TOWARDS A SET-THEORETIC APPROACH FOR STUDYING ORGANIZATIONAL CONFIGUATIONS*

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ABSTRACT

I argue that research on organizational configurations has been limited by a mismatch between theory and methods. While configurational theory stresses nonlinearity, synergistic effects, and equifinality, empirical research has largely drawn on methods that assume linearity, additive effects, and unifinality. I introduce set-theoretic methods as a viable alternative for overcoming this mismatch. Set-theoretic methods conceptualize cases as combinations of attributes and use Boolean algebra to derive simplified expressions of combinations that lead to a specific outcome. I demonstrate the value of such methods for studying organizational configurations and discuss their applicability for examining equifinality and limited diversity among configurations.

The study of organizational configurations, broadly defined as “any multidimensional constellation of conceptually distinct characteristics that commonly occur together” (Meyer, Tsui & Hinings, 1993: 1175), has occupied an important and central role in both organization theory and strategy research (e.g. Baker & Cullen, 1993; Bensaou & Venkatraman, 1995; Dess & Davis, 1984; Doty & Glick, 1994; Hambrick, 1984; Ketchen et al., 1997; Miller, 1986; Miller & Friesen, 1984; Mintzberg, 1979; 1980). In essence, a configurational approach suggests that organizations are best understood as clusters of interconnected structures and practices rather than as modular or loosely coupled entities whose components can be understood in isolation. Configurational analysis thus takes a systemic and holistic view of organizations, where patterns or profiles rather than individual independent variables are related to an outcome such as performance (Delery & Doty, 1996). Due to its multidimensional nature, the configurational approach is particularly relevant to the study of strategic management (Amburgey & Dacin, 1994; Dyas & Thanheiser, 1976; Inkpen & Choudhury, 1995; Ketchen, Thomas & Snow, 1993; Miller, 1996). A core theme of strategy concerns how firms can achieve a match between structures, activities, and the environment, suggesting that configuration itself is the very essence of strategy (cf. Miller, 1996). As a result, different typologies of configurations, such as those suggested by Miles & Snow (1978), Mintzberg (1983), and Porter (1980), have occupied a central place in the strategy literature.

While a configurational approach presents a very attractive perspective, the progress of empirical research has been less than satisfying. To establish and measure configuration membership, authors have used a variety of clustering algorithms (e.g. Bensaou & Venkatraman, 1995; Cool & Schendel, 1987; Fiegenbaum & Thomas, 1990;

Hambrick, 1983; Ketchen, Thomas & Snow, 1993), interaction effects (Baker & Cullen, 1993; Dess, Lumpkin & Covin, 1997), and deviation score approaches (Delery & Doty, 1996; Drazin & Van de Ven, 1985) to identify configurations and their effects, typically on performance as the key outcome variable. However, evidence on the relationship between configurations and performance has been equivocal. While some reviews of previous studies cast doubt the existence of such a relationship (Barney & Hoskisson, 1990; Thomas & Venkatraman, 1988), a meta-analysis of configurational studies by Ketchen et al. (1997) nevertheless suggests that configuration membership does predict performance. Other research has proposed that the inability to find a reliable link between configurations and performance may be due to insufficient statistical power in previous studies (Ferguson & Ketchen, 1999). In reviewing these results, Delery & Doty (1996) conclude that while the configurational approach holds promise, additional testing is necessary to validate the efficacy of a configurational perspective.

In this paper, I suggest that many of the problems of empirical research on organizational configurations derive from a mismatch between methods and theory. In terms of its theory, configurational theory suggests a clean break with the predominant linear paradigm. Rather than implying singular causation and linear relationships, a configurational approach assumes complex causality and non-linear relationships where "variables found to be causally related in one configuration may be unrelated or even inversely related in another" (Meyer, Tsui & Hinings, 1993: 1178). As a result, relationships between variables need not be symmetric (Black & Boal, 1994) and tend to involve synergistic effects that go beyond traditional bivariate interaction effects (Delery & Doty, 1996). Furthermore, configurational analysis stresses the concept of *equifinality*, which refers to a situation where "a system can reach the same final state, from different initial conditions and by a variety of different paths" (Katz & Kahn, 1978: 30). While unifinality assumes that there exists one optimal configuration, equifinality assumes that two or more organizational configurations can be equally effective in achieving e.g. high performance, even if they are faced with the same contingencies (Gresov & Drazin, 1997; Galunic & Eisenhardt, 1994). However, these theoretical ideas have not been well translated into empirical models. For one thing, the suggestion that there are frequently multiple paths to an outcome stands in contrast to conventional methods of multivariate regression analysis which estimate a single path for all cases under examination. Similarly, the use of cluster analysis and deviation scores to detect distinct groups of firms may often not allow the researcher to examine just *how* different design elements work together (Whittington, Pettigrew, Peck, Fenton & Conyon, 1999).

The primary purpose of this paper is to offer a fresh view of these methodological issues by introducing set-theoretic methods for studying cases as configurations. Set-theoretic methods are uniquely suitable for configurational theory as such methods explicitly conceptualize cases as *combinations* of attributes and emphasize that it is these very combinations that give cases their unique nature (Ragin, 1987, 2000). As such, set-theoretic methods differ from conventional, variable-based approaches in that they do not disaggregate cases into independent, analytically separate aspects but instead *treat configurations as different types of cases*. To examine these different configurations of attributes, set-theoretic methods use Boolean algebra, a notational system that permits the algebraic manipulation of logical statements. Such an approach in many ways offers a better fit with a configurational understanding of organizations and also allows for a sophisticated assessment of just how different causes combine to affect relevant outcomes such as performance. Furthermore, set-theoretic methods contribute to theory-building by providing a rigorous way for combining verbal statements with logical relationships that differs from the conventional correlational view, allowing for the expression of complex causal relations in ways that generate new insights for organizational theory and strategy research.

THE MISMATCH BETWEEN CONFIGURATIONAL THEORY AND METHODS

Configurational approaches to organization are based on the fundamental premise that patterns of attributes will exhibit different features and lead to different outcomes depending on how they are arranged. But while theoretical discussions of configurational theory thus stress nonlinearity, synergistic effects, and equifinality, empirical research has so far largely drawn on econometric methods that by their very nature tend to imply linearity, additive effects, and unifinality. This mismatch has caused problems. For example, the classic linear regression model treats variables as competing in explaining variation in outcomes, rather than showing how variables combine to create outcomes. By focusing on the relative importance of rival variables, a correlational approach has difficulties treating cases as configurations and examining combinations of variables. This becomes particularly evident in the fact that regression analysis focuses on the unique contribution of a variable while holding the values of all other variables in the equation constant. Holding other values constant, of course, stands in direct opposition to the fundamental assumption of a configurational approach that it is the presence or absence of particular other factors that gives a variable meaning or not. In other words, a correlational approach can answer with precision questions relating to the average, net effect of a variable on an outcome; it is much less adept at answering under what specific conditions a variable influences an outcome.

Interaction effects are one attempt to overcome this fundamental weakness of regression analysis, and both two- and three-way interactions have thus been used to study organizational configurations (e.g. Miller, 1988; Baker & Cullen, 1993; Dess, Lumpkin & Covin, 1997). However, interactions that go beyond two-way effects are exceedingly difficult to interpret. Theoretically, there is no reason why configurations should be limited to three variables only, but empirically three-way interactions currently represent the boundaries of regression analysis, and questions about their interpretation and stability persist (c.f. Dess, Lumpkin & Covin, 1997; Drazin & Van de Ven, 1985; Ganzach, 1998). Furthermore, the use of interaction variables still assumes that moderating effects hold across all cases, rather than seeing configurations as unique and different in nature.

The situation becomes even more challenging when we turn to the issue of equifinality. Standard regression methods are essentially unable to take equifinality into account (Van de Ven & Drazin, 1985). While interaction effects aim to estimate non-linear relationships, they nevertheless assume that this relationship is relevant for all cases under examination, thus contrasting with the idea of different paths to the same outcome. As a result, equifinality remains an underdeveloped construct (Gresov & Drazin, 1997).

To overcome some of the limitations of regression analysis for studying configurations, a number of studies have instead employed cluster analysis (e.g. Bensaou

& Venkatraman, 1995; Cool & Schendel, 1987; Dess & Davis, 1984; Fiegenbaum & Thomas, 1990; Hambrick, 1983; Ketchen, Thomas, & Snow, 1993). Typically, these studies use a variety of clustering algorithms to identify distinct groups of firms and then use ANOVA or MANOVA to examine whether the distinct groups show differences in their performance. Clustering is attractive for studying configurations because it provides an established statistical procedure for discovering cases that are similar to each other along a variety of characteristics. However, cluster analysis also has a number of known limitations. For example, cluster analysis tends to treat each configuration as a black box insofar as only differences between constellations of variables can be detected (Whittington et al., 1999). The analysis does not extend to the contribution of individual elements to the whole or to an understanding of just how these elements combine to achieve the outcome. It is assumed that the presence of a component in some way contributes to the outcome, but whether this is actually the case is largely impossible to establish. Consequently, empirical analysis is often disconnected from theoretical claims.

Furthermore, cluster-analytic methods have been criticized for their extensive reliance on researcher judgment (Ketchen & Shook, 1996). For example, there is not test statistic to guide the analysis, and the choice of a stopping rule which determines the cutoff point for clustering is largely at the discretion of the investigator. Since the number of clusters frequently affects subsequent findings, this is a considerable concern. Similar issues also surround the selection of the sample and variables, the scaling of the variables, and the choice of the similarity measure and clustering method (Ragin, 2000; Ketchen & Shook, 1996). As a result, findings are often not very stable. As Miller observes: “change their sample a little, or drop a single variable, and the clusters teeter precariously. Alter the grouping algorithm slightly, and an entirely different classification scheme emerges" (1996: 508). Accordingly, the interpretation of clusters is frequently difficult, and overall these issues suggest that clustering may not be a promising path for studying how configurations combine to create outcomes (Barney & Hoskisson, 1990; Wiggins & Ruefli, 1995).

A final method that has been suggested for studying organizational configurations is the use of deviation scores (Delery & Doty, 1996; Drazin & Van de Ven, 1985). In these approaches, the researcher theoretically defines an ideal type and then creates an empirical profile for this configuration. The researcher then calculates deviation scores that give the difference between these "ideal" profiles and the profiles of organizations in the sample. Deviation scores can then be used to test hypotheses about the fit between profiles and how it affects e.g. performance, since greater deviation from the ideal profile should result in lower performance. While this approach is more theoretically rigorous than cluster analysis, it still raises similar challenges. By relying on a fit measure based on a multidimensional profile, a deviation score approach allows the researcher only limited peeks into the black box of configurations, since it often remains unclear which aspect of the misfit actually affects the outcome in question. Furthermore, while a continuous fit measure presents an improvement over the binary measures of cluster membership, deviation scores similarly to a large extend on just how the "ideal" profile is initially defined. Previous studies have defined the ideal configuration using the empirically derived mean scores of their profiles (Drazin & Van de Ven, 1985) or by using plus or minus one standard deviation from the mean (e.g. Delery & Doty, 1996). However, such approaches are again sample-dependent, and ideal types thus largely depend on just how the sample is composed, rather than on substantive theory about what an ideal configuration means and what makes it ideal. Furthermore, the obtained results may be quite sensitive to even minor errors in estimating the "ideal" configurations, and the reliability of deviation scores will often be very low because it is the product of the reliability of the original variables (Gupta & Govindarajan, 1993). Finally, deviation score methods again hold challenges regarding the issue of equifinality, since equal effectiveness of different deviation score profiles would frequently lead to a lack of significance for the overall fit measure, thus disguising equifinality where it may be present.

While a configurational approach thus seems to hold much promise for both organization theory and strategic management, the disconnect between configurational theory and empirical methods thus remains a significant hindrance to the further development of this approach. However, there is an alternative methodology available in the form of set-theoretic methods for studying causal complexity. These methods are premised on the idea that different conditions combine rather than compete with each other in creating an outcome, and that there may be different combinations of conditions that lead to the same outcome, thus making them well-suited for studying configurations and equifinality.

A SET-THEORETIC APPROACH TO ORGANIZATIONAL CONFIGURATIONS

Instead of using either interaction effects, clustering algorithms, or deviation scores, a set-theoretical approach uses Boolean algebra to determine which combinations of organizational characteristics may combine to attain the outcome in question (Boswell &

Brown, 1999; Ragin, 1987 2000). At the center of set theory lies the idea that relationships between different variables are often best understood in terms of *set membership*. Consider the simple case that A is a member in the set Z (formally: $A \subset Z$). For purposes of analyzing organizational configurations, let A be a firm with an efficient production system and Z the set of firms with high financial performance. Thus the statement that firms with an efficient production system tend to exhibit high performance may be restated as saying that such firms form a subset of high-performing firms.

At the same time, the overlap between both sets need not be absolute. For example, consider B, the set of firms with a high rate of product innovation. This characteristic may also result in high financial performance, thus making firms that rapidly innovate another subset of high-performing firms (formally: $B \subset Z$). Yet there may in fact be little overlap between the two subsets A and B; one can easily imagine a situation where an efficient production system and a high rate of product innovation may inhibit or even preclude each other, thus making both A and B non-overlapping subsets of Z. This may be expressed in the following logical statement:

$$A + B \rightarrow Z \qquad (1)$$

where "+" denotes the logical operator *or* while "→" denotes the logical implication operator, as in "A or B implies Z." Both A and B thus present viable ways of attaining high financial performance, yet the design features involved in attaining that outcome may be quite different.

Now consider a somewhat more contingent statement: firms that exhibit an efficient production system (A) will be high-performing *if* their environments are not heterogeneous (~C). In logical terms, this statement may be expressed as follows:

$$A \bullet {\sim}C \rightarrow Z \qquad (2)$$

where "•" denotes the logical operator *and* while "~" denotes the logical *not*. In essence, the above statement presents a set-theoretic reformulation of a classic contingency hypothesis. Now let us extend the above by introducing another statement, namely that firms with a high rate of product innovation (B) will be high-performing if they also exhibit hierarchical control structures (D).[1] Combining this statement with the statement (2) from above results in the following statement:

$$A \bullet {\sim}C + B \bullet D \rightarrow Z \qquad (3)$$

The Boolean statement above thus elegantly summarizes two contingency statements (or hypotheses) about the relationship of organizational characteristics, the nature of the environment, and firm performance.

To further understand a set-theoretic approach, let us now consider in more detail the nature of the set-subset relationships. Such relationships may be better understood in terms of necessity and sufficiency (Ragin, 1987), which describe the ability to generalize from a limited set of cases to larger populations. Consider again statement (3). According to this statement, there are at least two combinations of attributes that may allow a firm to attain high performance. If we take a necessary condition to denote that an outcome can be attained only if the attribute in question is present, then clearly neither of the combinations is necessary. On the other hand, if we take a sufficient condition to denote that an outcome will always be obtained if the attribute in question is present, then either of the combinations is sufficient. However, note that this finding applies only to combinations of attributes, not to individual attributes. In fact, of the individual attributes A, B, ~C, and D, none is either necessary or sufficient in that no attribute is present in all combinations and no attribute can by itself produce the outcome. In other words, statement (3) denotes a situation of considerable causal complexity: four attributes combine to create the outcome, but neither is by itself necessary or sufficient. Note also that such situations of causal complexity are exceedingly difficult to capture using conventional linear regression, since necessity and sufficiency are outside the focus of correlational analysis.

To analyze whether different configurations of organizational characteristics are either necessary or sufficient for causing a certain outcome, a researcher using a set-theoretic approach first constructs a truth table that lists all possible configurations of characteristics, as well as whether these configurations lead to the outcome in question. In a second step, the researcher uses Boolean logic to determine commonalities among the configurations that lead to the outcome and to generate logical statements such as those above that describe these commonalities, thus allowing for the logical reduction of statements. This reduction procedure uses the Quine-McCluskey algorithm, a common algorithm for simplifying set-theoretic statements that is implemented in software packages such as QCA (Drass & Ragin, 1992) and fs/QCA (Drass & Ragin, 1999). To illustrate how this algorithm works, consider again the relatively simple situation of causal complexity described by statement (3). The corresponding truth table for such a situation would be as follows:

Insert Table 1 about here

In this table, shaded cells for characteristics indicate cells corresponding to statement (3). To find out whether any of the four conditions is necessary for causing the outcome, we would examine whether the condition is always present (or absent) in all cases where the outcome is achieved. Clearly, this is not the case here. However, the truth table shows that there are seven different configurations of the four individual organizational characteristics that are sufficient for causing the outcomes.[2] The combinations are again listed below:

1. A • B • C • D
3. A • B • ~C • D
4. A • B • ~C • ~D
7. A • ~B • ~C • D
8. A • ~B • ~C • ~D
9. ~A • B • C • D
11. ~A • B • ~C • D

While these combinations are all sufficient for causing high performance, the seven combinations can be simplified since some combinations are logically redundant. For example, firms with an efficient production system (A) that are not in heterogeneous environments (~C) may or may not have a high rate of product innovation (B or ~B) and may or may not a hierarchical control structure (D or ~D). Either way, the combination of A and ~C will still be sufficient to cause the outcome. As a result, the seven combinations may be logically reduced and simplified using the Quine-McCluskey algorithm. In Boolean algebra, this proceeds as follows for statements 3 and 4:

A • B • ~C • ~D + A • B • ~C • D =
A • B • ~C (D + ~D) =
A • B • ~C

Similarly, statements 7 and 8 can also be simplified:

A • ~B • ~C • D + A • ~B • ~C • ~D =
A • ~B • ~C (D + ~D) =
A • ~B • ~C

Finally, combining the results from both simplifications leads to the following:

A • B • ~C + A • ~B • ~C =
A • ~C (B + ~B) =
A • ~C

Using some very simple operations, we have thus arrived at a statement that by itself contains all four logical combinations involving A and ~C (3, 4, 7, and 8) that may lead to the outcome in question. The same operations can of course be applied to the four logical combinations involving B and D (1, 3, 9, and 11) that are also sufficient for producing high performance. The result is again a simple statement that contains all combinations that may cause the outcome:

$$A \bullet \sim C + B \bullet D \rightarrow Z \qquad (4)$$

The example I have discussed here has used crisp sets, i.e. the presence of attributes and thus the membership in sets of firms with such attributes has been defined using binary values. However, in practical research the use of crisp sets places undue limitations on the task of categorizing cases.[3] Clearly, attributes will be present to a varying extent, and this information may be very important for studying how attributes combine. Fortunately, set membership is not restricted to binary values of 0 and 1, but may instead be defined using "fuzzy" sets (Ragin 2000), thus providing a much more fine-tuned measurement. Fuzzy sets allow the researcher for example to exactly specify the degree to which the organizational environment is turbulent or to what extent certain management practices are actually implemented in an organization. As in crisp sets, fuzzy sets also define a value of 0 as fully out of the relevant set and a value of 1 as full set membership. However, while crisp sets cannot distinguish any further between cases, fuzzy sets use thresholds tied to substantive knowledge about a case to further partition set membership. For example, a simple six-value fuzzy set may contain the following values:

1.00 = fully in
0.80 = mostly in
0.60 = more in than out

0.40 = more out than in

0.20 = mostly out

0.00 = fully out

Partitioning may be more fine-grained up to continuous fuzzy sets similar to ratio scales, but different in that such fuzzy sets contain both a meaningful baseline and a meaningful ceiling (Ragin, 2000). It is important to note here that fuzzy sets, and particularly continuous ones, should lead the researcher to go beyond a simple rescaling of variables. For example, to obtain a fuzzy set measure of diversification, the simplest way would be to count the number of four-digit SIC codes in which a firm operates and then to convert these data into a continuous measure of how diversified a firm is. In fact, this is a common way for current research to proceed, and fuzzy sets clearly allow for it. However, fuzzy sets furthermore provide a expedient way of infusing substantive knowledge into the measure about what it means to operate in any given number of different industries. For example, should firms that operate in 5, 10, or 15 different SIC codes be classified as fully diversified? If the firm operates in 20 different SIC codes, do operations in an additional SIC codes truly make a difference? A fuzzy set is a superior way of addressing such questions since it asks the investigator to provide meaningful thresholds for values. In contrast, a mechanistic procedure such as standardizing, which relies on the sample mean as a reference point, tends to ignore the substantive meaning of variation that falls at the mean of the distribution.

Set-theoretic Methods and Equifinality

Set-theoretic methods also offer an attractive way of examining equifinality. While the concept of equifinality has received increasing attention for studying organizational configurations (Doty, Glick & Huber, 1993; Eisenhardt, 1988; Galunic & Eisenhardt, 1994, Gresov & Drazin, 1997; Pennings, 1992), the question of how to empirically examine equifinal outcomes is still largely unanswered. Gresov & Drazin (1997) were among the first to describe a process by which equifinality research may proceed, moving from identifying different forms of equifinality to matching these forms with the appropriate methodology. For the identification process, Gresov & Drazin recommend qualitative research, surveys, and factor analysis as ways of assessing the degree of consistency or conflict between different functional demands faced by an organization. After gathering this information about the cases, equifinal configurations can then be classified using categories, scales, or deviation from profiles. However, both qualitative, case-oriented research and quantitative, variable-oriented methods for assessing equifinality present challenges, since these methods tend to either quickly exhaust the levels of complexity they can process or they tend to leave the actual processes by which equifinality emerges relatively unexamined, particularly if more than two variables combine to create equifinal outcomes. Set-theoretic methods are able to overcome both these limitations and thus offer a particularly attractive way of examining equifinality. First, such methods allow the researcher to examine extensive numbers of different combinations of elements and detect the underlying commonalities of configurations that lead to a certain outcome. As such, set-theoretic methods overcome some of the limitations of case-oriented, qualitative research by offering a systematic approach for analyzing data that at the same time does not disaggregate the case as a variable-based approach would. Second, due to their explicit focus on necessity and sufficiency of different elements, set-theoretic methods allow researchers to open the black box of causality, enabling them to strip away elements that are not causally involved with the outcome.

Set-theoretic methods furthermore extend the analysis of equifinality by offering a technique for examining the relative importance of each path. Ragin (2003) refers to this relative importance as coverage, understood as the proportion of instances of the outcome that exhibit a certain causal combination or path. For example, while it may be true that the combinations A • ~C and B • D are both equifinal in that both lead to high performance, the coverage and thus the importance of each path may be quite different. Using simple calculations, it is possible to further partition path coverage in a manner that is roughly equivalent to partitioning explained variation in a conventional regression model (Ragin 2003). This allows for a very fine-grained analysis of equifinality by giving the researcher insights into the relative importance and unique contribution of different causal combination.

Limited Diversity in Organizational Configurations

It has already become clear that a set-theoretic approach is not so much about separate, independent effects of variables as it is about treating configurations as different cases that are meaningful in and of themselves. However, strategy researchers have frequently pointed out that not all possible configurations are realized, and that certain organizational elements show a tendency to appear together (Meyer, Tsui & Hinings, 1993; Miller, 1986; Mintzberg, 1980). In other words, within the multidimensional property space of organizational design features, there are certain cells that tend to be more crowded and certain cells that are empty. In set-theoretic research, this phenomenon is known as limited diversity, defined as a situation where one or more of the logically possible combinations of causal conditions specified in the analysis do not exist empirically (Ragin, 1987; 2000).

While understanding existing configurations clearly lies at the center of a set-theoretic approach, analyzing limited diversity is also important because it allows us to examine the structure of the property space. While it is desirable to describe combinations of attributes that cover a large proportion of the target population of organizations (Miller & Friesen, 1984), it is also instructive to understand what combinations do not occur.[4] Recently, Inkpen & Chowdhury (1995) have pointed out that most of the research on strategy has neglected to examine cases of strategic absence, i.e. those situations where strategy is expected but not observed. Examining the limited diversity of organizational configuration can likewise help the researcher understand not only whether a certain configuration is absent, but also *which* configurations are absent. Thus, if it is possible to detect clear and robust patterns of absence within the property space of organizational design features, such patterns may also provide insights into the nature of relations between different design elements. Furthermore, such patterns of absence may make explicit the otherwise implicit and widely shared assumptions about what design elements should or should not go together.

Moving beyond empirically observable instances of organizational configurations is also important because it allows moving from the descriptive realm to the question of how to design better configurations. In this task, insights from studying limited diversity of configurations may be helpful for building theory in at least two ways. First, such insights may allow building robustness and redundancy into organizational designs. If it is possible to identify more than one sufficient combination of design features that lead to high performance, then knowledge about two different paths to an outcome can be used to construct a superior configuration that may be more robust to changes in the environment. Thus, set-theoretic methods may allow the design of configurations that offer robustness of essential systems while limiting the use of resources to attain such robustness. Second, once we know what design elements are necessary or sufficient to attain the outcome in question, studying limited diversity allows the researcher to identify additional design combinations that may extend or improve existing configurations. One might conceive of existing combinations as being close to peaks in a rugged performance landscape (Gavetti & Levinthal, 2000), but not necessarily at the apex of such peaks. A localized search for additional configurations may then capitalize on knowledge about existing, workable configurations and non-existing, but perhaps promising design extensions of such configurations. Studying limited diversity thus offers new insights to a configurational approach because it provides a novel strategy for learning about property spaces and the relationships between different design elements, and thus offers guidance to the process of theory building.

Set-theoretic Methods and Theory Building.

I have argued that the assumptions of configurational theory require methods that can better assess complex, non-linear, and synergistic effects. While set-theoretic methods provide a novel way addressing these needs, such methods can in turn also provide new insights to configurational theory in particular and the theory of organizations more generally. I have already pointed out how knowledge about design configurations may guide theory-building by helping to identify promising organizational designs. However, set-theoretic methods may also affect theory on a deeper level.

Set-theoretic methods not only provide a way of analyzing relationships between different configurations of organizational characteristics, they also provide a language for expressing such relationships. The methods I have described here use a language that is "half-verbal-conceptual and half-mathematical-analytical" (Ragin, 2000: 4). This language is particularly suitable for combining the verbal expression of abstract concepts with the analytical rigor of logical relationships, something that is often amiss in current theory-building (Sutton & Staw, 1995). Much of our language for describing relationships tends to be correlational. However, causal relationships are different from correlations. Statements about correlations are symmetrical, but statements about causal relations are asymmetrical. For example, consider the following statement: "diversification will be negatively related to firm risk." As a correlational claim, it follows that firm risk is also negatively correlated with diversification. However, the *causal* relationship is directional and one-way: diversification decreases firm risk, not the other way around.

Furthermore, correlational statements cannot account for necessity and sufficiency, two crucial concepts for understanding causality. For example, consider the central tenet of structural contingency theory that organizational effectiveness depends on the fit between the organization and its environment. As Galunic & Eisenhardt put it, "the better the fit between structural components and contingent factors, the greater the viability and performance of the organization" (1994: 216). This is a concise and intuitively appealing statement. As a correlational claim, it is usually understood that this statement will apply while holding other relevant factors constant. The prediction is that if fit between structural components and e.g. the environment is relatively low, performance will tend to be low, while if the fit is relatively high, performance will also be high.

However, in terms of causal relationships, we may assume that more than just fit is necessary for high performance. We may find a number of firms that structurally show good fit with the environment but do not exhibit higher performance, perhaps due to a lack of resources or incompetent management. If that was the case, we may conclude that fit is a necessary, but not sufficient condition for higher performance, since without it high performance cannot be achieved, but fit by itself is not enough to guarantee high performance.

On the other hand, we may find a number of firms that score high on the performance measure but not high on the fit measure. This may be the case if some firms can overcome their bad fit or compensate for it by some other means, such as lucrative patents or a particularly committed workforce. If we find a considerable number of such firms, we may conclude that fit is sufficient, but not necessary for higher performance, since there seem to be other ways of achieving such performance.

Both kinds of cases I have described here are inconsistent with a correlational relationship, and we thus account for them by controlling for other characteristics. In some situations where there are a large number of inconsistent cases, we may "correct" for such heteroskedasticity by using statistical procedures. However, instead of treating such cases as a methodological nuisance, we may also consider how such cases can help us learn about the causal relationship between the characteristics in question. In fact, both kinds of cases I have described are perfectly consistent with a set-theoretic point of view. Thinking of firms as cases that have membership in different causal conditions thus forces us to consider whether these conditions are necessary, sufficient, or perhaps neither. Since necessity and sufficiency are two of the basic building blocks of causal relationships, incorporating them better into theory-building presents a step towards the building of theories that can account for complex causal relationships.

CONCLUSION

In this paper, I have argued that while the study of organizational configurations holds considerable promise for organization theory and strategy, it is currently impeded by a discrepancy between its theory and methods. To overcome this discrepancy, I propose the use of set-theoretic methods to study how different organizational elements combine rather than compete to produce an outcome. While I have only been able to provide a very brief sketch of these methods, it appears evident that a set-theoretical approach is much more closely aligned with the theoretical thrust of configurational theory which stresses the existence of effects that are not simply linear, additive, and unifinal. Set-theoretic methods offer a rigorous and nuanced way of assessing the complex ways in which causes combine to create outcomes. This approach brings us closer to understanding the realities of strategizing. While causal complexity may in fact be the most common form of causality facing a firm's decision makers, it is still not sufficiently addressed in empirical strategy research. In terms of causal relations, most empirical studies tend to focus on main and two-way interaction effects. However, there is a clear need to move beyond bivariate and simple contingency approaches, since most firms face multiple contingencies such as strategy, structure, leadership, and technology, with significant interdependencies between these contingencies (Galunic & Eisenhardt, 1994; Burton & Obel, 2004). Furthermore, these multiple contingencies may present the firm with contradictory requirements on strategy and structure (Miller, 1992). The resulting questions about trade-offs between multiple and differing demands are arguably at the core of strategy research and have led researchers to call for a new methodology that takes into account configurational patterns, equifinality, and multiple contingencies (Drazin & Van de Ven, 1985; Galunci & Eisenhardt, 1994). Set-theoretic methods provide way of assessing such situations of causal complexity, and these methods furthermore provide a sophisticated technique for studying equifinality, an issue that has so far largely been neglected in empirical research.

Set-theoretic may furthermore contribute to strategy research by focusing explicitly on localizing causal complexity. This aspect is especially significant for the domain of business policy, which is concerned with offering specific advice to managers. For most executives, the average population net-effect of a particular structural feature or strategic position is less relevant than its particular effect on their specific firm. Set-theoretic approaches are adept at identifying such localized effects. Rather than estimating the relative importance of different strategies across all cases, set-theoretic methods allow to examine which strategies make sense for which firms; and most of the time there will likely be different strategies for different firms.

While I have focused here mainly on contributing to configurational research, the implications of set-theoretic methods clearly extend well beyond this domain. One area where such methods are particularly applicable is research in the tradition of the resource-based view (RBV) (e.g. Barney, 1991, 1996; Conner, 1991, Dierickx & Cool, 1989; Peteraf, 1993; Wernerfelt, 1984). As pointed out by Black & Boal (1994), most research within the RBV tends to evaluate resources from a stand alone viewpoint, with less attention paid to how the value of resources may depend on the presence of other resources. In fact, resources typically do not stand alone, but are "nested in and configured with one another and the nature of relationships between them" (Black & Boal 1994: 132). While the idea of "resource bundles" has to some extent been recognized by RBV theorists (Barney & Zajac, 1994; Dierickx & Cool 1989; Galunic & Rodan 1998), it has been largely ignored by empirical research. However, competitive advantage may frequently depend on combining resources. As an example of such a situation, an automation study by Parthasarthy and Sethi (1992) showed that only the combination of speed and scope flexibility led to higher performance; by themselves, neither speed nor scope had a significant effect. Such conditions, where two or more resource factors are necessary but not sufficient, are more likely the rule than the exception in firms, thus calling for an approach that can effectively address causal combinations. Furthermore, resource bundles may themselves combine with other resource bundles to form configurations at higher levels, perhaps allowing for substitution of one combination for another. Within the RBV, conceptual attempts to capture such complex interactions have so far relied on network theory (Black & Boal, 1994) or a modular view of the firm that examines the likelihood of different resource recombinations (Galunic & Rodan, 1998). In contrast, a set-theoretic approach provides both the conceptual framework and the empirical methodology to analyze how resources combine to form bundles and how these bundles affect firm performance. Using set-theoretic methods to study competitive advantage thus presents a way of extending the RBV and moving beyond the current tendency of isolating unique resources. Again, a set-theoretic approach can both guide theory and empirical investigation in this regard, thus offering an improved understanding of the nature and effect of organizational configurations.

[1] For the moment, I will not consider the empirical truth of these examples but merely use them to illustrate set-theoretic relationships.

[2] Readers familiar with truth tables will have noticed that I use a reduced form of the table. The full table would have inlcuded 3^k-1 groupings, where *k* is the number of attributes. With four attributes, this would amount to 80 groupings (3^4-1=80).

[3] Another limitation refers to the use of necessary and sufficient conditions as absolute criteria, i.e. criteria where a single exception may disprove the rule. However, as Ragin (2000) shows, it is possible to use probabilistic criteria to evaluate set-theoretic relationships, thus allowing for measurement error etc.

[4] Some of the combinations that do not occur may involve configurations that are somehow unfeasible, logically impossible, or simply fail to show empirical instances. One needs to keep in mind that that the number of possible configurations grows exponentially with the number of attributes examined and that a lack of empirical instances may simply be due an overabundance of cells within the property space.

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TABLE 1

Truth Table for Hypothetical Combinations of Organizational Characteristics

	Organizational Characteristics				Outcome
	A	B	C	D	Z
Configuration Number	Efficient Production System	High Rate of Product Innovation	Heterogeneous Environment	Hierarchical Control Structure	High Performance
1	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	No	No
3	Yes	Yes	No	Yes	Yes
4	Yes	Yes	No	No	Yes
5	Yes	No	Yes	Yes	No
6	Yes	No	Yes	No	No
7	Yes	No	No	Yes	Yes
8	Yes	No	No	No	Yes
9	No	Yes	Yes	Yes	Yes
10	No	Yes	Yes	No	No
11	No	Yes	No	Yes	Yes
12	No	Yes	No	No	No
13	No	No	Yes	Yes	No
14	No	No	Yes	No	No
15	No	No	No	Yes	No
16	No	No	No	No	No