		Best [-0.28]	Best [0.05]			Best [-0.12]		Best [-0.14]
Dominant Constrained				Best [-0.27]				
Dominant Linked			Worst [-0.45]	Best [-0.31]		Best [-0.25]		
Related Constrained	Best [0.06]	Best [-0.16]	Best [0.28]		Best [0.16]		Best [0.20]	Worst [-0.86]
Related Linked	Best [-0.04]				Best [0.12]		Best [0.41]	Best [-0.26]
Unrelated Passive	Worst [-3.58]	Worst [-2.70]	Worst [-3.55]	Worst [-3.77]	Worst [-4.10]	Worst [-2.42]	Worst [-3.51]	Worst [-4.22]
Acquisitive Conglomerate	Worst [-19.3]	Worst [-15.29]	Worst [-23.18]	Worst [-21.38]	Worst [-16.71]	Worst [-16.54]	Worst [-19.2]	Worst [-23.7]

Note: Number indicated in parentheses is the p-value of the t-test for nearest best & worst; number indicated between brackets is the average PROFIT calculated.

Table XXVI. Summary of Wilcoxon Rank Sum Difference Tests: Longevity Averages Compared by Diversification Strategy

Diversification Strategy:	Environment:							
	Munificence		Dynamism		Complexity		Harshness	
	Low (2.46E-4)	High (0.0513)	Low (0.0088)	High (0.0610)	Low (0.0377)	High (0.0276)	Least (0.1249)	Most (0.0665)
Single Business	Worst [39.64]	Worst [39.58]			Worst [39.61]	Worst [39.75]		
Vertical Integration			Best [42.99]		Best [43.06]	Best [41.77]	Best [42.39]	Best [42.29]
Dominant Constrained				Best [41.69]		Best [41.76]		Best [41.77]
Dominant Linked		Best [41.43]		Best [40.85]			Best [43.10]	
Related Constrained	Best [43.23]		Best [41.10]					
Related Linked	Best [43.36]	Best [41.92]			Best [42.22]			
Unrelated Passive	Worst [38.10]	Worst [38.36]	Worst [37.61]	Worst [38.25]	Worst [38.50]	Worst [38.13]	Worst [36.49]	Worst [38.07]
Acquisitive Conglomerate	Worst [33.14]		Worst [36.58]	Worst [35.49]		Worst [37.18]	Worst [38.31]	Worst [32.54]

Note: Number indicated in parentheses is the p-value of the Wilcoxon rank sum test; number indicated between brackets is the average Longevity calculated.

Table XXVII. Summary of two-sample difference tests between early dead and survived agents: First CEO Extension

Variable	Average, Early Dead (Died within 1 st 30 iterations)	Average, Survived	P-value of ANOVA Test
PROFIT	-2.79	-15.77	0.00E+00*
STATUS	55.35	117.9	0.00E+00*
DIE	14.6	17.56	0.00E+00*
TYPE	0.67	1.31	2.54E-256**
BUYSELLPREF	0.995	0.999	0.9150**
AGENTMEM	20.23	20.02	0.2350*
PROPBIAIS	1.011	0.996	0.5217**
BIASCHANGE	0.486	0.508	0.0023*
Markup	4.70	5.55	0.00E+00*
ReactTime*Mag*Prob	12.28	14.60	0.00E+00*
TERRITSETUP	1.33	2.61	0.0558*
AVERSION	0.52	0.48	0.0106**
MOVE adj	1.22	1.26	0.0147**
Change	0.837	1.041	0.00E+00*
SEARCHLAND	22.26	22.22	0.8091*
THRESHFLEX	4.100	4.064	0.5272*
NumSBUs	0.61	0.37	0.0002*
DIVERSIFIED	0.41	0.67	3.29E-186**
PROPENDINGERS	4.86	4.17	1.49E-50**
ACQRACCEP	0.465	0.462	0.6420*
THRESHDIVFY	17.46	17.44	0.8949*
Agency Pay	0.505	0.496	0.2144*
Stakeholder Pay	0.503	0.506	0.6652*

* p-value for Wilcoxon Rank Sum Test; ** p-value for a Pearson χ^2 contingency table test

Table XXVIII. Summary of two-sample difference tests between agents in most and least harsh environments: First CEO Extension

Variable	Average, Least Harsh	Average, Most Harsh	P-value of ANOVA Test
PROFIT	-11.39	-14.08	0.0004*
STATUS	132.13	48.35	0.00E+00*
Longevity	39.62	41.38	0.0062*
DIE	16.79	16.27	0.0120*
TYPE	1.072	1.118	0.4247**
BUYSELLPREF	1.013	0.994	0.7175**
AGENTMEM	19.87	20.07	0.5134*
PROPBIAIS	0.954	1.035	2.75E-55**
BIASCHANGE	0.500	0.497	0.8146*
Markup	5.19	5.25	0.6069*
ReactTime*Mag*Prob	13.16	13.85	0.4571*
TERRITSETUP	3.545	1.380	0.00E+00*
AVERSION	0.513	0.488	0.2605**
MOVE adj	1.229	1.269	1.76E-07**
Change	0.977	1.012	0.0501*
SEARCHLAND	22.27	22.40	0.7051*
THRESHFLEX	4.098	4.040	0.5499*
NumSBUs	0.661	0.778	0.0119*
DIVERSIFIED	0.606	0.711	5.10E-05**
PROPENDINGERS	4.466	4.545	0.3114**
ACQRACCEPT	0.466	0.469	0.9316*
THRESHDIVFY	17.08	17.66	0.0756*
Agency Pay	0.514	0.489	0.0421*
Stakeholder Pay	0.507	0.500	0.5755*

* p-value for Wilcoxon Rank Sum Test; ** p-value for a Pearson χ^2 contingency table test

Table XXIX. Summary of Histogram Peaks, Second CEO Extension

Payrule Environment		Payrule Proportion at Peak All Agents		Payrule Proportion at Peak Survivors	
		Primary Peak	Secondary/ Tertiary Peak	Primary Peak	Secondary/ Tertiary Peak
Agency	Low Munificence	0.60	0.40	0.70	0.40
	High Munificence	0.65	0.45	0.65	0.70
	Low Dynamism	0.70	0.45	0.70	0.60
	High Dynamism	0.60	0.45	0.60	0.50
	Low Complexity	0.65	0.45	0.65	0.45/0.85
	High Complexity	0.60	0.45	0.60	0.45
	Least Harsh Env.	Multiple Peaks from 0.35 to 0.8		0.35	0.50
	Most Harsh Env	0.60	0.45/0.80	0.60	0.40
Stakeholder	Low Munificence	0.35	0.50/0.65	0.35	0.50/0.65
	High Munificence	0.40	0.65/0.75	0.65	0.40/0.50
	Low Dynamism	0.35	0.65/0.90	0.50	0.65/0.90
	High Dynamism	0.40	0.60	0.40	0.50/0.65
	Low Complexity	0.35	0.50	0.375	0.50
	High Complexity	0.35	0.65	0.40	0.50/0.65
	Least Harsh Env.	0.45	0.30/0.90	0.45	0.90
	Most Harsh Env.	0.35	0.65	0.40	0.70

Table XXX. Proposed Sensitivity Analysis for Future Study

Specification	Sensitivity
Algorithm 1.1, line 23 PEAKS[i, j, k] = 5*(i ²)	Compare “5” to A = 5 to 15 in increments of 1; Compare “i ² ” to 2*i, and i ³
Algorithm 1.1, line 24 MAXPEAK[i, j, k] = 5*i	Compare “5” to B = 5 to 15 in increments of 1
Algorithm 1.1, line 26 RESETFREQ[i, j, k] = (4 - j) ³	Compare (4 - j) ³ to (4 - j) and (4 - j) ²
Algorithm 1.1, lines 34-35: At 5x5 & 6x6 square perimeters around each peak, set RESOURCEMAX to MINPEAK + 1	Compare “5x5 & 6x6” to none (resulting in sharper peaks) and “8x8 to 10x10”
Algorithm 1.1, lines 36-37: At 3x3 & 4x4 square perimeters around each peak, set RESOURCEMAX to MINPEAK + (MAXPEAK*1/3)	Compare “3x3 & 4x4” to “3x3” (sharper peaks) and “4x4 to 7x7”
Algorithm 1.1, lines 38-39: For 2 squares away from each peak, set RESOURCEMAX to MINPEAK + (MAXPEAK*2/3)	Compare “2 squares” to “1 square” and “3 squares”
Algorithm 1.2, lines 73-75: THRESHFLEX = RAND[0.1, ..., 8.0] (flexibility threshold: after interaction with agent, if profits > THRESHFLEX, place on WHITELIST; if losses are > THRESHFLEX, place on BLACKLIST)	Compare “RAND[0.1, ..., 8.0]” to “RAND[0.01, ..., 1.0]” and agent-optimizable based on PROFIT
Algorithm 1.3, lines 9-10, 15-17, 20-21 Allocation of CAPITAL to CAPALLOCATD based on PROPBIAS	Use, or add, different allocation rules.
Agents purchase in lumps	Compare to agents purchasing one unit at a time and purchasing contingent on perceived uncertainty
Algorithm 2.1, lines 68-69: IF {PROFIT of candidate > 0}, Capital Required = (5 + 2*PROFIT of candidate)	Compare (5+2*PROFIT) to (5+C*PROFIT) where C = 0.5 to 10 in increments of 0.5

FIGURES

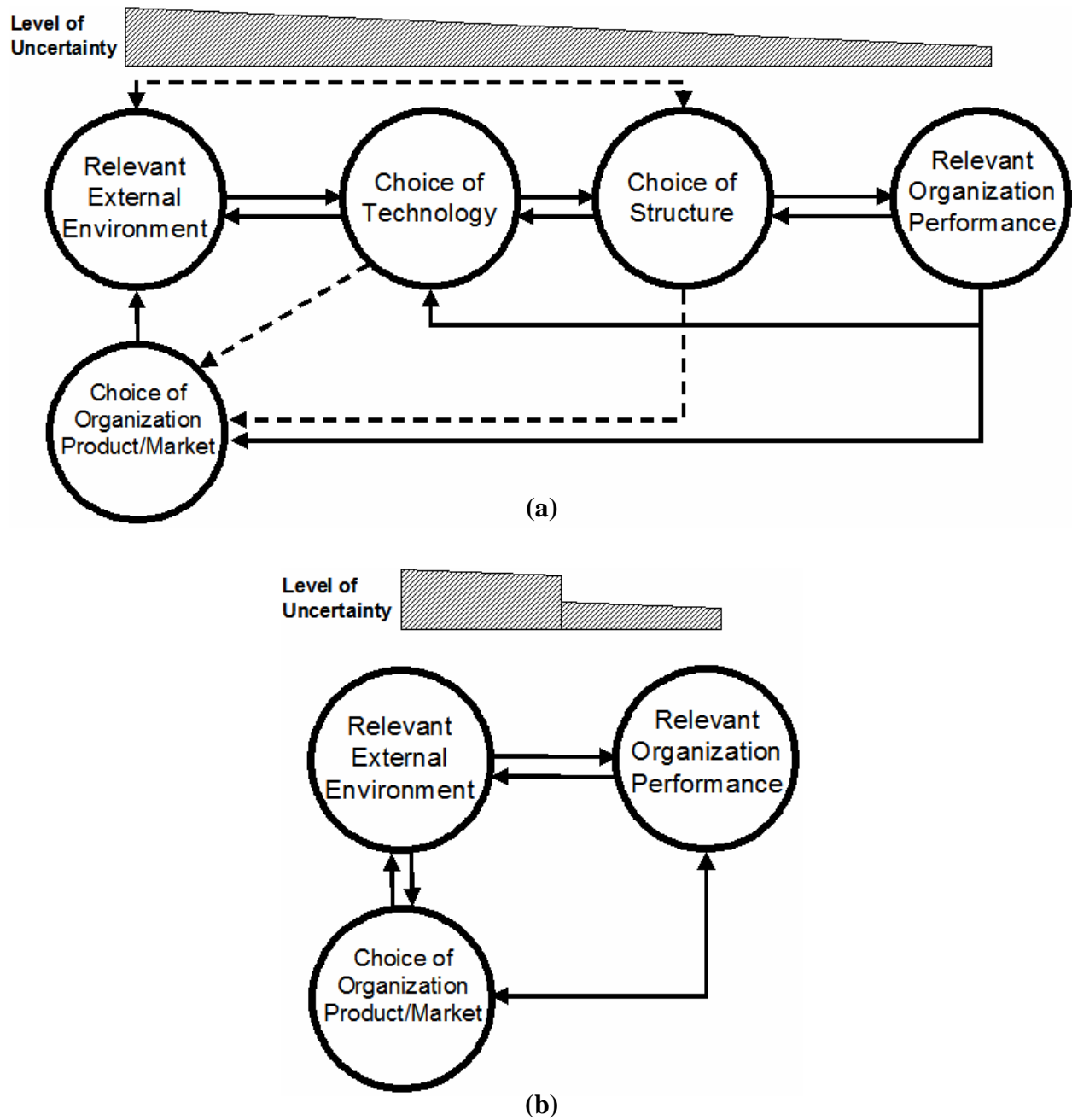


Figure 1. Integrated congruence model of organization-environment interaction (a) taken from Randolph & Dess (1984), and (b) reduced model as implied by Porter (1980) and applied toward a baseline simulation in this study.

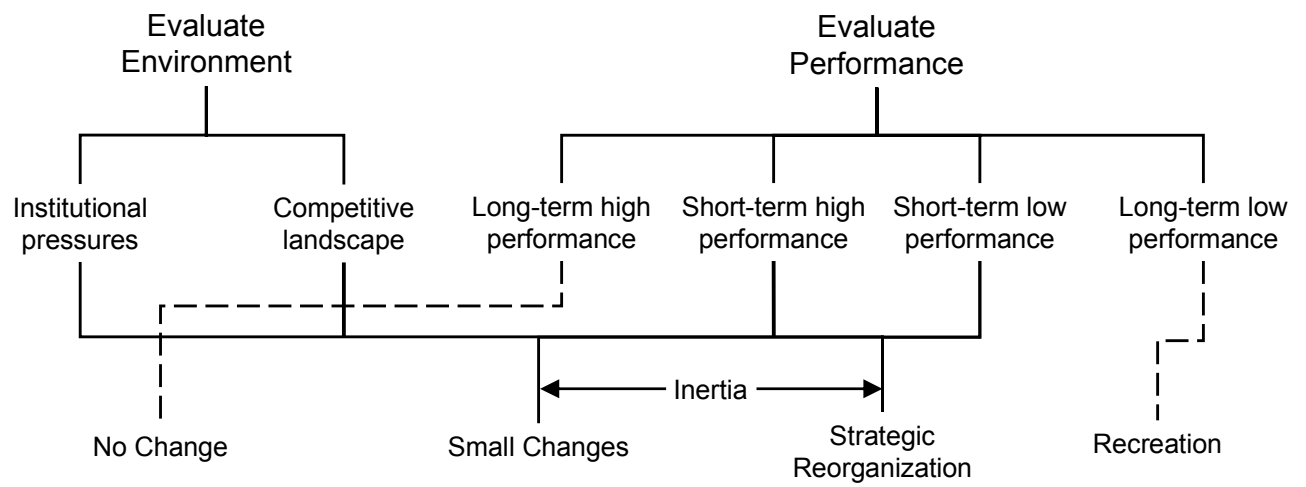


Figure 2. Decision hierarchy as derived from Tushman & Romanelli (1985) and Prahalad & Bettis (1986).

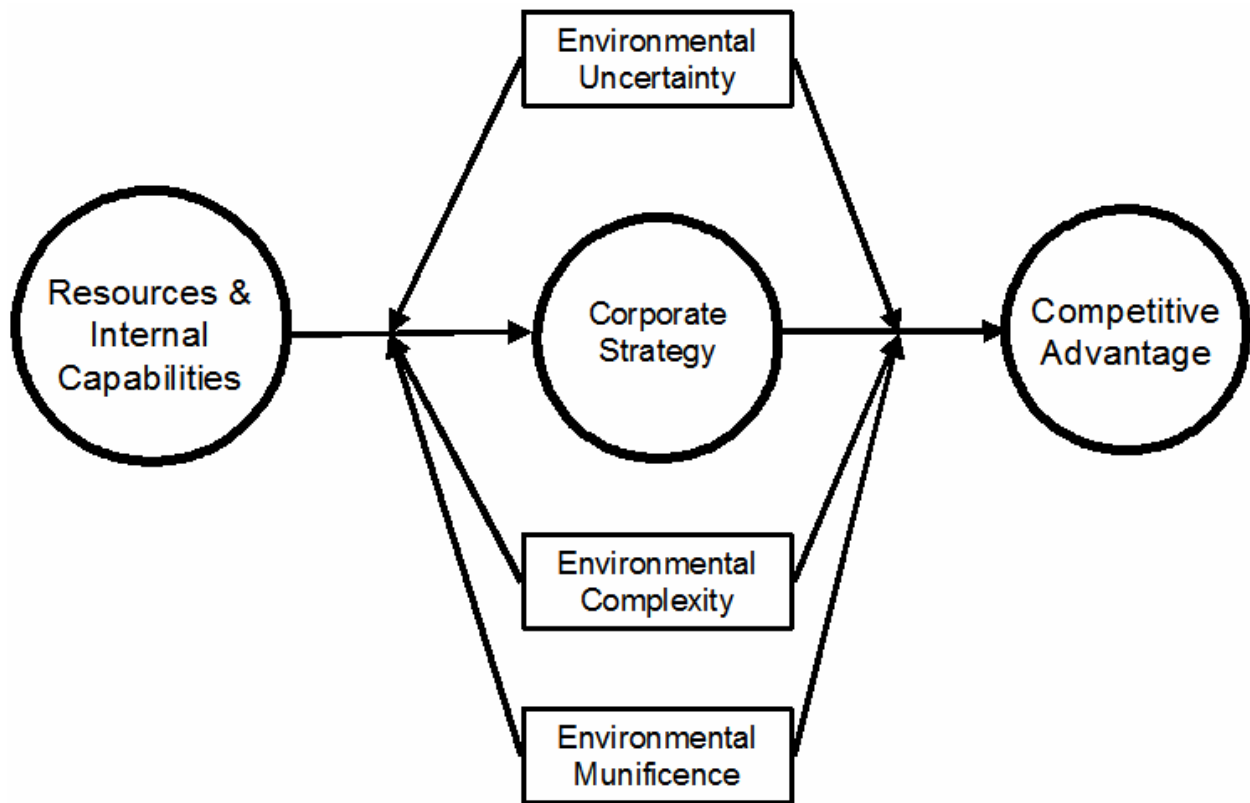


Figure 3. A contingency theory view of the strategic process, after Aragon-Correa & Sharma (2003).

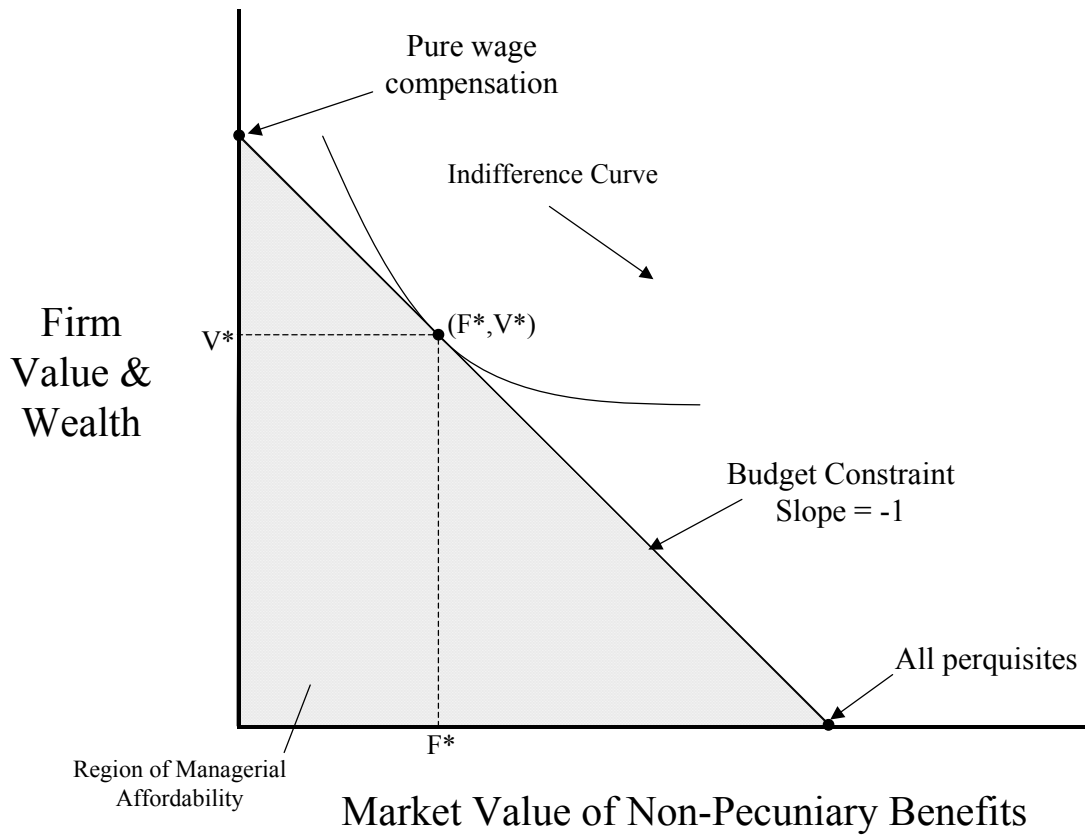


Figure 4. Owner-Manager tradeoff between sole and partial ownership (adapted from Jensen & Meckling, 1976).

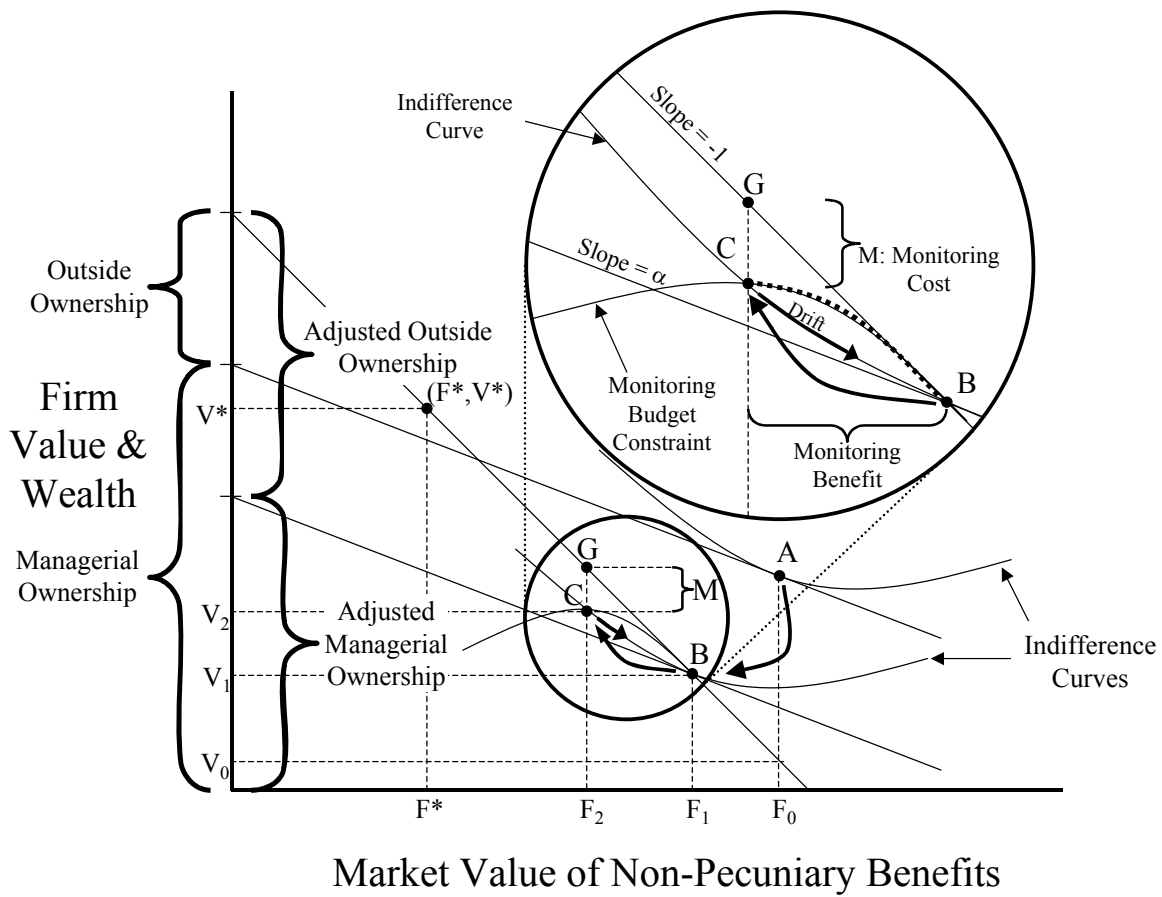


Figure 5. Dynamic positioning between owners and manager: Drift of the manager's pay package point (adapted from Jensen & Meckling, 1976).

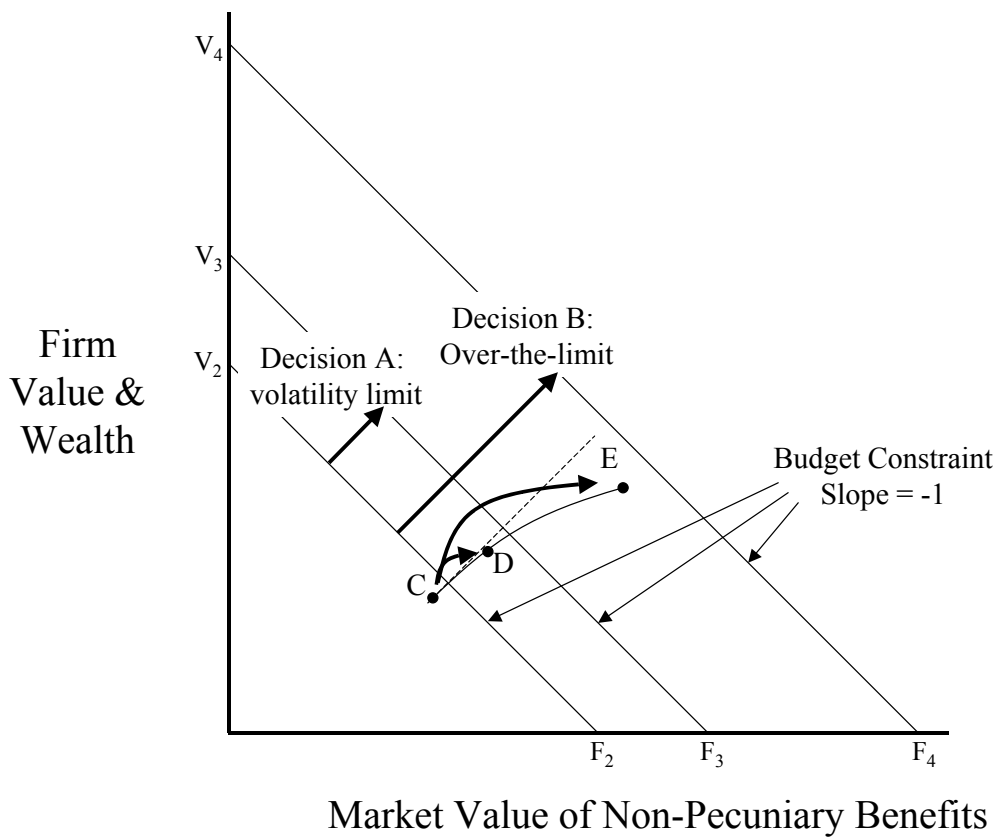


Figure 6. Drift of the pay package point by way of organizational expansion.

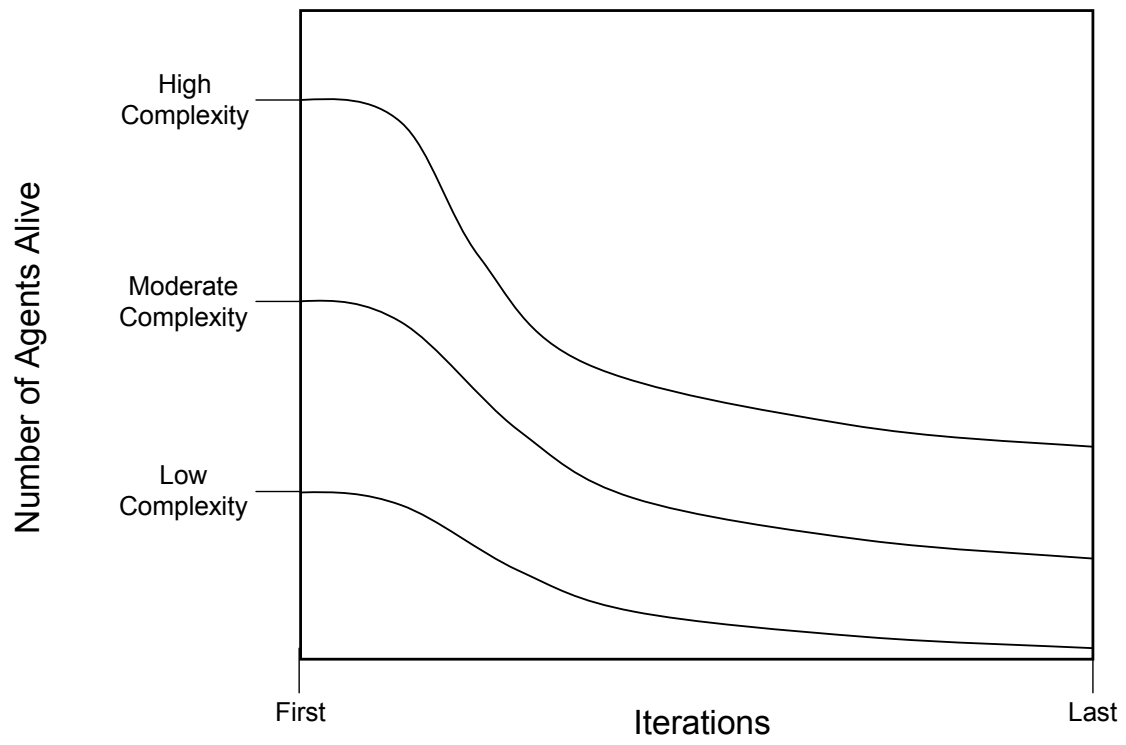


Figure 7. Expected death rate curves.

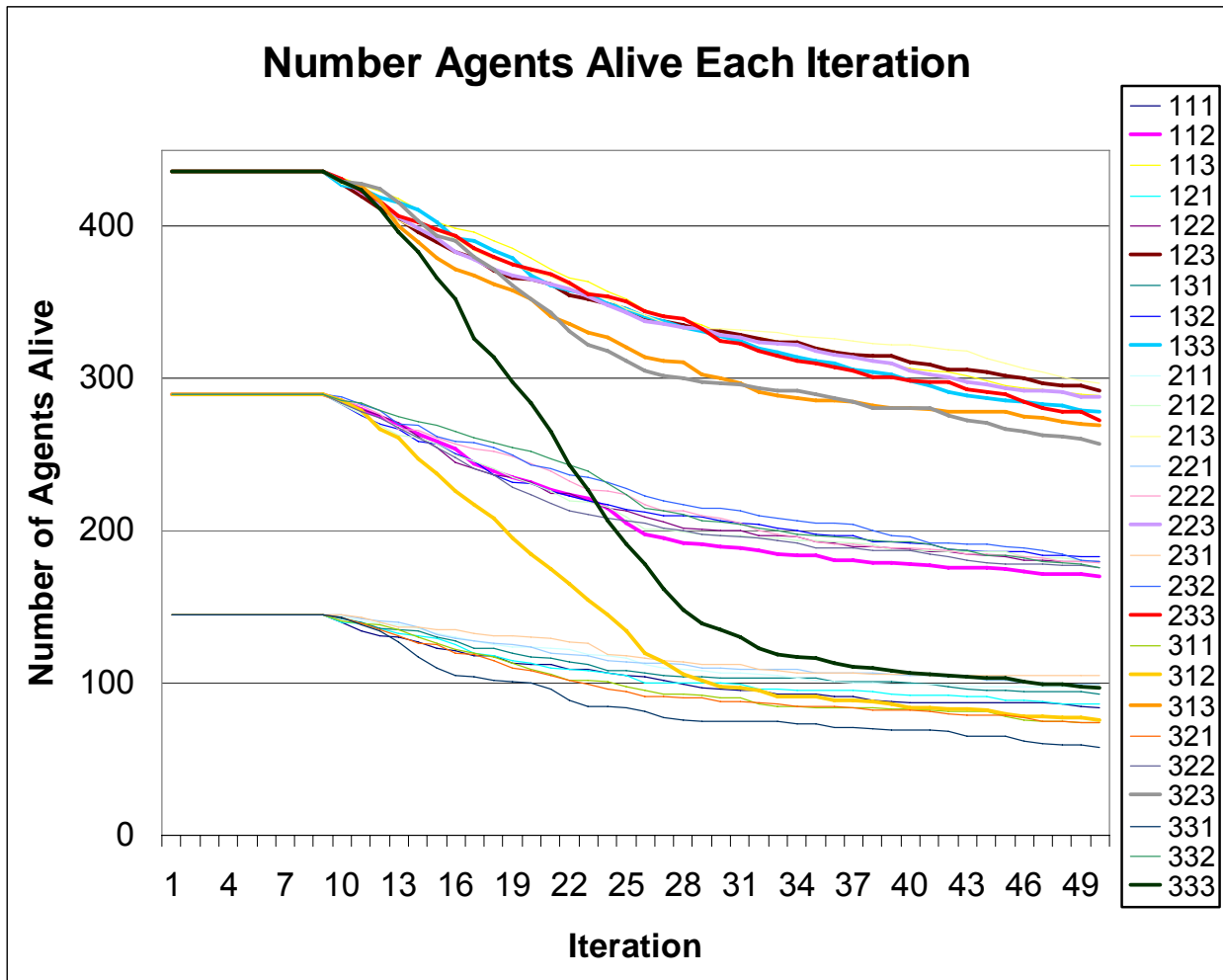


Figure 8. Death curves for each landscape in the baseline simulation.

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*** Linear Model ***

Call: lm(formula = PROFIT ~ STATUS + DIE + BUYSSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + Change +
  SEARCHLAND + SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2, data =
  Baseline.Results.Final2, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-40.51 -0.8084  0.1323  1.242  35.77

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)  -1.2354   0.4578   -2.6988  0.0070
      STATUS    0.0037   0.0004    8.9058  0.0000 **
      DIE       0.0164   0.0069    2.3932  0.0167 **
  BUYSSELLPREF  0.0770   0.0408    1.8847  0.0595 **?
    AGENTMEM    0.0092   0.0292    0.3136  0.7538
  AGENTMEM^2  -0.0005   0.0007   -0.6753  0.4995
    PROPBIAS  -0.2474   0.0408   -6.0647  0.0000 **
  BIASCHANGE   0.0554   0.1147    0.4832  0.6290
      Markup   0.4684   0.0582    8.0455  0.0000 **
  Markup^2    -0.0333   0.0053   -6.2499  0.0000 **
  ReactTime.Mag.Prob  0.0158  0.0114    1.3810  0.1673
  ReactTime.Mag.Prob.2 -0.0005  0.0004   -1.4679  0.1422
  TERRITSETUP -0.0163  0.0064   -2.5694  0.0102 **
    AVERSION   0.0687   0.0670    1.0255  0.3052
    MOVE.adj   0.0699   0.0695    1.0062  0.3144
      Change   0.1013   0.1122    0.9026  0.3668
  SEARCHLAND  -0.0195   0.0252   -0.7756  0.4380
  SEARCHLAND^2  0.0001   0.0006    0.1342  0.8932
  THRESHFLEX   0.0960   0.0597    1.6073  0.1080
  THRESHFLEX^2 -0.0081   0.0072   -1.1293  0.2588

```

```

Residual standard error: 2.946 on 7819 degrees of freedom
Multiple R-Squared: 0.0411
F-statistic: 17.64 on 19 and 7819 degrees of freedom, the p-value is 0

```

Figure 9. S-Plus output for multiple linear regression of baseline simulation variables, with PROFIT as the dependent variable.


```

*** Linear Model ***

Call: lm(formula = Longevity ~ STATUS + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + Change +
  SEARCHLAND + SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2, data =
  Baseline.Results.Final2, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-36.67 -12.42  3.939  10.37  28.18

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)  8.3123   1.9974   4.1617  0.0000
      STATUS  0.0493   0.0018  26.9304  0.0000 **
        DIE   0.8212   0.0299  27.4263  0.0000 **
BUYSELLPREF -0.1233   0.1782  -0.6919  0.4890
  AGENTMEM   -0.0054   0.1274  -0.0425  0.9661
  AGENTMEM.2 -0.0009   0.0031  -0.2787  0.7805
  PROPBIAS   0.0704   0.1780   0.3955  0.6925
  BIASCHANGE  2.6869   0.5003   5.3706  0.0000 **
      Markup  3.5954   0.2540  14.1536  0.0000 **
      Markup.2 -0.2680   0.0233 -11.5153  0.0000 **
ReactTime.Mag.Prob -0.0187   0.0499  -0.3745  0.7080
ReactTime.Mag.Prob.2  0.0005   0.0016   0.3359  0.7369
  TERRITSETUP  0.2131   0.0277   7.6875  0.0000 **
      AVERSION  0.2437   0.2923   0.8338  0.4044
      MOVE.adj  0.3162   0.3032   1.0428  0.2971
      Change   1.4081   0.4898   2.8751  0.0040 **
  SEARCHLAND   0.1374   0.1100   1.2493  0.2116
  SEARCHLAND.2 -0.0046   0.0024  -1.9080  0.0564 **?
  THRESHFLEX  -0.1555   0.2605  -0.5969  0.5506
  THRESHFLEX.2  0.0207   0.0312   0.6647  0.5063

Residual standard error: 12.85 on 7819 degrees of freedom
Multiple R-Squared: 0.2361
F-statistic: 127.2 on 19 and 7819 degrees of freedom, the p-value is 0

```

Figure 10. S-Plus output for multiple linear regression of baseline simulation variables, with Longevity as the dependent variable.

```

*** Linear Model ***

Call: lm(formula = PROFIT ~ DIE + STATUS + BUYSHELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + Change +
  THRESHFLEX + THRESHFLEX.2 + SEARCHLAND + SEARCHLAND.2, data =
  Baseline.Results.Final.Survived, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-40.94 -0.5487  0.4637  0.9975  34.52

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)  0.4325  0.6871    0.6295  0.5291
          DIE -0.0438  0.0100   -4.3657  0.0000 **
          STATUS  0.0012  0.0006    2.0037  0.0452 **
  BUYSHELLPREF  0.1180  0.0592    1.9920  0.0464 **
          AGENTMEM  0.0041  0.0423    0.0976  0.9223
  AGENTMEM^2 -0.0004  0.0010   -0.3528  0.7243
          PROPBIAS -0.2157  0.0593   -3.6359  0.0003 **
          BIASCHANGE -0.1662  0.1673   -0.9934  0.3206
          Markup  0.4949  0.0954    5.1865  0.0000 **
  Markup^2 -0.0348  0.0083   -4.1896  0.0000 **
  ReactTime.Mag.Prob  0.0289  0.0164    1.7643  0.0777
  ReactTime.Mag.Prob^2 -0.0010  0.0005   -1.9609  0.0499 **
          TERRITSETUP -0.0285  0.0081   -3.5022  0.0005 **
          AVERSION  0.1381  0.0971    1.4223  0.1550
          MOVE.adj  0.0859  0.0950    0.9037  0.3662
          Change -0.0171  0.1686   -0.1015  0.9191
          THRESHFLEX  0.2245  0.0867    2.5889  0.0097 **
  THRESHFLEX^2 -0.0201  0.0104   -1.9430  0.0521 **?
          SEARCHLAND -0.0208  0.0365   -0.5701  0.5686
  SEARCHLAND^2  0.0001  0.0008    0.1472  0.8830

Residual standard error: 3.289 on 4620 degrees of freedom
Multiple R-Squared:  0.03076
F-statistic: 7.718 on 19 and 4620 degrees of freedom, the p-value is 0

```

Figure 11. S-Plus output for multiple linear regression of baseline simulation variables for surviving agents, with PROFIT as the dependent variable.

Munificence (i)
Total Resources on Landscape

1	2	3
364	338	424
310	386	401
278	375	401
364	336	359
360	303	331
259	324	328
790	1430	2224
601	1338	1812
491	1060	1916

Anova: Two-Factor Without Replication

	<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
1	Row 1	3	1126	375	1931
1	Row 2	3	1096	365	2394
1	Row 3	3	1055	352	4208
2	Row 4	3	1059	353	218
2	Row 5	3	995	332	824
2	Row 6	3	911	304	1497
3	Row 7	3	4444	1481	516065
3	Row 8	3	3751	1250	372394
3	Row 9	3	3467	1156	514520
i = 1		9	3817	424	30329
i = 2		9	5890	654	227190
i = 3		9	8197	911	660445

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	5582259	8	697782	6.338	0.0009	2.591
Columns	1066642	2	533321	4.844	0.0226	3.634
Error	1761461	16	110091			
Total	8410362	26				

Figure 12. Two-way ANOVA results for baseline simulation comparing differences between means of total resources left on landscapes at termination at different levels of munificence.

Dynamism (j)
Total Resources on Landscape

1	2	3
364	364	790
310	360	601
278	259	491
338	336	1430
386	303	1338
375	324	1060
424	359	2224
401	331	1812
401	328	1916

Anova: Two-Factor Without Replication

<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Row 1	3	1518	506	60538
Row 2	3	1271	424	24234
Row 3	3	1028	343	16580
Row 4	3	2104	701	398104
Row 5	3	2027	676	330715
Row 6	3	1759	586	168982
Row 7	3	3007	1002	1120304
Row 8	3	2544	848	698259
Row 9	3	2646	882	803452
j = 1	9	3277	364	2240
j = 2	9	2964	329	1095
j = 3	9	11662	1296	371793

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	1168026	8	146003	1.274	0.3224	2.591
Columns	5409340	2	2704670	23.609	1.68E-05	3.634
Error	1832997	16	114562			
Total	8410362	26				

Anova: Two-Factor Without Replication

<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Row 1	2	728	364	0.194
Row 2	2	670	335	1290
Row 3	2	537	269	185.6
Row 4	2	674	337	2.229
Row 5	2	689	345	3452
Row 6	2	699	349	1339
Row 7	2	783	392	2090
Row 8	2	732	366	2416
Row 9	2	730	365	2674
j = 1	9	3277	364	2240
j = 2	9	2964	329	1095

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	18686	8	2336	2.337	0.1256	3.44
Columns	5454	1	5454	5.458	0.0477	5.32
Error	7995	8	999			
Total	32136	17				

Figure 13. Two-way ANOVA results for baseline simulation comparing differences between means of total resources left on landscapes at termination at different levels of dynamism.

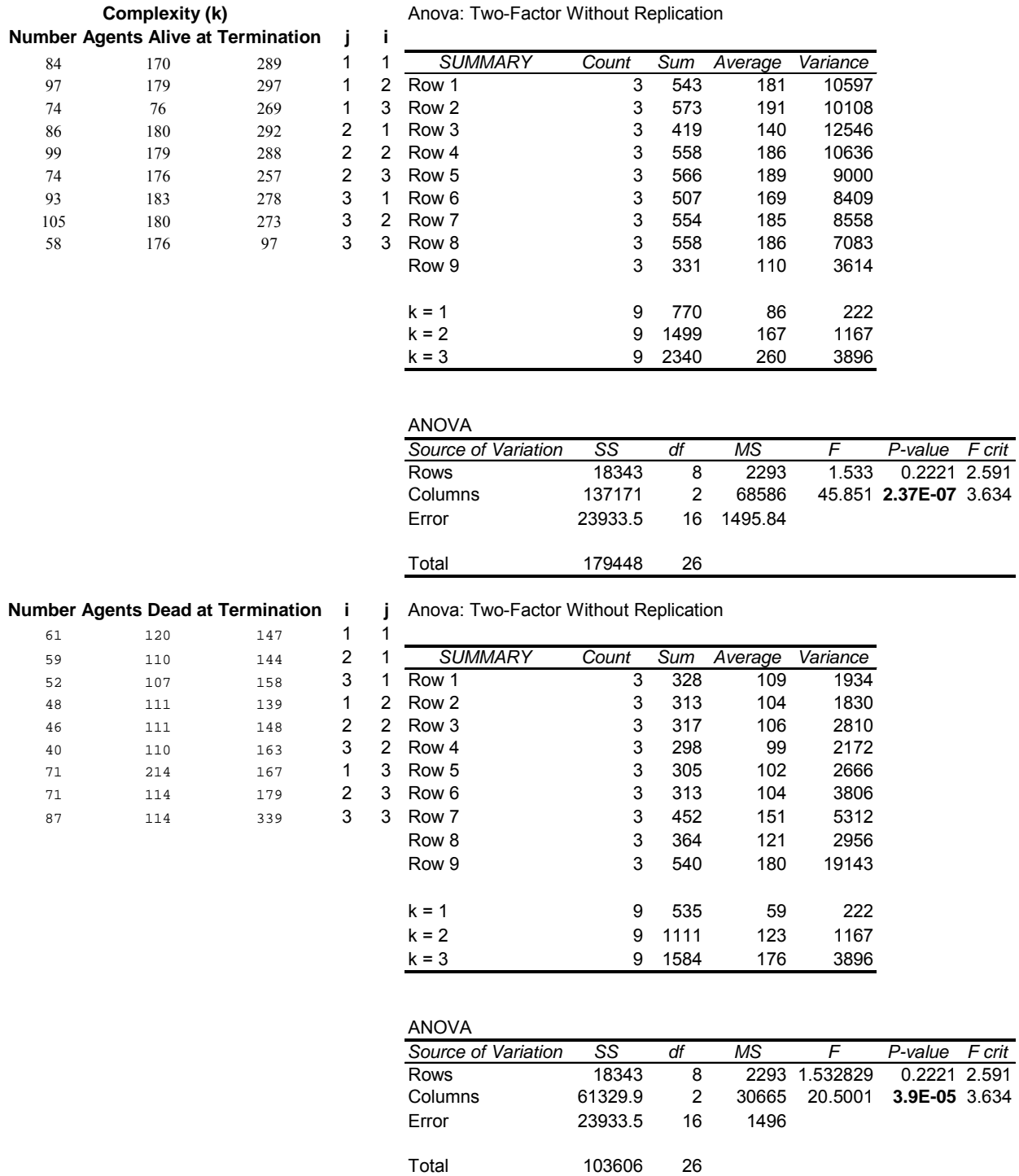


Figure 14. Two-way ANOVA results for baseline simulation comparing differences between means of total agents left alive, and left dead, on landscapes at termination at different levels of complexity.

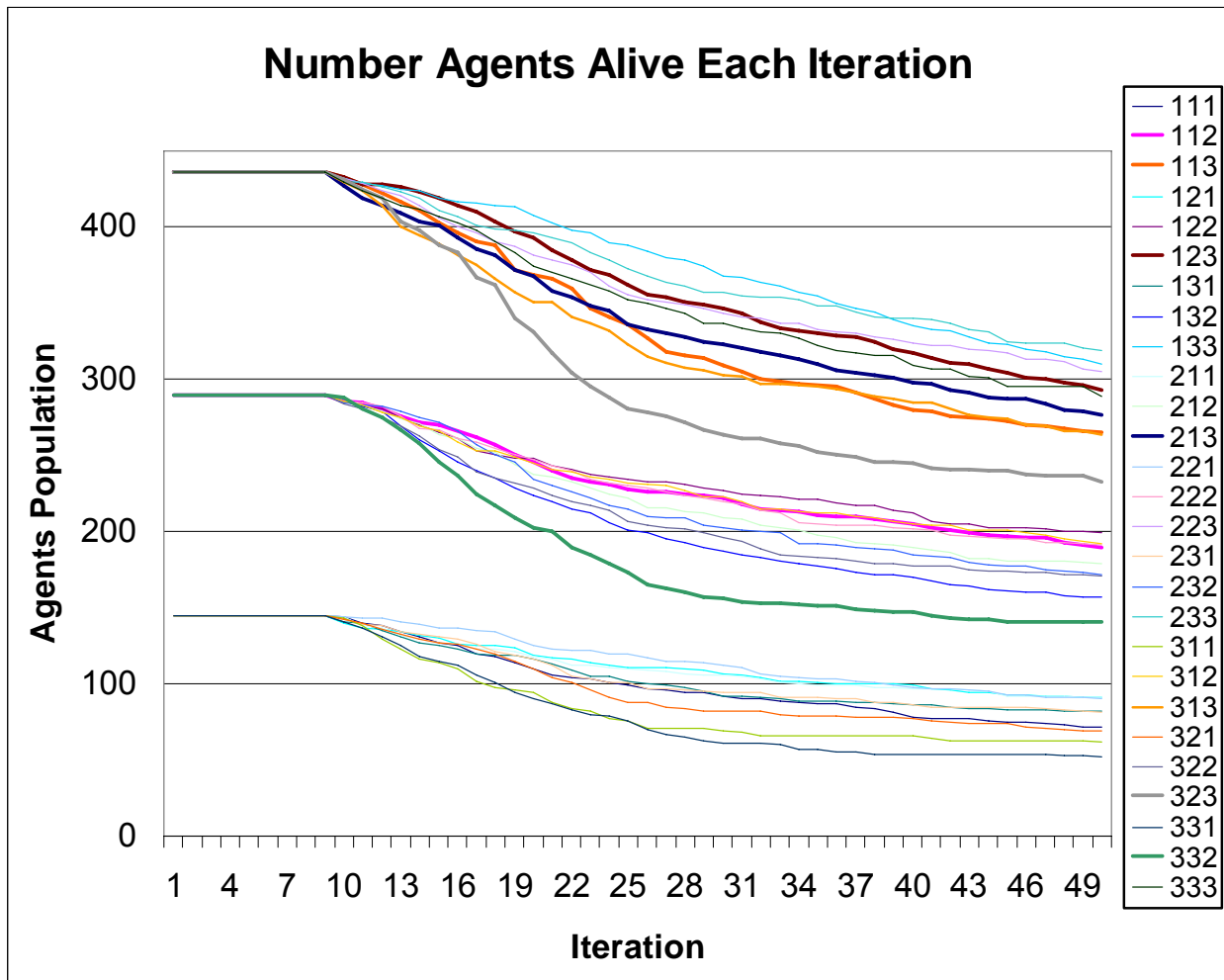


Figure 15. Death curves for each landscape in the diversification extension.

```

*** Linear Model ***

Call: lm(formula = PROFIT ~ STATUS + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
  SEARCHLAND.2 + Change, data =
  Diversification.for.baseline.like.regression, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-313.2  -1.415   3.171   5.838  126.7

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)  -8.4943   2.0165  -4.2124  0.0000
STATUS        0.0704   0.0015  46.0733  0.0000 **
DIE          -0.1070   0.0305  -3.5117  0.0004 **
BUYSELLPREF   0.0239   0.1837   0.1304  0.8963
AGENTMEM     -0.0239   0.1310  -0.1825  0.8552
AGENTMEM.2    0.0001   0.0032   0.0191  0.9847
PROPBIAS     -0.2351   0.1844  -1.2753  0.2022
BIASCHANGE    0.5755   0.5203   1.1062  0.2687
Markup        0.5117   0.2619   1.9542  0.0507 **?
Markup.2     -0.0452   0.0241  -1.8779  0.0604 **?
ReactTime.Mag.Prob  0.0166   0.0500   0.3321  0.7399
ReactTime.Mag.Prob.2 -0.0001   0.0016  -0.0860  0.9315
TERRITSETUP   0.0178   0.0254   0.6988  0.4847
AVERSION      1.1164   0.3015   3.7033  0.0002 **
MOVE.adj     -0.3754   0.3084  -1.2174  0.2235
SEARCHLAND   -0.0382   0.1141  -0.3353  0.7374
SEARCHLAND.2  0.0010   0.0025   0.3878  0.6982
Change        0.1789   0.3290   0.5438  0.5866

```

```

Residual standard error: 13.28 on 7821 degrees of freedom
Multiple R-Squared: 0.2172
F-statistic: 127.7 on 17 and 7821 degrees of freedom, the p-value is 0

```

Figure 16. S-Plus output for multiple linear regression of baseline simulation variables from diversification extension output, with PROFIT as the dependent variable.

```

*** Linear Model ***

Call: lm(formula = Longevity ~ STATUS + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
  SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
  Diversification.for.baseline.like.regression, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-34.99 -10.58   3.588   9.25  40.87

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)    7.9038   1.9236   4.1089  0.0000
STATUS         0.0350   0.0014  24.5060  0.0000 **
DIE            0.8170   0.0284  28.7200  0.0000 **
BUYSELLPREF   -0.1815   0.1715  -1.0582  0.2900
AGENTMEM      -0.1095   0.1224  -0.8952  0.3707
AGENTMEM.2    0.0032   0.0030   1.0661  0.2864
PROPBIAS      0.1433   0.1722   0.8319  0.4055
BIASCHANGE    1.4426   0.4858   2.9696  0.0030 **
Markup        2.9324   0.2445  11.9933  0.0000 **
Markup.2     -0.2105   0.0225  -9.3712  0.0000 **
ReactTime.Mag.Prob 0.0334  0.0467   0.7159  0.4741
ReactTime.Mag.Prob.2 -0.0010  0.0015  -0.6945  0.4874
TERRITSETUP   0.2009   0.0238   8.4565  0.0000 **
AVERSION     -0.0329   0.2815  -0.1169  0.9070
MOVE.adj      1.2334   0.2879   4.2836  0.0000 **
SEARCHLAND    0.1239   0.1065   1.1634  0.2447
SEARCHLAND.2 -0.0021   0.0023  -0.8871  0.3751
THRESHFLEX    0.3958   0.2516   1.5731  0.1157
THRESHFLEX.2 -0.0508   0.0299  -1.6977  0.0896
Change        4.6937   0.3072  15.2800  0.0000 **

Residual standard error: 12.4 on 7819 degrees of freedom
Multiple R-Squared: 0.2322
F-statistic: 124.5 on 19 and 7819 degrees of freedom, the p-value is 0

```

Figure 17. S-Plus output for multiple linear regression of baseline simulation variables from diversification extension output, with Longevity as the dependent variable.

Munificence (i)
Total Resources on Landscape

1	2	3	j	k
379	341	400	1	1
322	392	364	1	2
330	361	377	1	3
328	309	309	2	1
322	347	293	2	2
333	360	368	2	3
847	1342	2179	3	1
663	1268	1980	3	2
538	982	1687	3	3

Anova: Two-Factor Without Replication

<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Row 1	3	1121	374	884
Row 2	3	1078	359	1223
Row 3	3	1068	356	590
Row 4	3	946	315	123
Row 5	3	962	321	719
Row 6	3	1060	353	340
Row 7	3	4368	1456	453303
Row 8	3	3911	1304	434576
Row 9	3	3207	1069	335727
i = 1	9	4062	451	36439
i = 2	9	5701	633	188361
i = 3	9	7957	884	653839

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	5424123	8	678015	6.759048	0.0006	2.591
Columns	849973	2	424987	4.236637	0.0334	3.634
Error	1604996	16	100312			
Total	7879093	26				

Figure 18. Two-way ANOVA results for diversification extension comparing differences between means of total resources left on landscapes at termination at different levels of munificence.

Dynamism (j)			j	k
Total Resources on Landscape				
379	328	847	1	1
322	322	663	1	2
330	333	538	1	3
341	309	1342	2	1
392	347	1268	2	2
361	360	982	2	3
400	309	2179	3	1
364	293	1980	3	2
377	368	1687	3	3

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	3	1554	518	81772
Row 2	3	1307	436	38727
Row 3	3	1200	400	14266
Row 4	3	1992	664	345067
Row 5	3	2006	669	269799
Row 6	3	1703	568	128802
Row 7	3	2888	963	1111527
Row 8	3	2637	879	910607
Row 9	3	2432	811	575842
j = 1	9	3266	363	739
j = 2	9	2968	330	617
j = 3	9	11486	1276	334407

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	926276	8	115785	1.05	0.440	2.591
Columns	5192989	2	2596494	23.61	1.68E-05	3.634
Error	1759828	16	109989			
Total	7879093	26				

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	2	707	354	1309
Row 2	2	644	322	0.04
Row 3	2	662	331	5.18
Row 4	2	650	325	539
Row 5	2	738	369	1025
Row 6	2	721	360	1.45
Row 7	2	709	355	4118
Row 8	2	657	328	2493
Row 9	2	745	373	41.9
j = 1	9	3266	363	739
j = 2	9	2968	330	617

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	6268	8	784	1.368	0.334	3.438
Columns	4953	1	4953	8.650	0.019	5.318
Error	4581	8	573			
Total	15802	17				

Figure 19. Two-way ANOVA results for diversification extension comparing differences between means of total resources left on landscapes at termination at different levels of dynamism.

Complexity (k)			i	j
Number Agents Alive at Termination				
73	191	266	1	1
92	200	294	1	2
83	158	311	1	3
92	180	278	2	1
91	192	306	2	2
82	173	320	2	3
63	193	265	3	1
70	172	234	3	2
53	142	290	3	3

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	3	530	177	9466
Row 2	3	586	195	10217
Row 3	3	552	184	13503
Row 4	3	550	183	8657
Row 5	3	589	196	11570
Row 6	3	575	192	14422
Row 7	3	521	174	10481
Row 8	3	476	159	6857
Row 9	3	485	162	14332
k = 1	9	699	78	193
k = 2	9	1601	178	354
k = 3	9	2564	285	732

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	4522	8	565	1.58	0.206	2.591
Columns	193304	2	96652	270.75	4.60E-13	3.634
Error	5712	16	357			
Total	203537	26				

Complexity (k)			i	j
Number Agents Dead at Termination				
73	100	171	1	1
54	91	143	1	2
63	133	126	1	3
54	111	159	2	1
55	99	131	2	2
64	118	117	2	3
83	98	172	3	1
76	119	203	3	2
93	149	147	3	3

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	3	344	115	2562
Row 2	3	288	96	1999
Row 3	3	322	107	1486
Row 4	3	324	108	2763
Row 5	3	285	95	1456
Row 6	3	299	100	954
Row 7	3	353	118	2270
Row 8	3	398	133	4172
Row 9	3	389	130	1009
k = 1	9	615	68	193
k = 2	9	1018	113	354
k = 3	9	1369	152	732

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	4522	8	565	1.58	0.206	2.591
Columns	31634	2	15817	44.31	2.99E-07	3.634
Error	5712	16	357			
Total	41868	26				

Figure 20. Two-way ANOVA results for diversification extension comparing differences between means of total agents left alive, and left dead, on landscapes at termination at different levels of complexity.

```

*** Linear Model ***
Call: lm(formula = PROFIT ~ STATUS + NumSBUs + DIVERSIFIED + PROPENDDIVERS +
ACQRACCEP + THRESHDIVFY + DIE + BUSELLPREF + AGENTMEM + AGENTMEM.2 +
PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
Diversification.for.baseline.like.regression, na.action = na.exclude)
Residuals:
    Min       1Q   Median       3Q      Max
-242.6 -0.9717  0.3043  1.57  136.9

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)  -1.0685   1.3717  -0.7789  0.4360
      STATUS    0.0131   0.0011  11.6573  0.0000
        DIE     0.0051   0.0197   0.2573  0.7970
BUSELLPREF    0.0568   0.1183   0.4799  0.6313
  AGENTMEM   -0.1084   0.0844  -1.2849  0.1989
  AGENTMEM.2  0.0023   0.0021   1.1055  0.2690
  PROPBIAS   -0.1543   0.1188  -1.2996  0.1938
BIASCHANGE    0.3297   0.3352   0.9835  0.3254
   Markup    0.3007   0.1687   1.7822  0.0748
  Markup.2  -0.0213   0.0155  -1.3734  0.1697
ReactTime.Mag.Prob -0.0146  0.0322  -0.4523  0.6511
ReactTime.Mag.Prob.2  0.0003  0.0010   0.3140  0.7535
TERRITSETUP -0.0035   0.0164  -0.2139  0.8306
  AVERSION    0.4480   0.1942   2.3071  0.0211
  MOVE.adj   -0.2788   0.1986  -1.4036  0.1605
SEARCHLAND   -0.0348   0.0734  -0.4742  0.6354
SEARCHLAND.2  0.0009   0.0016   0.5703  0.5685
THRESHFLEX   0.2671   0.1735   1.5392  0.1238
THRESHFLEX.2 -0.0298   0.0206  -1.4466  0.1481
      Change   0.4816   0.2192   2.1971  0.0280

      NumSBUs  -4.1021   0.0456  -89.8772  0.0000 **
  DIVERSIFIED -0.8352   0.1349  -6.1917  0.0000 **
PROPENDDIVERS  0.0368   0.0454   0.8110  0.4174
  ACQRACCEP   -0.0648   0.3243  -0.1997  0.8418
THRESHDIVFY  -0.0102   0.0134  -0.7654  0.4440

Residual standard error: 8.549 on 7814 degrees of freedom
Multiple R-Squared: 0.676
F-statistic: 679.3 on 24 and 7814 degrees of freedom, the p-value is 0

```

Figure 21. S-Plus output for multiple linear regression of baseline simulation variables from diversification extension output, including diversification variables, with PROFIT as the dependent variable; increase in R^2 over baseline-only variables is 45.88%.

```

*** Linear Model ***

Call: lm(formula = Longevity ~ STATUS + NumSBUs + DIVERSIFIED + PROPENDIVERS +
  ACQRACCEP + THRESHDIVFY + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
  SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
  Diversification.for.baseline.like.regression, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-44.36 -10.3   3.251   9.244  34.77

Coefficients:
                Value Std. Error  t value Pr(>|t|)
(Intercept)    7.9087    1.9630    4.0289  0.0001
      STATUS     0.0389    0.0016   24.0933  0.0000
        DIE     0.8013    0.0281   28.4935  0.0000
BUYSELLPREF   -0.1413    0.1693   -0.8345  0.4041
  AGENTMEM    -0.1029    0.1208   -0.8517  0.3944
AGENTMEM.2     0.0030    0.0030    1.0097  0.3127
  PROPBIAS     0.1072    0.1699    0.6310  0.5280
BIASCHANGE     1.4984    0.4797    3.1235  0.0018
      Markup     2.8499    0.2414   11.8040  0.0000
Markup.2      -0.2068    0.0222   -9.3263  0.0000
ReactTime.Mag.Prob  0.0396    0.0461    0.8584  0.3907
ReactTime.Mag.Prob.2 -0.0011    0.0015   -0.7743  0.4388
  TERRITSETUP   0.1855    0.0235    7.8978  0.0000
  AVERSION      0.0411    0.2779    0.1478  0.8825
  MOVE.adj      1.1618    0.2842    4.0881  0.0000
  SEARCHLAND     0.1200    0.1051    1.1420  0.2535
SEARCHLAND.2  -0.0019    0.0023   -0.8336  0.4045
THRESHFLEX     0.3671    0.2483    1.4783  0.1394
THRESHFLEX.2  -0.0490    0.0295   -1.6619  0.0966
      Change     3.9334    0.3137   12.5402  0.0000

      NumSBUs     0.3182    0.0653    4.8723  0.0000 **
  DIVERSIFIED     1.7099    0.1930    8.8585  0.0000 **
PROPENDIVERS    -0.6380    0.0650   -9.8210  0.0000 **
  ACQRACCEP      1.2204    0.4641    2.6293  0.0086 **
THRESHDIVFY     0.1059    0.0192    5.5273  0.0000 **

Residual standard error: 12.23 on 7814 degrees of freedom
Multiple R-Squared:  0.253
F-statistic: 110.3 on 24 and 7814 degrees of freedom, the p-value is 0

```

Figure 22. S-Plus output for multiple linear regression of baseline simulation and diversification variables from diversification extension output, with Longevity as the dependent variable; increase in R^2 over baseline-only variables is 2.08%.

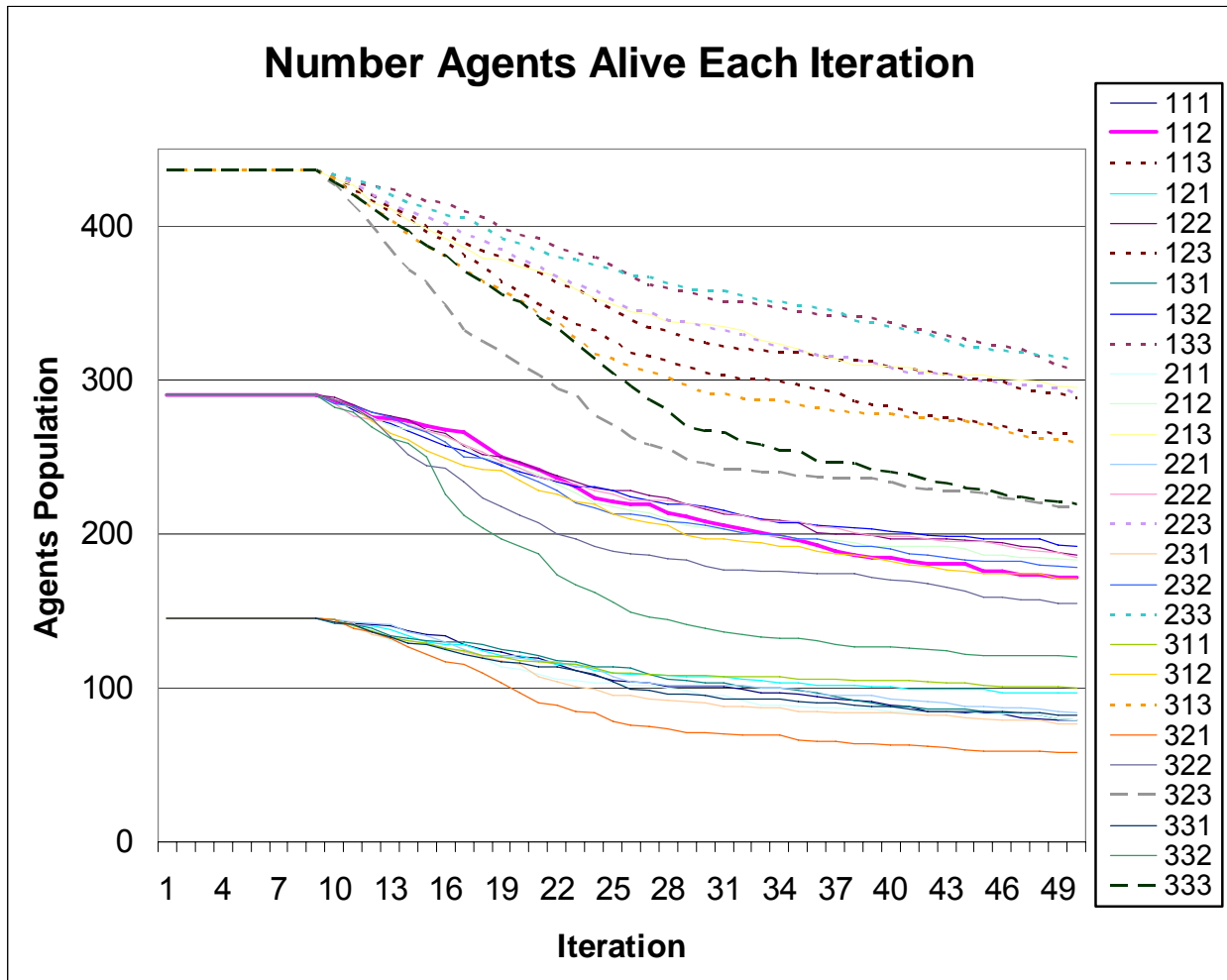


Figure 23. Death rate curves for each landscape in the first CEO compensation extension.

```

*** Linear Model ***

Call: lm(formula = PROFIT ~ STATUS + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
  SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
  CEO.Ext.Profiles.for.Reggression, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-245.5  -4.278   6.507  11.78  161.4

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)  14.6571   3.5137   4.1714  0.0000
STATUS        0.0464   0.0025  18.1943  0.0000 **
DIE          -0.2518   0.0494  -5.0986  0.0000 **
BUYSELLPREF  -0.1056   0.2901  -0.3640  0.7159
AGENTMEM      0.1013   0.2083   0.4864  0.6267
AGENTMEM.2   -0.0025   0.0051  -0.4777  0.6329
PROPBIAS      0.3372   0.2902   1.1622  0.2452
BIASCHANGE    0.2164   0.8205   0.2637  0.7920
Markup       -0.6094   0.4271  -1.4270  0.1536
Markup.2      0.0396   0.0388   1.0217  0.3069
ReactTime.Mag.Prob 0.0181   0.0733   0.2475  0.8045
ReactTime.Mag.Prob.2 -0.0007   0.0018  -0.3903  0.6963
TERRITSETUP  -0.2747   0.0413  -6.6534  0.0000 **
AVERSION      0.9458   0.4764   1.9853  0.0471
MOVE.adj     -1.8525   0.5686  -3.2582  0.0011 **
SEARCHLAND   -0.2839   0.1891  -1.5014  0.1333
SEARCHLAND.2  0.0067   0.0041   1.6334  0.1024
THRESHFLEX   -0.7877   0.4294  -1.8343  0.0666
THRESHFLEX.2  0.0828   0.0512   1.6194  0.1054
Change     -19.9588   0.7677 -25.9974  0.0000 **

Residual standard error: 20.96 on 7819 degrees of freedom
Multiple R-Squared: 0.1239
F-statistic: 58.21 on 19 and 7819 degrees of freedom, the p-value is 0

```

Figure 24. S-Plus output for multiple linear regression of baseline simulation variables from first CEO compensation extension output, with PROFIT as the dependent variable.

```

*** Linear Model ***

Call: lm(formula = Longevity ~ STATUS + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
  SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
  CEO.Ext.Profiles.for.Reggression, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-32.43 -10.36  3.361  9.365 39.82

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)    0.2199   2.0731   0.1061  0.9155
STATUS          0.0371   0.0015  24.6555  0.0000 **
DIE             0.7876   0.0291  27.0242  0.0000 **
BUYSELLPREF   -0.0971   0.1712  -0.5674  0.5704
AGENTMEM       -0.2034   0.1229  -1.6546  0.0980
AGENTMEM.2     0.0045   0.0030   1.4916  0.1358
PROPBIAS       -0.1264   0.1712  -0.7384  0.4603
BIASCHANGE     1.5063   0.4841   3.1118  0.0019 **
Markup         2.0011   0.2520   7.9420  0.0000 **
Markup.2       -0.1391   0.0229  -6.0822  0.0000 **
ReactTime.Mag.Prob 0.1644   0.0432   3.8024  0.0001 **
ReactTime.Mag.Prob.2 -0.0024  0.0011  -2.2291  0.0258 **
TERRITSETUP    0.2204   0.0244   9.0458  0.0000 **
AVERSION       -0.0671   0.2811  -0.2388  0.8113
MOVE.adj       1.9575   0.3355   5.8355  0.0000 **
SEARCHLAND     0.3644   0.1116   3.2659  0.0011 **
SEARCHLAND.2  -0.0067   0.0024  -2.7776  0.0055 **
THRESHFLEX     0.2391   0.2534   0.9439  0.3453
THRESHFLEX.2  -0.0327   0.0302  -1.0826  0.2790
Change        10.0827   0.4530  22.2591  0.0000 **

Residual standard error: 12.37 on 7819 degrees of freedom
Multiple R-Squared: 0.263
F-statistic: 146.8 on 19 and 7819 degrees of freedom, the p-value is 0

```

Figure 25. S-Plus output for multiple linear regression of baseline simulation variables from first CEO compensation extension output, with Longevity as the dependent variable.

Munificence (i)
Total Resources on Landscape

1	2	3	j	k
298	406	334	1	1
355	466	330	1	2
400	412	431	1	3
308	329	316	2	1
330	344	319	2	2
316	309	298	2	3
810	1524	2050	3	1
557	1290	1837	3	2
419	1202	1685	3	3

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	3	1038	346	3037
Row 2	3	1151	384	5278
Row 3	3	1243	414	240
Row 4	3	953	318	122
Row 5	3	993	331	155
Row 6	3	923	308	81
Row 7	3	4384	1461	387345
Row 8	3	3684	1228	412483
Row 9	3	3306	1102	408189
i = 1	9	3792	421	27757
i = 2	9	6283	698	239967
i = 3	9	7600	844	586882

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	5234109	8	654264	6.531	0.0007	2.591
Columns	831116	2	415558	4.148	0.0354	3.634
Error	1602744	16	100171			
Total	7667969	26				

Figure 26. Two-way ANOVA results for first CEO compensation extension comparing differences between means of total resources left on landscapes at termination at different levels of munificence.

Dynamism (j)			i	k	Anova: Two-Factor Without Replication				
Total Resources on Landscape									
298	308	810	1	1					
355	330	557	1	2					
400	316	419	1	3					
406	329	1524	2	1					
466	344	1290	2	2					
412	309	1202	2	3					
334	316	2050	3	1					
330	319	1837	3	2					
431	298	1685	3	3					

SUMMARY	Count	Sum	Average	Variance
Row 1	3	1415	472	85821
Row 2	3	1242	414	15515
Row 3	3	1135	378	3023
Row 4	3	2259	753	447109
Row 5	3	2100	700	264734
Row 6	3	1923	641	238599
Row 7	3	2700	900	991916
Row 8	3	2486	829	762558
Row 9	3	2414	805	585673
j = 1	9	3432	381	3021
j = 2	9	2869	319	192
j = 3	9	11374	1264	326934

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Rows	878073	8	109759	0.996	0.475	2.59
Columns	5026791	2	2513395	22.809	2.07E-05	3.63
Error	1763105	16	110194			
Total	7667969	26				

Anova: Two-Factor Without Replication				
SUMMARY	Count	Sum	Average	Variance
Row 1	2	605	303	47
Row 2	2	685	342	316
Row 3	2	716	358	3567
Row 4	2	735	368	2936
Row 5	2	810	405	7501
Row 6	2	721	361	5287
Row 7	2	650	325	160
Row 8	2	649	325	59
Row 9	2	729	364	8838
j = 1	9	3432	381	3021
j = 2	9	2869	319	192

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Rows	14633	8	1829	1.32	0.3513	3.438
Columns	17641	1	17641	12.75	0.0073	5.318
Error	11070	8	1384			
Total	43343	17				

Figure 27. Two-way ANOVA results for first CEO compensation extension comparing differences between means of total resources left on landscapes at termination at different levels of dynamism.

Complexity (k)			j	i
Number Agents Alive at Termination				
79	172	265	1	1
97	186	289	1	2
79	192	307	1	3
79	183	295	2	1
84	185	291	2	2
77	178	313	2	3
100	171	260	3	1
58	155	218	3	2
82	120	219	3	3

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	3	516	172	8649
Row 2	3	572	191	9232
Row 3	3	578	193	12996
Row 4	3	557	186	11669
Row 5	3	560	187	10714
Row 6	3	568	189	14020
Row 7	3	531	177	6427
Row 8	3	431	144	6496
Row 9	3	421	140	5002
Column 1	9	735	82	148
Column 2	9	1542	171	489
Column 3	9	2457	273	1249

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	9625	8	1203	3.53	0.0153	2.591
Columns	164954	2	82477	241.66	1.11E-12	3.634
Error	5461	16	341			
Total	180040	26				

Complexity (k)			j	i
Number Agents Died at Termination				
66	118	171	1	1
48	104	147	1	2
66	98	129	1	3
66	107	141	2	1
61	105	145	2	2
68	112	123	2	3
45	119	176	3	1
87	135	218	3	2
63	170	217	3	3

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	3	355	118	2756
Row 2	3	299	100	2464
Row 3	3	293	98	992
Row 4	3	314	105	1410
Row 5	3	311	104	1765
Row 6	3	303	101	847
Row 7	3	340	113	4314
Row 8	3	440	147	4392
Row 9	3	450	150	6229
Column 1	9	570	63	148
Column 2	9	1068	119	489
Column 3	9	1467	163	1249

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	9625.333333	8	1203	3.53	0.0153	2.591
Columns	44882	2	22441	65.75	1.92E-08	3.634
Error	5460.666667	16	341			
Total	59968	26				

Figure 28. Two-way ANOVA results for first CEO compensation extension comparing differences between means of total agents left alive, and left dead, on landscapes at termination at different levels of complexity.

```

*** Linear Model ***

Call: lm(formula = PROFIT ~ STATUS + NumSBUs + DIVERSIFIED + PROPENDDIVERS +
  ACQRACCEPT + THRESHDIVFY + DIE + BUYSHELLPREF + AGENTMEM + AGENTMEM.2 +
  PROPBIAS + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
  ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
  SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
  CEO.Ext.Profiles.for.Regression, na.action = na.exclude)

Residuals:
  Min      1Q  Median      3Q      Max
-216 -3.675  3.127  8.585 165.7

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)  13.1297   3.1198   4.2084  0.0000
      STATUS    0.0031   0.0024   1.2568  0.2089
      DIE     -0.1388   0.0428  -3.2398  0.0012
  BUYSHELLPREF  0.0129   0.2510   0.0515  0.9590
      AGENTMEM  -0.1223   0.1803  -0.6782  0.4977
      AGENTMEM.2  0.0032   0.0044   0.7210  0.4710
      PROPBIAS  0.1817   0.2511   0.7238  0.4692
      BIASCHANGE  0.6255   0.7100   0.8811  0.3783
      Markup   -0.6436   0.3697  -1.7410  0.0817
      Markup.2  0.0510   0.0336   1.5202  0.1285
  ReactTime.Mag.Prob -0.0353  0.0634  -0.5572  0.5774
  ReactTime.Mag.Prob.2  0.0005  0.0016   0.3208  0.7484
      TERRITSETUP -0.2061  0.0358  -5.7562  0.0000
      AVERSION   0.1832   0.4126   0.4439  0.6571
      MOVE.adj  -0.9799   0.4922  -1.9907  0.0465
      SEARCHLAND -0.2516   0.1636  -1.5377  0.1242
  SEARCHLAND.2  0.0058   0.0035   1.6348  0.1021
      THRESHFLEX -0.3898   0.3716  -1.0490  0.2942
  THRESHFLEX.2  0.0385   0.0443   0.8708  0.3839
      Change  -15.3198   0.6899  -22.2061  0.0000

      NumSBUs   -3.4314   0.0973  -35.2722  0.0000 **
      DIVERSIFIED -6.8981   0.3263  -21.1377  0.0000 **
  PROPENDDIVERS  1.4427   0.0955  15.1141  0.0000 **
      ACQRACCEPT  -2.6747   0.6864  -3.8969  0.0001 **
      THRESHDIVFY  0.0238   0.0270   0.8821  0.3777

Residual standard error: 18.13 on 7814 degrees of freedom
Multiple R-Squared:  0.3448
F-statistic: 171.3 on 24 and 7814 degrees of freedom, the p-value is 0

```

Figure 29. S-Plus output for multiple linear regression of baseline simulation variables from first CEO compensation extension output, including diversification variables, with PROFIT as the dependent variable; increase in R^2 over baseline-only variables is 22.09%.

```

*** Linear Model ***

Call: lm(formula = PROFIT ~ Agency.Pay + Agency.Pay.2 + Stake.Pay + Stake.Pay.2 +
  Agency.Stake + Agency.Stake.2 + STATUS + NumSBUs + DIVERSIFIED +
  PROPENDIVERS + ACQRACCEP + THRESHDIVFY + DIE + BUYSELLPREF + AGENTMEM +
  AGENTMEM.2 + PROPBIAS + BIASCHANGE + Markup + Markup.2 +
  ReactTime.Mag.Prob + ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION +
  MOVE.adj + SEARCHLAND + SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 +
  Change, data = CEO.Ext.Profiles.for.Regression, na.action = na.exclude
)

Residuals:
  Min      1Q  Median      3Q      Max
-217 -4.55   2.91  9.095 165.9

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)  9.9034   3.3138   2.9885  0.0028
      STATUS  0.0024   0.0024   1.0195  0.3080
      DIE    -0.1482   0.0421  -3.5167  0.0004
BUYSELLPREF -0.0798   0.2471  -0.3227  0.7469
AGENTMEM    -0.1412   0.1775  -0.7954  0.4264
AGENTMEM.2  0.0036   0.0044   0.8221  0.4110
PROPBIAS    0.1589   0.2471   0.6431  0.5202
BIASCHANGE  0.5982   0.6990   0.8558  0.3921
      Markup -0.7246   0.3639  -1.9910  0.0465
      Markup.2  0.0561   0.0330   1.6970  0.0897
ReactTime.Mag.Prob -0.0028  0.0629  -0.0451  0.9641
ReactTime.Mag.Prob.2  0.0000  0.0015  -0.0043  0.9965
TERRITSETUP -0.2056  0.0353  -5.8257  0.0000
AVERSION    0.1117  0.4063   0.2751  0.7833
MOVE.adj    -0.5194  0.4906  -1.0588  0.2897
SEARCHLAND  -0.1542  0.1614  -0.9555  0.3393
SEARCHLAND.2  0.0040  0.0035   1.1645  0.2442
THRESHFLEX  -0.4857  0.3659  -1.3276  0.1843
THRESHFLEX.2  0.0519  0.0436   1.1918  0.2334
      Change -13.9033  0.6959 -19.9789  0.0000
      NumSBUs -3.3983  0.0958 -35.4806  0.0000
DIVERSIFIED -7.0496  0.3216 -21.9186  0.0000
PROPENDIVERS  1.4339  0.0940  15.2565  0.0000
ACQRACCEP    -2.6317  0.6756  -3.8952  0.0001
THRESHDIVFY  0.0300  0.0266   1.1295  0.2587

      Agency.Pay -9.3563  4.5549  -2.0541  0.0400 **
      Agency.Pay.2 -2.2892  3.5174  -0.6508  0.5152
      Stake.Pay 10.5564  4.4159   2.3905  0.0168 **
      Stake.Pay.2 -7.0945  3.4422  -2.0610  0.0393 **
      Agency.Stake 14.7157  7.0425   2.0895  0.0367 **
      Agency.Stake.2 -4.6179  6.5964  -0.7001  0.4839

Residual standard error: 17.84 on 7808 degrees of freedom
Multiple R-Squared:  0.3661
F-statistic: 150.3 on 30 and 7808 degrees of freedom, the p-value is 0

```

Figure 30. S-Plus output for multiple linear regression of baseline simulation variables from first CEO compensation extension output, including diversification variables and CEO compensation variables, with PROFIT as the dependent variable; increase in R^2 over model with only baseline and diversification variables is 2.13%.

```

*** Linear Model ***

Call: lm(formula = Longevity ~ STATUS + NumSBUs + DIVERSIFIED + PROPENDDIVERS +
ACQRACCEP + THRESHDIVFY + DIE + BUYSELLPREF + AGENTMEM + AGENTMEM.2 +
PROPBIA + BIASCHANGE + Markup + Markup.2 + ReactTime.Mag.Prob +
ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION + MOVE.adj + SEARCHLAND +
SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 + Change, data =
CEO.Ext.Profiles.for.Regression, na.action = na.exclude)

Residuals:
    Min       1Q   Median       3Q      Max
-33.88 -10.11  2.743  9.352 32.89

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)    2.6466   2.0808   1.2719  0.2034
STATUS         0.0425   0.0016  26.1723  0.0000
DIE            0.7739   0.0286  27.0943  0.0000
BUYSELLPREF   -0.1343   0.1674  -0.8022  0.4224
AGENTMEM      -0.1497   0.1203  -1.2451  0.2131
AGENTMEM.2    0.0032   0.0030   1.0749  0.2825
PROPBIA      -0.0865   0.1675  -0.5168  0.6053
BIASCHANGE    1.3792   0.4735   2.9127  0.0036
Markup        2.0060   0.2465   8.1366  0.0000
Markup.2     -0.1427   0.0224  -6.3761  0.0000
ReactTime.Mag.Prob  0.1785   0.0423   4.2211  0.0000
ReactTime.Mag.Prob.2 -0.0027   0.0010  -2.5929  0.0095
TERRITSETUP   0.1939   0.0239   8.1210  0.0000
AVERSION      0.0835   0.2752   0.3036  0.7614
MOVE.adj      1.7293   0.3283   5.2675  0.0000
SEARCHLAND    0.3672   0.1091   3.3643  0.0008
SEARCHLAND.2 -0.0067   0.0024  -2.8513  0.0044
THRESHFLEX    0.1817   0.2479   0.7331  0.4635
THRESHFLEX.2 -0.0275   0.0295  -0.9304  0.3522
Change        8.3383   0.4601  18.1216  0.0000

                NumSBUs   0.4067   0.0649   6.2676  0.0000 **
                DIVERSIFIED 2.7684   0.2177  12.7190  0.0000 **
                PROPENDDIVERS -0.6885   0.0637 -10.8148  0.0000 **
                ACQRACCEP   0.4522   0.4578   0.9878  0.3233
                THRESHDIVFY -0.0082   0.0180  -0.4563  0.6482

Residual standard error: 12.09 on 7814 degrees of freedom
Multiple R-Squared: 0.2956
F-statistic: 136.6 on 24 and 7814 degrees of freedom, the p-value is 0

```

Figure 31. S-Plus output for multiple linear regression of baseline simulation variables from first CEO compensation extension output, including diversification variables, with Longevity as the dependent variable; increase in R^2 over model with only baseline and diversification variables is 3.26%.

```

*** Linear Model ***

Call: lm(formula = Longevity ~ Agency.Pay + Agency.Pay.2 + Stake.Pay + Stake.Pay.2 +
  Agency.Stake + Agency.Stake.2 + STATUS + NumSBUs + DIVERSIFIED +
  PROPENDDIVERS + ACQRACCEP + THRESHDIVFY + DIE + BUYSSELLPREF + AGENTMEM +
  AGENTMEM.2 + PROPBIAS + BIASCHANGE + Markup + Markup.2 +
  ReactTime.Mag.Prob + ReactTime.Mag.Prob.2 + TERRITSETUP + AVERSION +
  MOVE.adj + SEARCHLAND + SEARCHLAND.2 + THRESHFLEX + THRESHFLEX.2 +
  Change, data = CEO.Ext.Profiles.for.Regression, na.action = na.exclude
)

Residuals:
    Min       1Q   Median       3Q      Max
-33.55 -10.09   2.72   9.319  33.85

Coefficients:
                Value Std. Error t value Pr(>|t|)
(Intercept)    1.8465   2.2420   0.8236  0.4102
      STATUS    0.0424   0.0016  26.1578  0.0000
        DIE     0.7728   0.0285  27.0996  0.0000
  BUYSSELLPREF -0.1625   0.1672  -0.9720  0.3311
    AGENTMEM    -0.1450   0.1201  -1.2075  0.2273
  AGENTMEM.2    0.0031   0.0030   1.0392  0.2988
    PROPBIAS   -0.0901   0.1672  -0.5391  0.5899
    BIASCHANGE  1.3550   0.4729   2.8651  0.0042
      Markup    1.9695   0.2462   7.9990  0.0000
    Markup.2   -0.1400   0.0224  -6.2653  0.0000
  ReactTime.Mag.Prob  0.1946   0.0425   4.5751  0.0000
  ReactTime.Mag.Prob.2 -0.0029   0.0010  -2.8355  0.0046
    TERRITSETUP  0.1952   0.0239   8.1717  0.0000
    AVERSION    0.1066   0.2749   0.3879  0.6981
    MOVE.adj    1.8427   0.3319   5.5515  0.0000
    SEARCHLAND  0.3788   0.1092   3.4684  0.0005
  SEARCHLAND.2 -0.0069   0.0024  -2.9124  0.0036
    THRESHFLEX  0.1440   0.2475   0.5819  0.5607
  THRESHFLEX.2 -0.0225   0.0295  -0.7618  0.4462
      Change    8.8543   0.4708  18.8062  0.0000
    NumSBUs     0.4161   0.0648   6.4209  0.0000
  DIVERSIFIED   2.7023   0.2176  12.4187  0.0000
  PROPENDDIVERS -0.6972   0.0636 -10.9645  0.0000
    ACQRACCEP   0.4760   0.4571   1.0413  0.2978
    THRESHDIVFY -0.0055   0.0180  -0.3085  0.7577

    Agency.Pay  -0.7099   3.0817  -0.2304  0.8178
  Agency.Pay.2  0.6064   2.3798   0.2548  0.7989
    Stake.Pay   0.0109   2.9877   0.0037  0.9971
  Stake.Pay.2   3.1676   2.3289   1.3602  0.1738
    Agency.Stake -6.1693   4.7647  -1.2948  0.1954
  Agency.Stake.2  5.8502   4.4629   1.3109  0.1899

Residual standard error: 12.07 on 7808 degrees of freedom
Multiple R-Squared: 0.2988
F-statistic: 110.9 on 30 and 7808 degrees of freedom, the p-value is 0

```

Figure 32. S-Plus output for multiple linear regression of baseline simulation variables from first CEO compensation extension output, including diversification variables and CEO compensation variables, with Longevity as the dependent variable; increase in R^2 over model with only baseline and diversification variables is 0.32%.

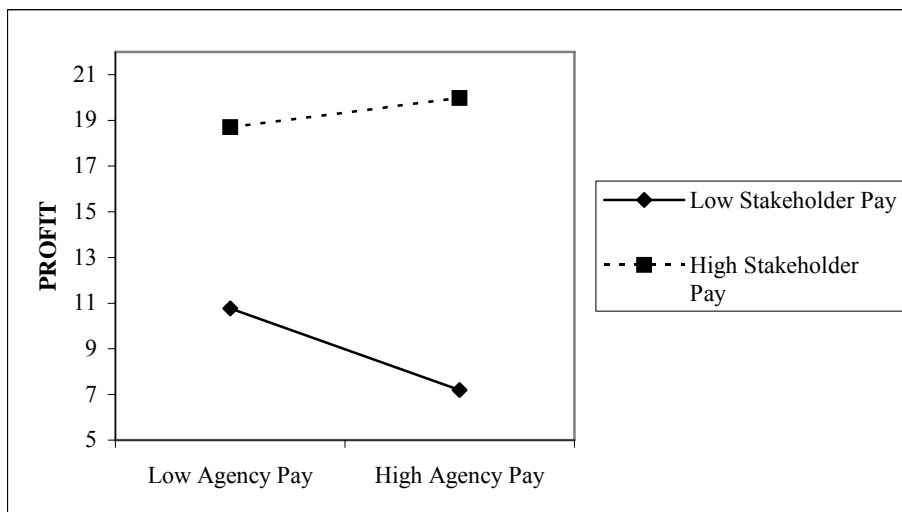
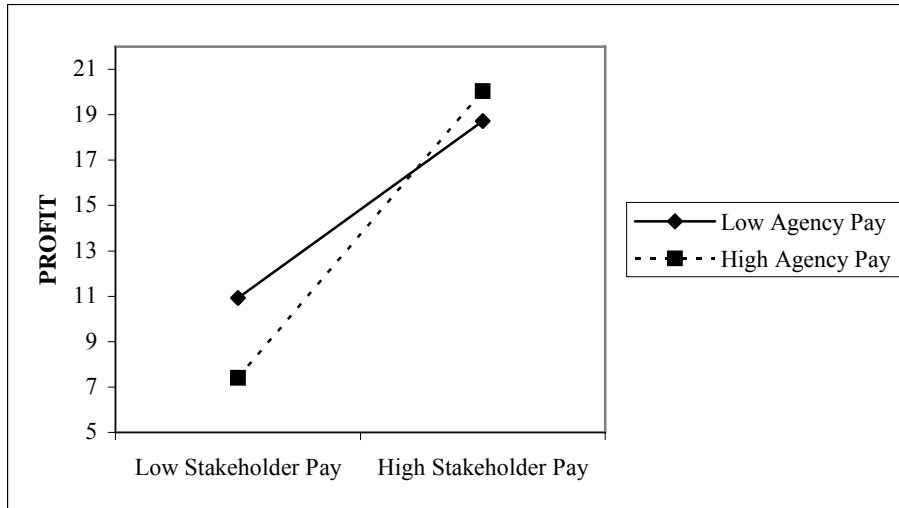


Figure 33. Conditional effects plots showing the effects of the Stakeholder Pay proportion on the mean response conditional on different levels of the Agency Pay proportion. Estimated regression model was $E\{Y\} = 9.9 - 9.35(\text{Ag. Pay}) + 10.56(\text{Stake. Pay}) + 14.72A*S$. Means were 0.4996 and 0.5015 and standard deviations were 0.2881 and 0.2852 for agency pay and stakeholder pay proportions, respectively.

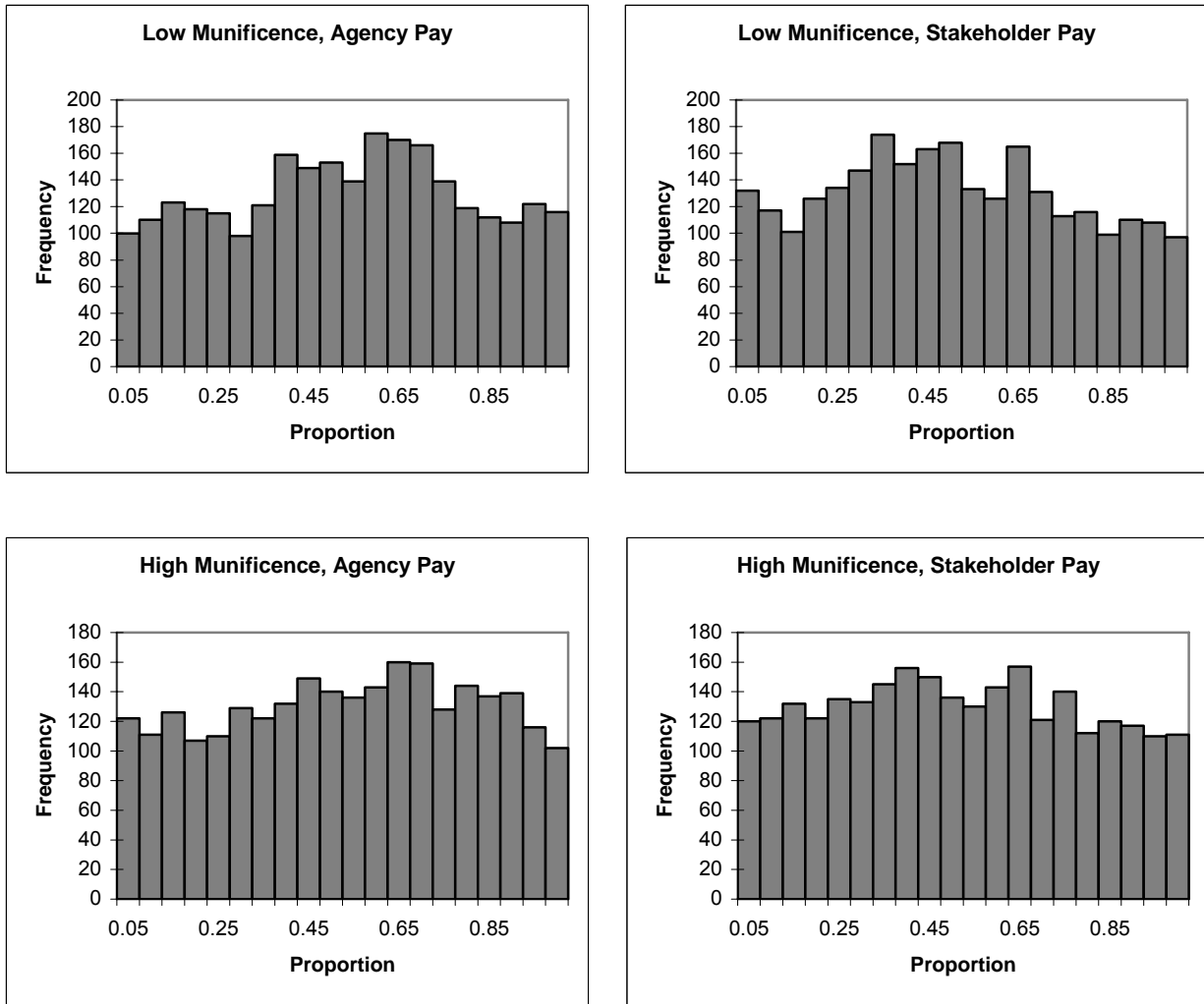


Figure 34. All-agents frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for low-munificence and high-munificence environments. Results are from the second CEO compensation extension, where agents were allowed to change their proportions toward higher profits.

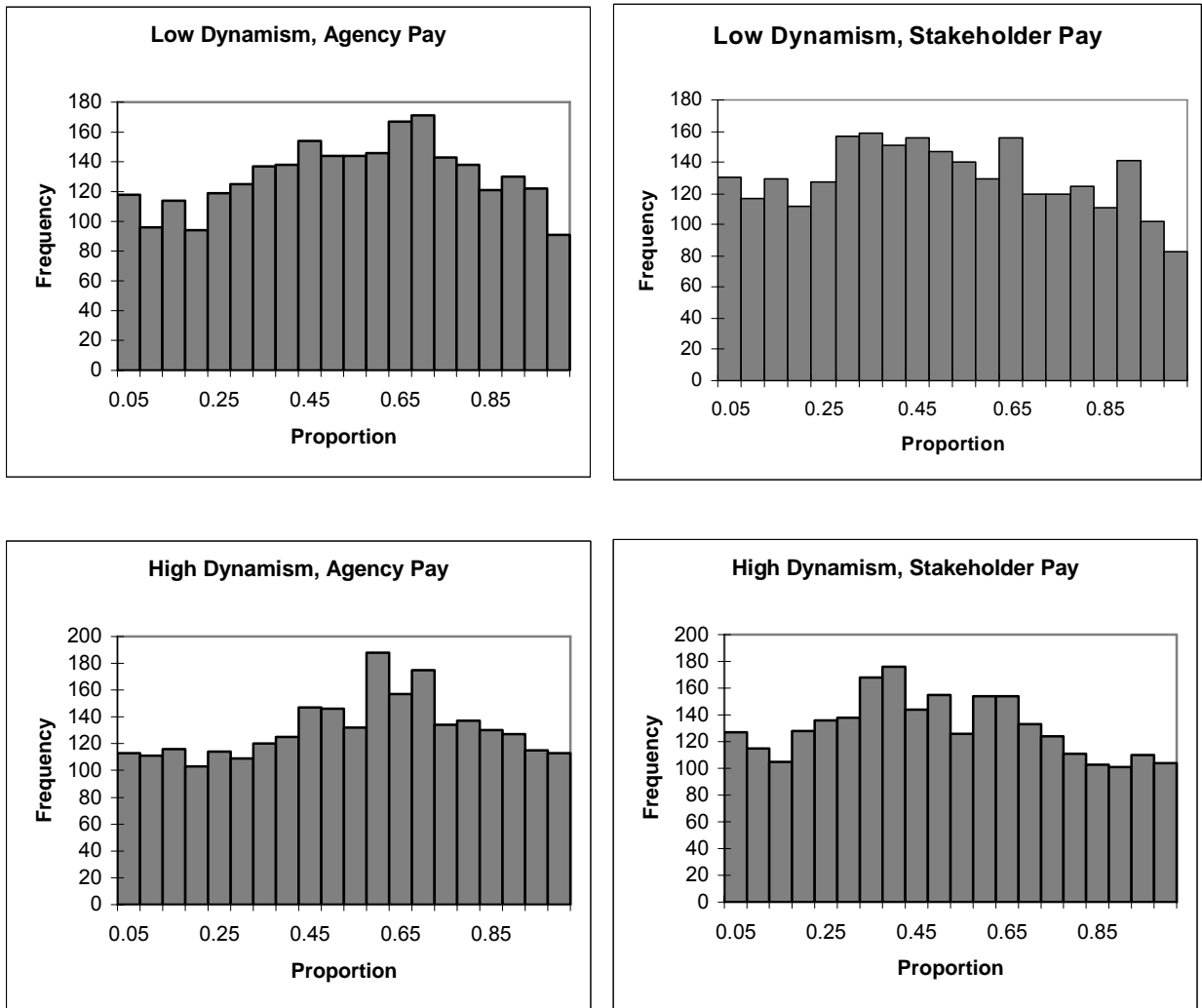


Figure 35. All-agents frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for low-dynamism and high-dynamism environments. Results are from the second CEO compensation extension, where agents were allowed to change their proportions toward higher profits.

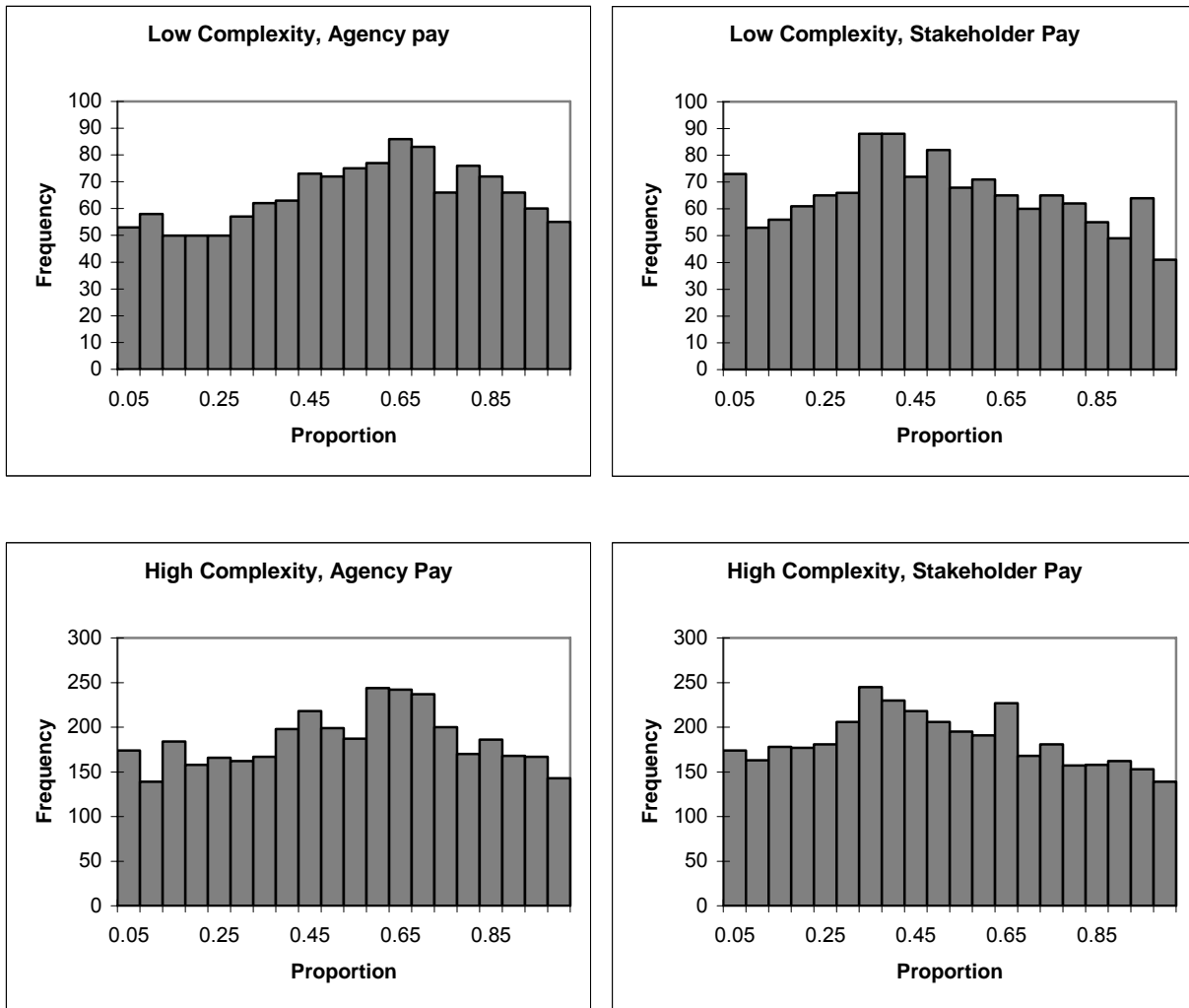


Figure 36. All-agents frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for low-complexity and high-complexity environments. Results are from the second CEO compensation extension, where agents were allowed to change their proportions toward higher profits.

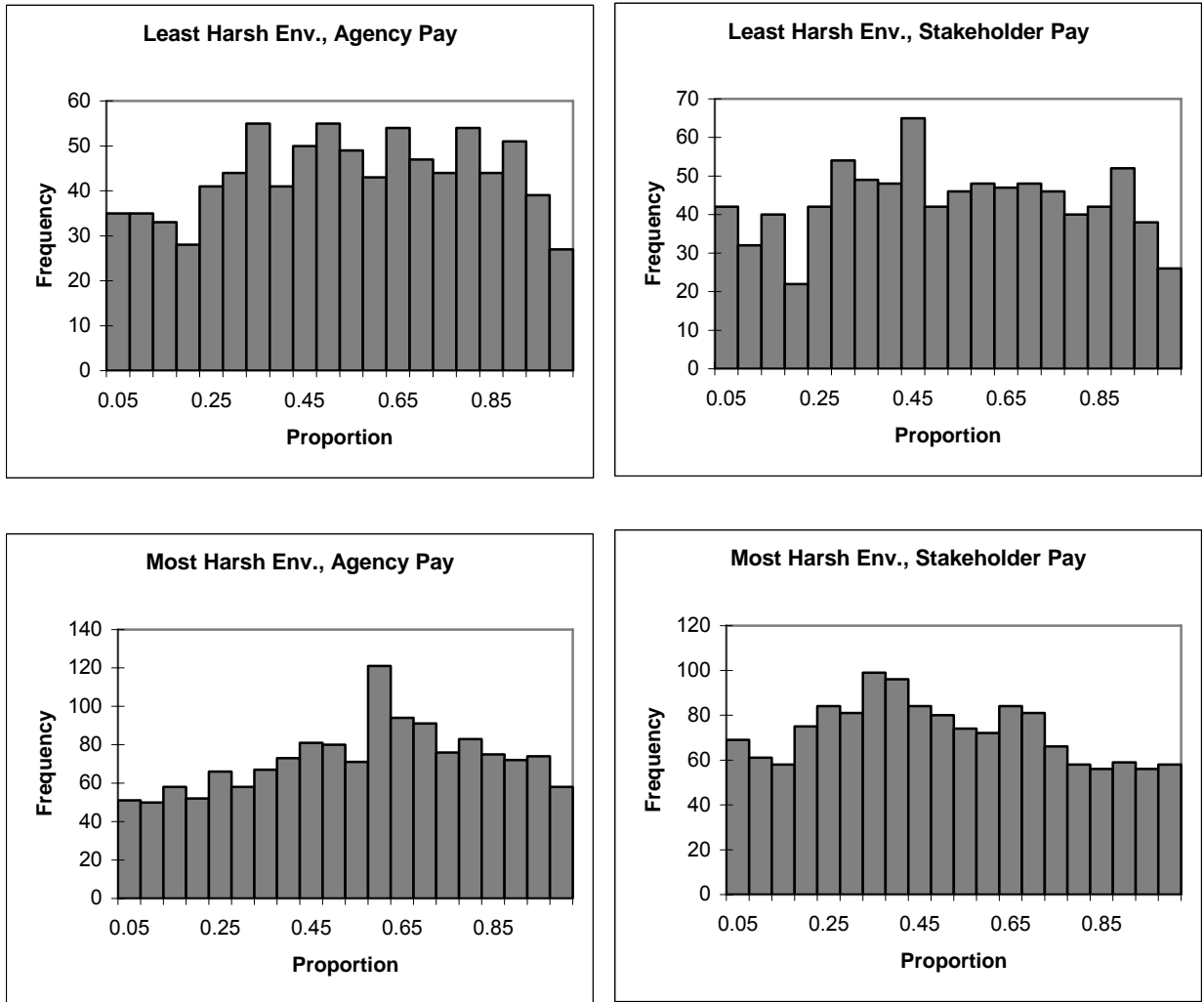


Figure 37. All-agents frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for least harsh and most harsh environments. Results are from the second CEO compensation extension, where agents were allowed to change their proportions toward higher profits.

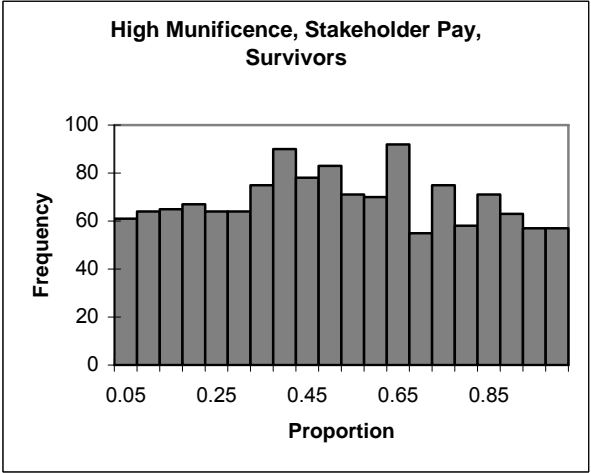
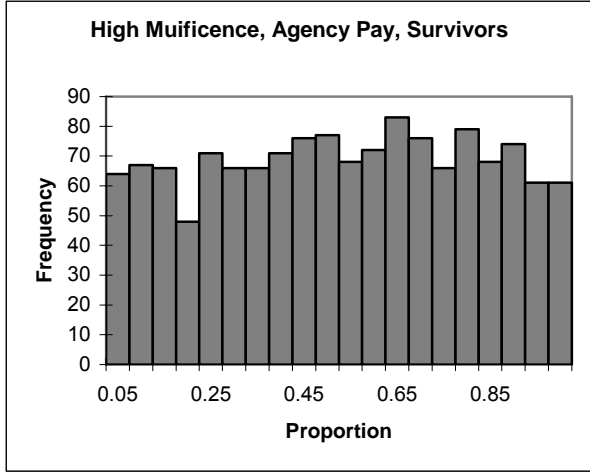
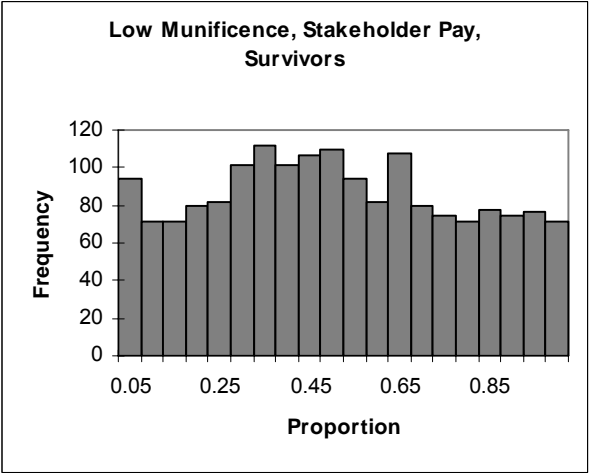
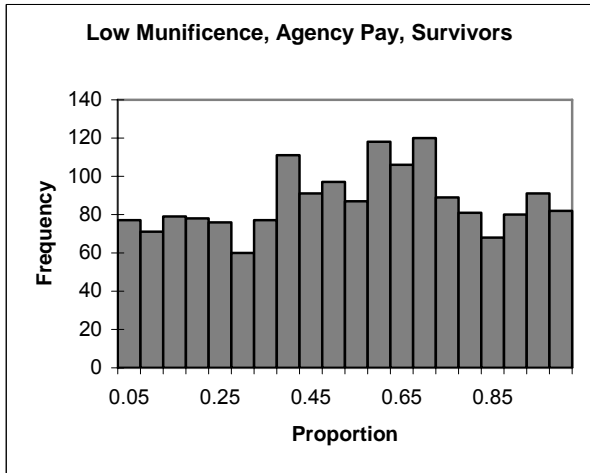


Figure 38. Survivors-only frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for low-munificence and high-munificence environments. Results are from surviving agents of the second CEO compensation extension.

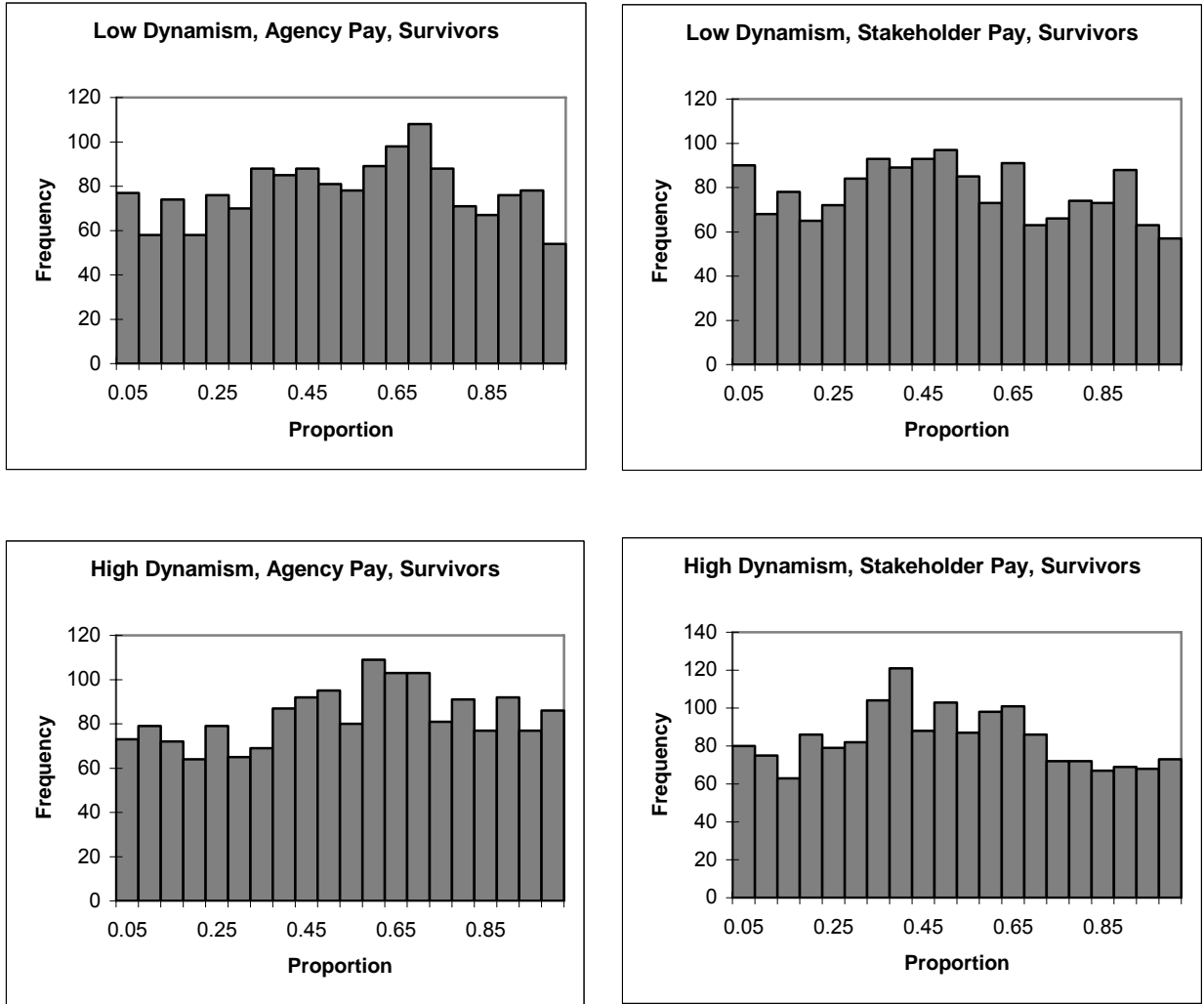


Figure 39. Survivors-only frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for low-dynamism and high-dynamism environments. Results are from surviving agents of the second CEO compensation extension.

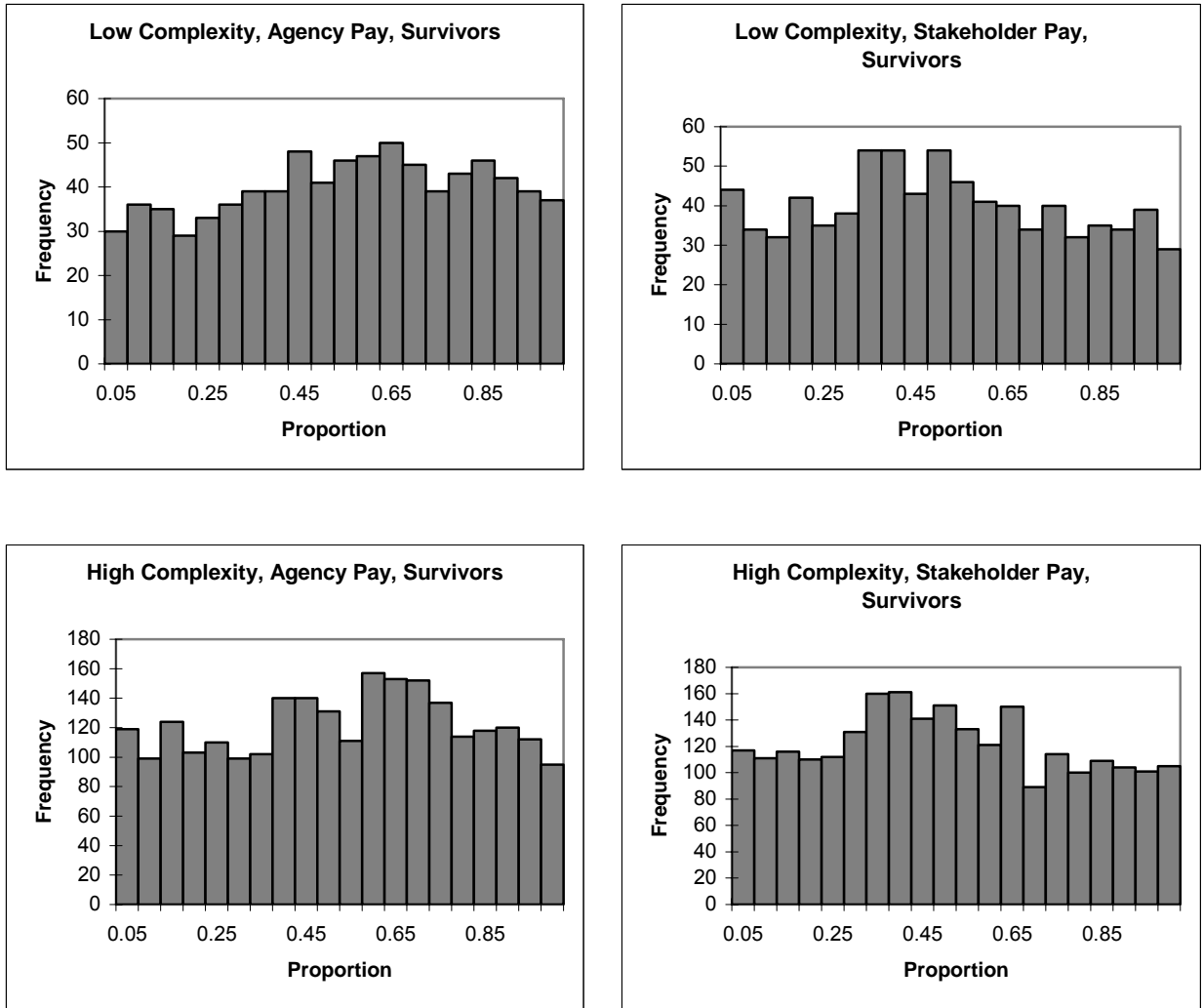


Figure 40. Survivors-only frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for low-complexity and high-complexity environments. Results are from surviving agents of the second CEO compensation extension.

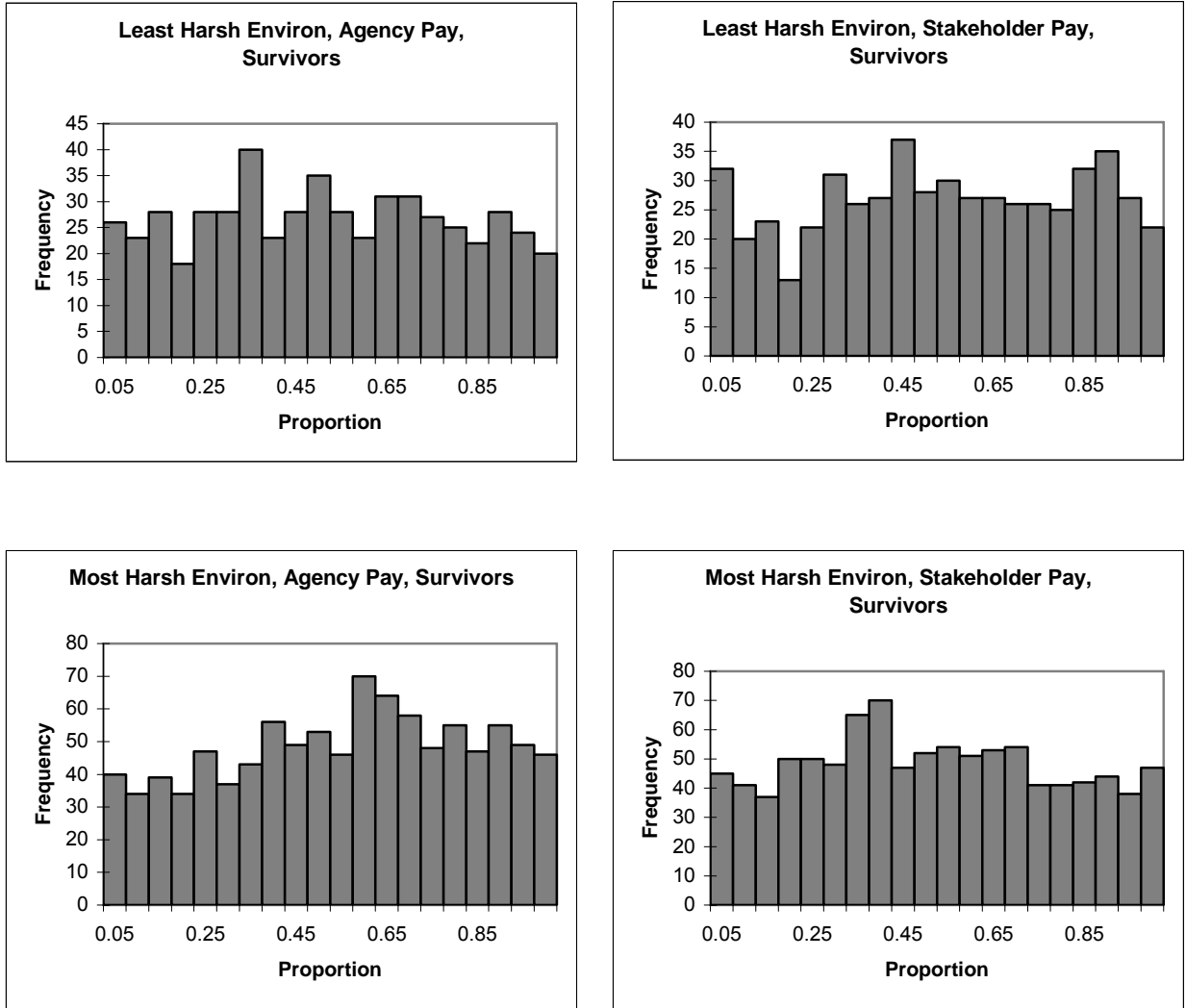


Figure 41. Survivors-only frequency histograms of proportion of payrule used, for the agency payrule (stewardship payrule = 1 – agency payrule) and the stakeholder payrule (fit payrule = 1 – stakeholder payrule), and for least harsh and most harsh environments. Results are from surviving agents of the second CEO compensation extension, where agents were allowed to change their proportions toward higher profits.