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Measuring Industry Dynamics: Towards a Comprehensive Concept**

Abstract

We present a detailed literature-based analysis of the correct composition of the industry dynamics construct and an empirical test of the formative multidimensional character we propose. By providing a comprehensive definition and measurement concept of industry dynamics with the utmost degree of content validity, we supply the base necessary for future empirical research on that topic. Based on this measurement concept, advanced research methods such as structural equation modeling can exploit their full potential. Furthermore, we equip managers with a valuable tool that can assist them to better understand their industry environment and benchmark it against other industries.

JEL Classifications: C82, E32, L16.

Keywords: Content Validity; Environmental Dynamism; Multidimensional Measurement Concept; Task Environment.

1 Introduction

The consideration of the dynamics of organizational environments is deeply rooted in the tradition of organization theory and strategic management research and does not so far seem to have lost its relevance. In their pioneering work on contingent organizational responses, Burns and Stalker (1961) noted that successful firms in a stable environment tend to have "mechanistic" or highly bureaucratized structures and processes while successful firms in changing and uncertain environments tend to have "organic" or flexible structures and processes. Emery and Trist (1965), whose work was elaborated and extended by Terreberry (1968), developed four ideal types of environments with respect to their changing patterns

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** We are grateful to Ulrich Lichtenthaler, Oliver Baumann, and Michael Dowling for their helpful comments and suggestions on an earlier draft of this paper. We also benefited from an inspiring discussion at the Workshop "Wissenschaftliche Kommission Organisation" 2010 in Berlin.

that require specific types of behavioral responses which are necessary for survival in each different environmental type. Lawrence and Lorsch (1967) extended the earlier work of Burns and Stalker (1961) and stated that the uncertainty level of top managers increases as environmental volatility increases. Thompson (1967) also based his work on contingency arguments and focused on change as an important environmental dimension to which organizations must adapt if they want to survive – an assertion deeply embedded within the behavioral theory of the firm (Cyert and March (1963); March and Simon (1958)). Numerous studies have followed the lines of these arguments and have made industry dynamics a central research topic. The broad range of research fields within which the impact of industry dynamics is investigated can be seen in *Appendix A* which gives an exemplary overview of recent work that is relevant in our context. Compared to other environmental characteristics, such as complexity and munificence, it is environmental dynamism that is generally regarded as having the most important impact on organizational variables (Dess and Beard (1984); McArthur and Nystrom (1991); Simerly and Li (2000); Suarez and Oliva (2005); Wu, Levitas, and Priem (2005)) and is the predominant contingency factor in the literature (Tosi and Slocum (1984); Dess, Ireland, and Hitt (1990); Miller (1992); Rajagopalan, Rasheed, and Datta (1993)).

Thus, having a valid concept to measure environmental dynamism is obviously highly relevant. However, as our study shows, there are serious concerns regarding the validity of the concepts that are used to measure environmental dynamism. Therefore, in this paper we participate in the ongoing and as yet unresolved discussion surrounding the conceptualization and measurement of environmental dynamism (Tosi, Aldag, and Storey (1973a; 1973b); Lawrence and Lorsch (1973); Snyder (1987); Sharfman and Dean (1991a; 1991b); Dess and Rasheed (1991); Bluedorn (1993); Harris (2004)). Addressing the major problems inherent in current measurement concepts, we present a comprehensive concept intended to thoroughly measure the construct of industry dynamics. With this goal in mind, we structure our paper as follows:

In *Section 2* we discuss the importance of distinguishing between objective and perceptual measures of industry dynamics. This distinction is often ignored in the literature, leading to inconsistent measurement concepts. We explain the problems resulting from the incorrect application of perceptual measures instead of objective ones for theory testing. Further, we explicate the relevance of correctly operationalized objective measures of environmental dynamism for management practice. In *Section 3* we define the construct of industry dynamics, both in terms of the objects comprising an industry and the attributes forming those objects' dynamism. Therewith, we derive nine distinct aspects that characterize the dynamics of an industry. Even though a precise construct definition is an important prerequisite to avoiding serious problems in terms of content validity, current measurement concepts generally fall short of doing this and reduce industry dynamics to a single aspect – the volatility of sales figures. We demonstrate that each of the nine aspects we describe deserves consideration and an operationalization tailored to its idiosyncratic features. In line with this, it is also a goal of our study to replicate the results of Wholey and Brittain (1989) who made a first (but incomplete) attempt to test for the multidimensional character of industry dynamics. *Section 4* deals with the methodology of our analysis and contains a literature-assisted compilation of useful metrics to measure the nine aspects of industry dynamics. In addition we discuss another prevalent limitation, the difference between measures based on firm data and measures based on industry data (i.e., aggregated firm data). The discrepancy between the two can be immense, considering that highly turbulent but uncorrelated resource flows between firms within an industry may cancel each other out and lead to a smoothed and stable industry average (Markowitz (1952)). In *Section 5* we test for the multidimensionality of industry dynamics. We apply our measurement concept on a sample of 82 industries based on four-digit SIC codes and present our results. In *Section 6* we examine whether these results can substantiate the multidimensional construct structure we have defined and we discuss aspects of construct validity under consideration of the formative versus reflective discrimination. This is important, as the widespread mistreatment of industry dynamism as reflective (and thus unidimensional) construct has severe consequences when it comes to reliability and validity assessment. In *Section 7* we draw a conclusion and give an outlook for future research.

2 Objective Compared to Perceptual Measures of Industry Dynamics

Early studies on environment-structure relations (e.g., Lawrence and Lorsch (1967); Duncan (1972)) were criticized for not distinguishing between the environment as an objective phenomenon outside the organization and the environment as perceived by organizational members. In using managers' perceptions of uncertainty as surrogate measures of environmental variability, these studies treat the data as if it represented an objectively real environment (Tinker (1976); Snyder and Glueck (1982)) and end up with serious problems in terms of construct validity (Starbuck (1976)). The rationale behind the rejection of the originally assumed convergence of objective and perceptual measures is that measures based solely on subjective data provide information about the subject, but not about the environment (Bourgeois (1980)). Managers' perceptions may vary substantially across organizations in a similar environment (Snow (1976); McCabe (1990)) and thus, the same objective environment may appear differently to different organizations (Miles, Snow, and Pfeffer (1974); Anderson and Paine (1975); Lorenzi, Sims, and Slocum (1981)). Researchers also assume that perceptions are easily influenced and may vary considerably over time, while the objective environment does not (Lenz and Engledow (1986); Buchko (1994)). Indeed, some studies have shown that executives' perceptions are only a weak surrogate for objective measures of their environments (Tosi, Aldag, and Storey (1973b); Lorenzi, Sims, and Slocum (1981); Mezias and Starbuck (2003)).

To explain that divergence, Child (1975) argues that perceptual differences result from the capacity of the organization's systems with which managers are equipped to obtain and process information. But the majority of researchers ascribes the discrepancy to factors rooted in the individual. Individual perceptual and interpretive processes, different assumptions and experiences (McCabe (1990)), and limitations in cognitive reasoning abilities (Milliken (1987); Boyd, Dess, and Rasheed (1993)) may lead to an overemphasis of environmental sectors that specifically affect the individual manager's functional area or to an overgeneralization from more recent events to the overall state (Sharfman and Dean (1991a)). Yasai-Ardekani (1986) states that due to the individual's characteristics and organizational structures, assumptions about environments may persist despite environmental changes. Snyder and Glueck (1982) assume that executives in an industry have a bias toward rating their industry as more volatile than it really is and that few executives believe they work in a stable industry.

However, Doty et al. (2006) show that divergence between measures of objective and perceptual variation should not be interpreted solely as perceptual error or bias, but instead reflect real differences between both constructs. For example, since researchers typically use SIC codes to define industries, it is questionable that executives' understanding of the boundaries of their industry is congruent with SIC classification (Dess and Beard (1984); Doty et al. (2006)). Summing up, the arguments presented so far explain why firms facing ostensibly similar conditions pursue different strategies (Bourgeois (1985)), may not react to observable environmental changes (Child (1972)) and why studies that utilize perceptual measures of environmental uncertainty as surrogate measures of environmental attributes may be confounded by spurious associations or non-associations (Downey, Hellriegel, and Slocum (1977)).

What should be clear from the above is that using surveys to obtain information on the true objective industry dynamism might be problematic; questionnaires can only capture individual raters' perceptions, which creates validity problems. However, this approach still appears in recent studies (e.g., Mendelson and Pillai (1999a; 1999b); Brews and Purohit (2007); Jansen, Vera, and Crossan (2009)).

Bourgeois (1985) developed another putative objective measure that in fact is perceptual. He calculates industry volatility by using the changes in the U.S. Department of Commerce's annual forecasts of industry output. With that, he only gauges the ability of industry analysts to predict industry outcomes and not observable alterations of real industry characteristics (Downey, Hellriegel, and Slocum (1975); Tushman and Anderson (1986)). No less debatable is the use of subjective assessments by professors or other experts to obtain objective data on industry dynamism, as was done by Nadkarni and Narayanan (2007b)[1].

Thus, the dissimilarity between objective and perceptual measures of industry dynamism should be beyond question. However, from our point of view there is no question of superiority, but rather of intent and field of application. While perceptual measures are more useful for understanding managerial behavior, objective measures are valuable for studies that focus on organizational outcomes, for understanding external constraints imposed on organizations, and for quantifying structural differences between industries (Snow and Darran (1975); Tinker (1976); Boyd, Dess, and Rasheed (1993); Boyd and Fulk (1996); Harris (2004)). Also, longitudinal comparisons of changes within an industry and comparisons with other industries during the same time period would benefit from objective measures, because perceptions may not be reliable within such frameworks due to cognitive limitations of executives (Boyd, Dess, and Rasheed (1993); Mendelson and Pillai (1999a)). Moreover, adequate perceptual measures would be considerably time consuming for the respondents to complete. This disadvantage is further amplified by the fact that in general, respondents with the desired comprehensive industry understanding are top managers. Their limited accessibility normally precludes the accomplishment of studies involving large numbers of firms.

1 Nonetheless, Snyder and Glueck (1982) showed that industry analysts from stock brokerage firms are more objective raters than managers.

Researchers who use objective instead of perceptual measures could compute dynamism indexes for a great number of industries without having to resort to input from top executives, which is of high importance for research practice. Furthermore, a regular publication of a listing of such indexes would release researchers from even this computation, and at the same time assures uniformity of data across studies (Aldag and Storey (1975)). Besides advantageously accessibility of data and higher potential for replication and comparison across studies, objective measures also enhance the generalizability of study results (Boyd, Dess, and Rasheed (1993); Boyd and Fulk (1996)). These advantages might explain why researchers have increasingly turned to objective measurement concepts in recent years (Bluedorn (1993); Harris (2004)).

Many researchers postulate that organizations will ultimately suffer if their managers' perceptions unjustifiably ignore or distort crucial objective shifts in environmental states (Miles, Snow, and Pfeffer (1974); Hatten and Schendel (1976); Jauch and Kraft (1986); McCabe (1990); Boyne and Meier (2009)). In that case organizations misinterpret the status quo and will most likely consume slack resources in the performance of their tasks (Downey and Slocum (1975)). Such organizations probably react inappropriately to real situations and needlessly waste resources by implementing decisions based on faulty information (Bourgeois (1985)). Moreover, firm members' accurate perceptions of the environment is a necessary prerequisite for any organization to successfully match its structure with environmental demands (Boyd, Dess, and Rasheed (1993)). Also, managers who have inaccurate perceptions of their environments may lose out to competitors who see opportunities more clearly (Mezias and Starbuck (2003)). Thus, it is the managers' obligation to become aware of relevant environmental changes so that strategies and techniques may be developed for coping and dealing effectively with environmental constraints (Tung (1979)).

Accurate, objective data about environmental change can improve the quality of decision-making in organizations by improving perceptions about reality (Snyder (1987); Doty et al. (2006)). In addition to information on their own industry, managers may have a legitimate interest in interindustry comparisons of dynamism (Snyder and Glueck (1982); Snyder (1987)). Such cross-industry benchmarking analysis can prove to be useful for market entry decisions by helping firms to distinguish which industries are moving at a pace that could be difficult for them to match (Jurkovich (1974)). In introducing his concept of industry clockspeed, Fine (1996; 1998) suggests that benchmarks of industry change can be used to transfer experiences of companies in fast clockspeed industries to companies in medium or slow evolving industries.

Summing up, easily computable objective measures of environmental dynamism should be extremely useful to executives who must make decisions in the face of changing environmental conditions – at least the accuracy of managers' perceptions can be scrutinized with the help of such measures. Consequently, management scholars have a responsibility to conduct research to assist organizations in this regard (Snyder (1987)). We address the present study to this very task.

3 Construct Definition

3.1 Objects of Industry Dynamics

For purposes of operationalization and measurement of environmental dynamism, we must make a distinction between the different objects with which an organization interacts, i.e., the sectors that compose the organizations environment, and the attributes that form the dynamism construct and thus describe what precisely is meant by the term dynamism (Tung (1979); Tosi and Slocum (1984); Rossiter (2002)). Addressing the shortcomings of existing concepts in the literature, we first define the objects and then the attributes of the focal construct to finally arrive at a construct definition that covers the multidimensional character of industry dynamics.

Concerning the objects that comprise organizational environments, Dill's (1958) definition of the organizational task environment has been established as common practice. This part of the organizations' total environment is supposed to be potentially relevant to the setting and attainment of goals. It should be separated from the more remote macro or general environment as it contains those sectors that an organization's strategy directly deals with and whose changes or discontinuities have a greater effect on managers' decisions (Osborn and Hunt (1974); Bourgeois (1980); Daft, Sormunen, and Parks (1988); Ebrahimi (2000); Garg, Walters, and Priem (2003)). The objects that must be included into the definition of the task environment have changed during the ongoing research process: While Dill (1958) originally included customers, suppliers, competitors, and regulatory groups; Duncan (1972) and Bourgeois (1985) added technology; and Dess and Beard (1984) excluded regulatory groups. In the final configuration that has been established, the task environment is defined as an array of customers, competitors, and technology (Daft, Sormunen, and Parks (1988); Miller (1992); Garg, Walters, and Priem (2003)). We assume that this definition is an appropriate solution, because it is also assumed that the strategic characteristics of these three objects have the highest impact on the ability of a top management group to manage (Prahalad and Bettis (1986); Ginsberg (1989); von Krogh, Erat, and Macus (2000))[2]. When the dynamism of these objects is the focal point, the customer object is typically concret-

2 We admit that restricting to just these three objects might be too high a constraint for other researchers who may require the consideration of regulations, suppliers, alliance partners, and so on. Regarding regulations, we decided against including them in the definition of the task environment, because regulations can rarely be attributed to a specific industry. Changes of company taxation law, foreign trade agreements, or emission regulations doubtless have a high impact on organizations, but affect many industries simultaneously. Due to that overlap, they are ill-suited for a disjunct industry dynamics measurement concept. Arguing against suppliers as an object included in the task environment contends that, according to prevalent industry classification schemes (e.g., the SIC system), suppliers of an industry are generally defined as an own supplier industry. Hence, suppliers are understood not as an object of an industry, but as an industry in and of itself. Examples are SIC code 1311 (crude petroleum and natural gas extraction), which is the supplier industry of SIC code 2911 (petroleum refining), or SIC code 3721 (aircrafts) is supplied by the two SIC codes 3728 (aircraft parts) and 3724 (aircraft engines), or SIC Code 3714 (motor vehicle parts and accessories) supplies the four SIC codes 3711 (motor vehicles and passenger car bodies), 3713 (truck and bus bodies), 3715 (truck trailers), and 3716 (motor homes). However, there can certainly be an additional investigation of dynamism interrelationships between supplier and buyer industries, but doing so is regrettably beyond the scope of this paper. Finally, alliance partners should not be seen as a separate object of industries, since alliance partners are generally either suppliers or competitors. Nevertheless, the strategic process that makes suppliers or competitors into alliance partners with regard to the underlying industry dynamics is another, yet highly interesting, discussion (e.g., Yin and Shanley (2008)), but again beyond the scope of this paper.

ized to "customer preferences" or "demand" (Henderson, Miller, and Hambrick (2006); Wirtz, Mathieu, and Schilke (2007); Jansen, Vera, and Crossan (2009)). In the same manner we adjust the denotation of the competitor object into "competitive situation".

Some researchers note that the task environment approximates the concept of "industry" (Child (1975); Bourgeois (1980; 1985); Lenz and Engledow (1986); Rasheed and Prescott (1992)), which is why we use the terms "environmental dynamism" and "industry dynamism" interchangeably. Consequently, we can assume that the characteristics of a concrete object comprising the organization's task environment are more or less homogeneous within an industry and largely heterogeneous across industries. However, regarding those objects' dynamism, this does not mean, that all emerge in the same way. On the contrary, illustrations and also some empirical results of former studies indicate that the objects must be treated as independent entities and cannot be gauged by a single item such as industry sales. That point is expressed by Tosi and Slocum (1984), who argue that as each organizational unit responds to specific environmental sectors, the idiosyncratic change patterns of specific environmental sectors will have different effects on organizations. For example, the dynamism of the market environment (i.e., demand patterns) will have different effects on the marketing department than will technological changes on the R&D department. In this context, we can also argue that when rapid technological changes overlap with a low frequency of changes in customer preferences within an industry, frequent product innovations based on newly available technologies may prematurely shorten the life cycles of the innovating firms' strong products (Garg, Walters, and Priem (2003)).

Another example is Sharfman and Dean's (1991a) criticism of the dynamism factor developed by Dess and Beard (1984), which considers only market changes and disregards technological and competitive situation changes. Sharfman and Dean also make clear that there is no reason to expect that indicators of technological dynamism must correlate with market-based measures of dynamism, since the alterations of both objects can have completely different causes and consequences (Sharfman and Dean (1991b)). This proposition is also reflected by some empirical results. For example, the exploratory factor analysis on the multifaceted measurement items in the Dess and Beard (1984) study shows clearly that industry dynamism is a multidimensional construct in terms of the certain objects comprising organizations' environments. The Bourgeois (1985) and McCabe (1990) studies support this result. Unfortunately, because Dess and Beard (1984) were looking for a one-factor solution, they dismissed two of the three factors on hand and restricted themselves to a sales-based explanation of industry dynamism.

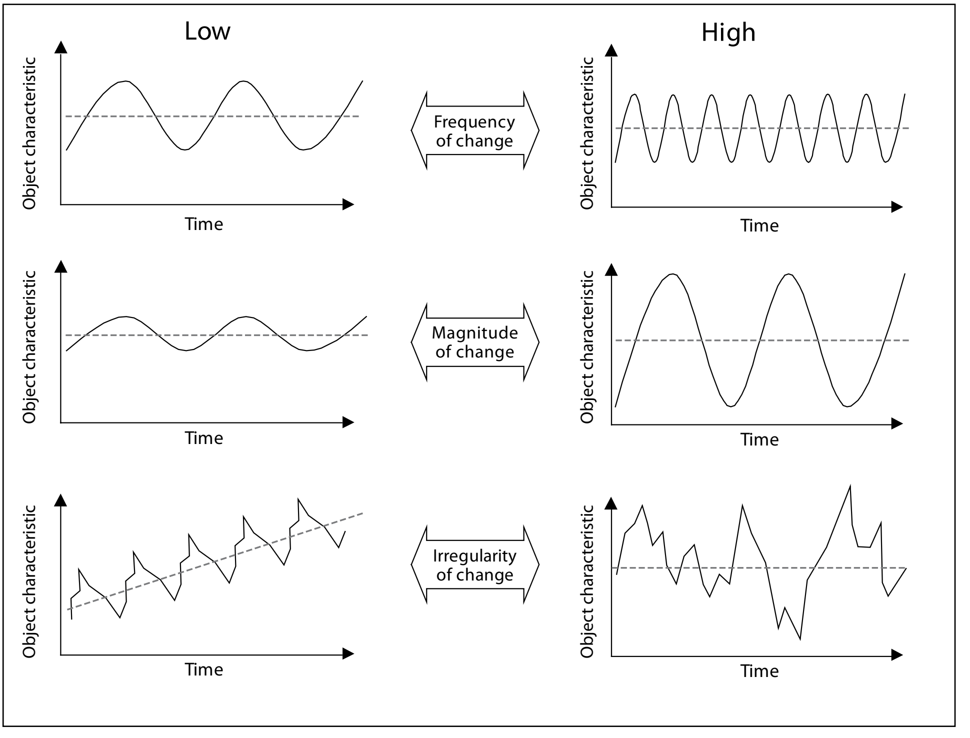
We assume that it is mostly for questionable reasons of simplicity that so many studies take up the concept of Dess and Beard (1984) to measure industry dynamism (e.g., Keats and Hitt (1988); Boyd (1995); Bergh (1998); Bergh and Lawless (1998); Li and Simerly (1998); Simerly and Li (2000); Carpenter and Fredrickson (2001); Andersen (2004); Cannella, Park, and Lee (2008); McNamara, Haleblian, and Dykes (2008); Wang and Li (2008)) and thus neglect important aspects of industry dynamics. Our assumption that the three objects of customers, competitors and technology must be treated equally and independently is also rooted in the survey results of Daft, Sormunen, and Parks (1988) and Elenkov (1997). These authors find that a specific level of importance is allocated to each environmental sector and more importantly, that sectors are perceived to have independent change patterns. Also, Boyd, Dess, and Rasheed (1993) emphasize the relative importance of the different environmental segments. Studies that focus on technological dynamism and emphasize its role in shaping industries (Tushman and Anderson (1986)) and its impact on company success (Wu, Levitas, and Priem (2005)) further underline that industry dynamism must be more than alterations in industry sales. Consequently, separate objective measures of environmental dynamism should be used for each sector (i.e., object) of the environment (Jauch and Kraft (1986)). In the course of our paper we will meet this requirement and demonstrate the independence of the three objects of industry dynamism – a step long overdue as the few and only vague empirical results mentioned above did not cover competitive dynamics and the underlying data stems from the early 1980s (McCabe (1990)) or even from the 1970s (Dess and Beard (1984); Sharfman and Dean (1991a)).

3.2 Attributes of Industry Dynamics

Child (1972) was the first to decompose environmental dynamism into three different attributes: (1) the frequency or rate of change (i.e., the span of intervals between changes), (2) the magnitude or intensity of change (i.e., the degree of difference at each change), (3) the irregularity or predictability of change. The Jurkovich (1974) and Miles, Snow, and Pfeffer (1974) studies further underline the importance of that threefold distinction. We agree with Wholey and Brittain (1989), who reason that decomposing dynamism into the three attributes of a wave function – frequency, magnitude and irregularity – exhaustively describes the change pattern of a system and is consistent with the classification above[3]. Wholey and Brittain also empirically demonstrate the independence of these three attributes, clearly separating them by factor analysis. Dess and Rasheed (1991) and Boyd, Dess, and Rasheed (1993) emphasize the value of Wholey and Brittain's study for empirical research. Yet, as important as their study is to the progress in measuring dynamics, it also has a severe shortcoming: The authors focus only on sales figures and hence do not consider the multidimensionality of the construct's object structure. It is our intent to overcome this limitation. *Figure 1* shows plots describing the attributes of industry dynamism.

3 Suarez and Oliva (2005) include speed of change as an additional dynamism attribute, which they define as the rate of change of the disturbance (deviation/time). However, we only examine industry changes within a predetermined time interval. Hence, speed of change is a function of the frequency of changes and need not be observed in our instance.

Figure 1: Attributes of industry dynamics



We note especially that the irregularity of change has often been used as a synonym for perceived uncertainty, because the absence of pattern is supposed to reduce the degree of accuracy with which one can predict the future (e.g., Child (1975); Lorenzi, Sims, and Slocum (1981)). However, this equation constitutes an inappropriate mixing of the subjective (i.e., perceptual) with the objective approach in capturing industry dynamism. Cameron, Kim, and Whetten (1987) dispel this confusion and propose that uncertainty is best thought of as an outcome of irregularity of change rather than as a synonym. However, when Tosi, Aldag, and Storey (1973b) had tried to confirm this assumption empirically, they were unable to do so. Yet, the independence of perceived uncertainty and objective irregularity that they discovered might be explained by their inappropriate use of volatility indexes as measures of irregularity. Since such measures cannot distinguish irregular fluctuations from fluctuations attributable to constant, and thus highly predictable, growth trends (Downey and Slocum (1975); Wholey and Brittain (1989)). Since we have discussed the problems associated with perceptual measures to gauge objective characteristics at length, we do not want to take a position on the question of whether objective irregularity corresponds to perceived uncertainty, and thus consciously label the third dynamism attribute "irregularity" and not "predictability". We consider this distinction to be important because the idea of predictability involves subjective perceptions and projections (Suarez and Oliva (2005); Kim and Rhee (2009)), but in this paper we focus on the objective dynamics of industries.

The widely used concept of Dess and Beard (1984) not only restricts industry dynamics to a single object, but also ignores two of the three attributes and merely concentrates on the irregularity attribute. This reduction of industry dynamics to irregularity does not seem satisfying to us. That magnitude or intensity of change also matters becomes clear when one refers to the work of Tushman and Anderson (1986), Gersick (1991), Romanelli and Tushman (1994), Tushman and O'Reilly (1996), and Brown and Eisenhardt (1997). The importance of frequency or rate of change has been sufficiently elaborated by the work of Bourgeois and Eisenhardt (1988), Fine (1996; 1998), Mendelson and Pillai (1999a; 1999b), Nadkarni and Narayanan (2007a; 2007b), and McCarthy et al. (2010).

3.3 Summary and Definition

To sum up, there still seems to be much need to elucidate on the true structure of industry dynamics when one commemorates the vast number of studies gauging only irregularities in industry sales to map industry dynamics. However, there may be specific research questions that permit or even require the focus on certain aspects of the whole construct of industry dynamism, but the deviation from the more comprehensive construct has to be well-grounded in the specific theoretical context. Otherwise, one risks creating serious problems regarding content validity.

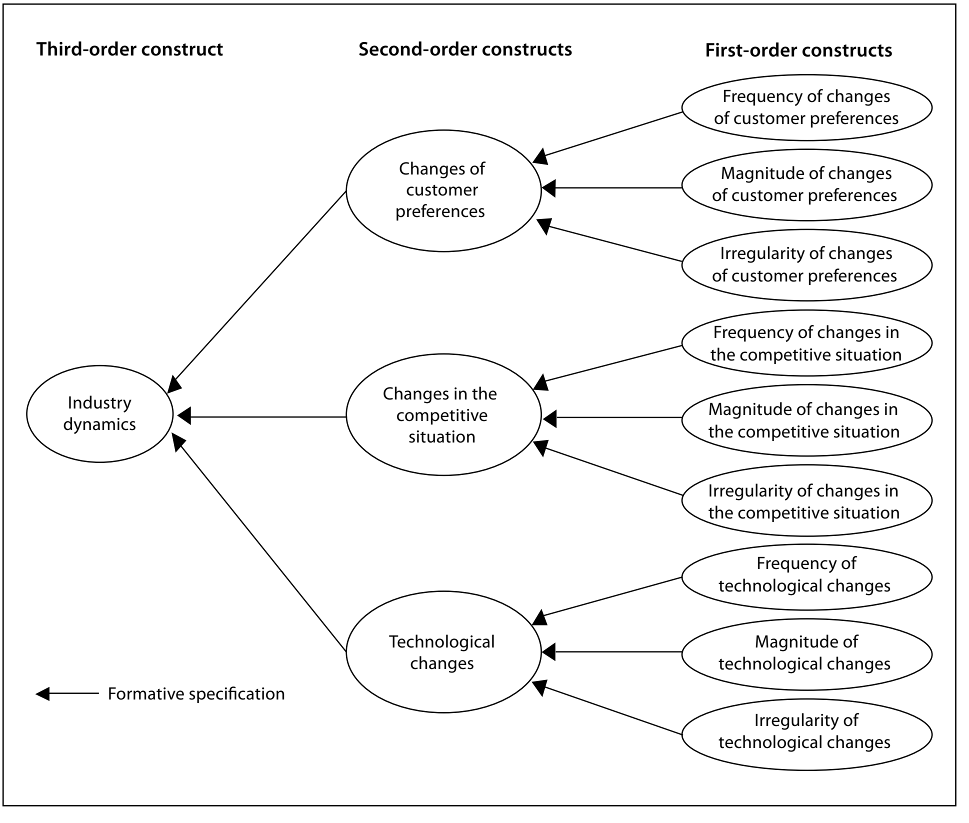
Based on the previous discussion, we define industry dynamics as *the frequency, the magnitude, and the irregularity of changes of customer preferences, of changes in the competitive situation and of technological changes during a certain time span and within the boundaries of an industry*. From this definition we derive a matrix containing nine exclusive aspects of industry dynamics. *Figure 2* illustrates this matrix.

Figure 2: Aspects of industry dynamics

		Attributes of industry dynamics		
		Frequency	**Magnitude**	**Irregularity**
Objects of industry dynamics	**Customer preferences**	(1)	(2)	(3)
	Competitive situation	(4)	(5)	(6)
	Technology	(7)	(8)	(9)

Our explanations also imply that these nine aspects form (i.e., cause) the construct of industry dynamics; they do not reflect it (Williams, Vandenberg, and Edwards (2009); Podsakoff, Shen, and Podsakoff (2006)). A reflective specification would mean that if the dynamics within an industry increase, then all nine aspects of industry dynamics must also increase, but under formative specification the direction of causality is reversed (i.e., an increase in a certain aspect causes an increase in industry dynamics). As a consequence, while reflective aspects are principally interchangeable, ignoring a formative aspect would change the essential nature of the construct (Jarvis, MacKenzie, and Podsakoff (2003); Diamantopoulos and Winklhofer (2001); Edwards and Bagozzi (2000)). In *Figure 3* we show the multidimensional structure of the latent construct of industry dynamics. The formative specification of the construct is illustrated by the direction of the arrows[4]. Thus, we postulate that industry dynamics is independent in its nine different aspects, which is tested in the following.

Figure 3: Structure of industry dynamics construct



4 Applying the terminology of Jarvis, MacKenzie, and Podsakoff (2003), industry dynamics represents a multidimensional formative third-order construct. Yet, one can argue that the conceptualization of a construct by two subsequent formative construct levels does not really make sense, as the first order constructs can directly form the third-order construct without any need for intervening second-order constructs. However, the conceptualization as a higher-order construct can significantly reduce model complexity and increase the degrees of freedom in the context of partial least squares model estimation (Albers and Götz (2006)).

4 Method

4.1 Measures

4.1.1 Frequency of Changes in Customer Preferences

Subsequently, we compile the measures needed to capture the nine aspects of industry dynamics. We proceed by following the order of the numbering in *Figure 2*.

Consistent with previous research, we assume that a fluctuation in firm sales is an acceptable approximation for a change of those firms' customers' preferences. Hence, the number of oscillations in a sales time series is supposed to match the rate of customer preference changes. To obtain this number, we follow Wholey and Brittain (1989) and count the number of slope reversals in a sales time series (*V1*). We define a slope reversal as when a year with growth in sales is followed by a year with decline in sales, and vice versa. A large number of slope reversals indicates a high frequency of preference changes.

4.1.2 Magnitude of Changes in Customer Preferences

To obtain a measure for the magnitude of preference changes, Wholey and Brittain (1989) use a sales time series corrected for growth, and compute the difference between the minimum and maximum values. Because their procedure to correct for growth is not available to us, we use regression analysis to correct for growth and calculate the maximum percentage deviation of the real values from the regression line. Since a normal linear regression of sales on a time variable will not be able to display a constant annual growth rate[5], we use logarithmic transformations of sales regressed on a time variable (Keats and Hitt (1988); Harris (2004)). We then calculate the magnitude of preference changes as the maximum percentage deviation of real values from regressed values (*V2*).

4.1.3 Irregularity of Changes in Customer Preferences

The first scholars who attempted to objectively measure the irregularity of changes in firm sales were Tosi, Aldag, and Storey (1973b). They used the coefficient of variation of a sales time series as a measure of market volatility. Lawrence and Lorsch (1973) criticized the Tosi, Aldag, and Storey approach because periodically occurring seasonal fluctuations such as summer slumps or Christmas peaks would result in an increased coefficient of variation even though those fluctuations are completely regular and highly predictable. We are not so concerned about that point of criticism, because the use of total annual

5 A constant annual growth rate would not result in a linear, but a quadratic equation of sales over time. E.g., a starting value of 100 and a constant ten percent annual growth rate would lead to sales values of 110 in year two, 121 in year three, 133 in year four, 146 in year five, 161 in year six, and so on. This is not a linear equation but a second-degree polynomial equation. Hence, correcting for growth by linear regression would not be possible.

values instead of quarterly or monthly data would automatically smooth for periodical seasonal fluctuations. However, the Tosi, Aldag, and Storey approach has also been accused of being unable to detect variations in regular growth trends, since it only measures the variation about the mean (Milliken (1987); Boyd, Dess, and Rasheed (1993))[6]. This more severe limitation has been overcome by other researchers such as Bourgeois (1985), who calculates a detrended volatility measure by using differences from year to year as the basis of the coefficient of variation. Cameron, Kim, and Whetten (1987) apply the coefficient of alienation, which is a statistic that measures the lack of linear association between two variables; Wholey and Brittain (1989) use R-squared, which measures how well a regression line approximates real data points. Child (1975) uses an alternative approach, in which he takes a standardized sales time series and calculates the standard error of the regression slope coefficient divided by the mean. The resulting Figure represents the remaining variation of a linear trend in sales over time weighted for relative industry size. Dess and Beard (1984) adapt Child's concept, which today seems to have been established as common praxis. Nevertheless, as we note above, a constant growth rate cannot be captured by linear regression over time; it necessitates a logarithmic transformation of sales. Therefore, we regress logarithmized sales on time and use the standard error of the regression slope coefficient divided by the mean to capture irregularity of changes in customer preferences (*V3*).

4.1.4 Frequency of Changes in the Competitive Situation

Beesley and Hamilton (1984) contend that the turbulence created by the rate of entries and exits of firms within an industry is important to determine the competitive situation of an industry. Mamede (2009) elaborates, contending that changes in the competitive structure of an industry can be captured by the frequency of entries and exits of firms. According to Malerba and Orsenigo (1996), entry often occurs through acquisition. Jauch and Kraft (1986) state that the collective actions of competitors can be measured by the rate of entries, exits, restructurings and mergers. Based on the work of Fine (1996; 1998), Nadkarni and Narayanan (2007b) recommend measuring the frequency of competitor changes, which they label as "organizational clockspeed", by the rate of strategic actions within an industry such as mergers and acquisitions, forming alliances, and organizational restructurings. It follows from the above that the number of mergers and acquisitions is an appropriate item to measure the frequency of changes in an industry's competitive situation, because an acquisition implies both an entry (the acquirer) and an exit (the acquiree). We propose that other forms of ascertainable entries (e.g., IPOs) and exits (e.g., insolvencies) are relatively minor compared to the vast number of M&A[7]. However, the mere number of mergers and acquisitions would be meaningless if it were not weighted for the total number of competitors. One hundred acquisitions among 200 competi-

6 Compare the following two sales time series of five consecutive years: 100, 200, 300, 400, 500, and 300, 500, 100, 200, 400. Both coefficients of variation are the same, as both deviate from the mean value of 300 to the same extent. However, the first time series is a perfectly linear (i.e., perfectly regular), but the second series has a totally irregular pattern of change.

7 Worldwide M&A activity in 2008 amounted to 31,093 deals (ranking value US-$2,902 billion), while worldwide IPO activity only added up to 1,188 deals (proceeds US-$147 billion), Source: Thomson One Banker.

tors represents a very high frequency, but 100 acquisitions among 2000 competitors are relatively few. Hence, we measure the frequency of changes in the competitive situation as the average annual sum of mergers and acquisitions divided by the total number of competitors (*V4*).

4.1.5 Magnitude of Changes in the Competitive Situation

Without question, in numerical terms most entries and exits can be ascribed to very small companies and are primarily a characteristic of the fringe of an industry whose changes have a less intense impact on the overall competitive situation within an industry (Beesley and Hamilton (1984); Malerba and Orsenigo (1996)). Excluding firms with less than 20 employees, the annual sum of entries and exits in most industrial countries accounts for three to eight percent of the total number of competitors. Including these firms, the Figure even increases to 20 to 25 percent (Mamede (2009)). Hence, from the frequency of changes (i.e., the number of M&A) one cannot conclude on the intensity or magnitude of competitive dynamics. For example, ten deals of $1 million each represent a less intense change in the competitive situation of an industry than do ten deals of $1 billion each. Thus, we use the average M&A volume as a magnitude measure of changes in an industry's competitive situation (*V5*).

4.1.6 Irregularity of Changes in the Competitive Situation

Ensley, Pearce, and Hmieleski (2006) propose that when the number of industry establishments is regressed on a time variable, industry dynamics are reflected by the standard error of the regression slope coefficient. We have already contended that the standard error of the regression slope coefficient has frequently been used to gauge the irregularity attribute of industry dynamics (cf. V 3), and the number of industry establishments refers to the competitor object (cf. V 4). Hence, referring to our construct definition, Ensley, Pearce, and Hmieleski's approach can be interpreted as a measure to capture the irregularity of changes in the competitive situation. Moreover, we assume merger and acquisition activity within an industry as being the primary means to capture changes in the competitive situation. Thus, we regress annual M&A quantities on time and compute the standard error of the regression slope coefficient divided by the mean to obtain our irregularity measure of changes in the competitive situation (*V6*).

4.1.7 Frequency of Technological Changes

Regarding the frequency of technological changes, industries can be compared by the rate at which they introduce technically new products into the market, which in turn may be reflected by the duration of the product life cycle (Child (1975)). Also, the introduction of technologically new processes (Buchko (1994)) and the patent activity of firms (Jauch and Kraft (1986); Sharfman and Dean (1991a)) may be relevant to describing the dynamism pattern of an industry's technology. These approaches are partially adopted in the work of Mendelson and Pillai (1999a) who operationalize the concept of industry clockspeed introduced by Fine (1996; 1998). Mendelson and Pillai suggest the following three measures: (1) the fraction of total revenue derived from new products as an indicator of innovation, (2) the total duration of the product life cycle, and (3) the rate of decline in the prices of input materials as an incentive to frequently redesign products. However, it would be difficult to obtain these metrics other than by surveying managers as was done in the Mendelson and Pillai study. Because survey-based metrics contradict our standpoint on perceptual measures of industry dynamics, we reject their approach. Alternatively, Fine (1996) suggests looking at metrics such as the capital equipment obsolescence rate. He compares the economic lifetime of a typical semiconductor factory, which will be outdated in about four years, with automobile companies' factories that will last 20 years or more. These differences by no means indicate suboptimality or a handicap of the automobile industry; the two industries merely have different clockspeeds. Such obsolescence rates can be measured by the average number of years over which firms depreciate capital equipment, because it indicates how frequently firms replace their capital equipment (Nadkarni and Narayanan (2007b); Nadkarni and Barr (2008)). We value this measure, because it is based on publicly available data. Since the average depreciation time of capital equipment is not easily available, we approximate that metric by using the average of annual depreciation expenses as a percentage of total assets. For example, if a company depreciates on average 25 percent of its total assets per year, it will have completely replaced these assets after four years. Thus, a high percentage indicates a rapid obsolescence rate of capital equipment[8]. Hence, we apply the average of annual depreciation expenses as percentage of total assets as a measure for the frequency of technological changes (*V7*).

4.1.8 Magnitude of Technological Changes

According to the punctuated equilibrium model, industries emerge through continuous incremental technological changes that are interrupted (i.e., punctuated) by discontinuous radical technological innovation (Tushman and Anderson (1986)). New technologies as a result of radical innovations (e.g., the automobile and the computer) lead to fundamental industry restructurings or even to the death of old and emergence of new industries (Gersick (1991); Brown and Eisenhardt (1997)). In a longitudinal study over the lifecycle of three industries, Tushman and Anderson (1986) found that clearly outstanding innovations occurred only eight times in the 190 years observed across the three industries, that is, on average, about one every 24 years. Our measurement concepts of industry dynamics, as well as most of the others, assess the dynamics of a persisting industry in a more short-term perspective over an interval of about five years, and not over the whole industry lifecycle. Hence, the mere distinction between incremental and radical innovation to capture magnitude of change is too broad for our requirements. However, once a dominant design emerges, technological progress is continuously driven by numerous

8 We are well aware of the fact that total assets also contain assets other than capital equipment and that a firm's depreciation expenses also contain the depreciation of assets other than capital equipment. However, because the usefulness of measurement concepts correlates highly with data availability, we must rely on our metric being a good indicator. At least, we can assume that our metric is positively correlated with the true capital equipment obsolescence rate.

incremental improvements that can dramatically alter industry productivity. Technological action, such as investment in research and development, may be a powerful lever in directly shaping industry dynamics (Tushman and Anderson (1986)).

We assume that there are considerable intensity differences even within the phase of incremental change. These differences should be captured by our measurement concept. For that purpose, Buchko (1994) recommends indicating the percentage of firm sales attributable to innovation. Therefore, we measure the magnitude of technological changes by the average percentage of firm sales attributable to research and development activity (i.e., average R&D intensity) (*V8*).

4.1.9 Irregularity of Technological Changes

To measure irregularities in technological change, Jauch and Kraft (1986) suggest calculating the volatility of the research and development intensity. We have already contended that the R&D intensity directly spurs technological change within an industry. Hence, we assume that irregularities in R&D intensity may reflect irregularities in technological change. Ensley, Pearce, and Hmieleski (2006) propose a measure following that logic. They calculate the standard error of the regression slope coefficient of a R&D intensity time series to capture technological instability[9]. Thus, we regress the R&D intensity on a time variable and compute the standard error of the regression slope coefficient divided by the mean to measure the irregularity of technological changes (*V9*). A high value indicates that technological shifts occur relatively irregularly.

4.1.10 Concluding Remarks on Measures

One can critically discuss the use of figures such as the number of mergers and acquisitions, depreciation expenses and R&D expenses to calculate objective dynamism measures, because these figures are actively shaped by the firms' managers and are a direct result of their actions. One can argue that because managers only respond to what they perceive, the resulting metrics express only some kind of perceptual measures of industry dynamics. This is clearly not our goal. However, we do not suggest, as does Weick (1979), that an objective environment does not exist and that the environment is only "enacted" through attention and beliefs of managers. We propose that even if a firm's actions may only be the result of its managers' perceptions, it does not imply that those managers are capable of reliably assessing their industry's dynamism. One manager might perceive a single acquisition every two years as a high frequency, another manager in the same industry might assess five acquisitions per year as a medium rate. These perceptual distortions are signifi-

9 We note that an alternative measure is the "technological volatility index" developed by Tosi, Aldag, and Storey (1973b), who use the ratio of R&D plus capital expenditures to total assets. However, their measure nearly represents our magnitude metric and does not seem applicable to capturing the irregularity of shifts in those variables. Dess and Beard (1984) suggest that irregularity of technological change may be reflected by the percentage of scientists and engineers in the total workforce. Since we agree with Sharfman and Dean (1991a) that this percentage may be an indicator of technical complexity rather than of irregularity, we reject that approach.

cantly exacerbated when conducting cross-industry comparisons. It follows that the use of archival data from secondary sources is the most reliable way to measure objective industry dynamics. Although we define nine distinct measures, we base their computation on only four different figures: sales, M&A, depreciation to total assets and R&D intensity. This approach simplifies data collection without reducing model comprehensiveness. *Figure 4* gives an overview on the nine indicators of industry dynamics we use in our study.

Figure 4: Indicators for aspects of industry dynamics

		Attributes of industry dynamics		
		Frequency	**Magnitude**	**Irregularity**
Objects of industry dynamics	**Customer preferences**	Slope reversals of sales time series (**V1**)	Max. percentage deviation of real values from log-sales regression **(V2)**	Standard error of log-sales regression slope coefficient divided by mean (**V3**)
	Competitive situation	Annual M&A quantity weighted for total number of competitors (**V4**)	Average M&A volume (**V5**)	Standard error of M&A quantity regression slope coefficient divided by mean (**V6**)
	Technology	Annual percentage of depreciation to total assets (**V7**)	Average R&D intensity (**V8**)	Standard error of R&D intensity regression slope coefficient divided by mean (**V9**)

4.2 Data

Since the measurement of industry dynamics requires the assessment of changes within an industry over time, we must define the time span to be observed. Hence, we chose the five-year interval between 2002 and 2006, a length of time that is typical for this particular kind of study (Castrogiovanni (2002)). We did so because we wanted to observe a "normal" interval, that was more or less recent but free from major global shocks that would distort our results. By using 2002 as the starting year, we exclude the heaviest downturns caused by the dotcom crash and the terrorist attacks in 2001. Using 2006 as the end point excludes the effects of the subprime mortgage crisis that began in 2007.

The unit of analysis for our study is the industry, which we define by the four-digit Standard Industrial Classification (SIC) codes. The SIC system has been widely used in strategic management research and is supposed to provide the most consistent basis for assessing attributes of task environments (e.g., Dess and Beard (1984); Keats and Hitt (1988); Doty et al. (2006)). It was indicated that the SIC system is an adequate organizational species classification system to the extent that it has high homogeneity within classes but shows heterogeneity across classes (Rasheed and Prescott (1992)). Most importantly for researchers, there is very good database access to the required data for measurement calculations based on SIC codes, which facilitates larger sample size and in turn is the basis for better generalizability of results. Moreover, the SIC system is also consistent with the definition of an industry as the group of firms producing products that are close substitutes for each other (Starbuck (1976); Porter (1980)). This makes SIC codes best suited for our purposes, since our measures are all based on the collective actions of organizations. These significant advantages are opposed by three limitations: (1) The codes are sometimes defined too broadly or too narrowly (Boyd, Dess, and Rasheed (1993)); (2) The allocation of diversified firms to a single four-digit SIC code based on their dominant line of business may be a source of measurement error (Dess and Beard (1984)); (3) The SIC system has not been updated for more than a decade, because it was replaced by the North American Industry Classification System (NAICS) in 1997. An alternative international and up-to-date classification scheme is the International Standard Industrial Classification (ISIC) provided by the United Nations Organization. Unfortunately, so far this system has failed to gain much recognition in management research. This lack of recognition might be caused by the low support of company databases. However, despite the trade-off between the advantages and disadvantages of the SIC system, we propose that the advantages outweigh the disadvantages. We obtain a diverse random sample of 82 different four-digit SIC codes. We exclude financial services, wholesale trade, and retail trade, because these industries do not allow a meaningful interpretation of our technology-related measures.

We obtain our data from the Thomson One Banker database, which includes secondary firm data of 55,000 public companies in over 70 countries and over 621,000 M&A transactions globally. We collect firm sales (*V1, V2, V3*), depreciation expenses to total assets *(V7)*, and R&D intensities (*V8, V9*) of firms with a primary SIC code in the relevant industry. *Appendix B* reports the number of firms for each SIC code that provided the data to calculate these measures. We define the total number of competitors (*V4*) within a SIC code as the quantity of firms listed in the database that reported sales in the corresponding SIC code. To calculate these measurements we use only data of firms with a complete time series from 2002 to 2006 for the respective variable. To compute our M&A-based measures (*V4, V5, V6*), we included all deals completed between 2002 and 2006. We assign a deal to a specific SIC code based on the target company's SIC code, regardless of whether the acquirer is also listed within that code. In *Appendix C* we present the scores for the nine variables for each of the 82 SIC codes, the mean values and the standard deviations. For better comparison across industries, we normalized each score to a minimum value of zero and a maximum value of one.

We note that on the one hand, we can calculate measures on the SIC level, and on the other hand, we can compute them for each firm and aggregate the results to obtain an industry score. For instance, consider the example of an industry composed of only two firms and the calculation of our irregularity metric of customer preferences (*V3*). The first firm has a five-year sales time series of 90/80/240/300/80 and the second firm of 10/120/60/100/420. Both firms (and thus the whole industry) are characterized by a highly irregular development with a high standard error of the regression slope coefficient. However, if we were to first aggregate firm sales to get overall industry sales and then calculate our measure, the result would be just the opposite. Since the sum of both firms' sales creates a perfectly linear industry sales time series of 100/200/300/400/500, the resulting standard error of the regression would be zero. That result would completely distort the relevant information, namely, that demand within that industry is constantly shifting and lacks any pattern. Instead, it would rather be an indicator of the overall economic situation, which is not the focal point here. Consequently, we stick with the former approach and compute the industry scores by averaging the results obtained for each firm weighted for firm size.

This weighted-average approach has also been used by other researchers (e.g., Tosi, Aldag, and Storey (1973b); Snyder and Glueck (1982); Sutcliffe (1994)). However, this approach is not meaningful for all of our metrics. It does not make sense to gather our M&A-based measures on the firm level, since a firm can be an acquisition target only once in its life. Therefore, the interpretation of individual acquisition statistics would be difficult and only acquirer-oriented. Hence, we use cumulated annual deal statistics at the SIC level.

5 Results

To test for the independence of the nine aspects of industry dynamics, we conduct a principal components factor analysis with varimax rotation, a method also applied by Dess and Beard (1984) and Wholey and Brittain (1989). The results of our factor analysis, which we present in *Table 1*, confirm that the nine aspects of industry dynamics each load heavily on a separate factor, which corroborates their independence and the formative character of the construct of industry dynamics[10]. The encircled part in the upper left corner of *Table 1* replicates the results of Wholey and Brittain (1989), who analyze the change patterns of 44 industries' sales data in the late 1970s and demonstrate the independence of the three customer-related aspects of industry dynamics. Although these three aspects are only a fraction of our study, we see the replication of their results as an important step, because substantiating the results of past empirical studies across dissimilar samples and settings helps to introduce greater levels of precision in administrative science (Rasheed and Prescott (1992)).

10 We note that the *Kaiser criterion* (eigenvalues must reach a value of one) should not be regarded as a valid criterion for deciding on the appropriate number of factors in the subsequent factor analyses. In a nine-variable case such as ours, the only possibility to obtain a nine-factor solution with eigenvalues of at least one is when each factor accounts for a proportion of exactly one ninth of the total variance. Equal distribution of variance is not a necessary condition for formative indicators.

Table 1: Results of principal component factor analysis of aspects of industry dynamics

	Factor Loadings								
Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
V1	**.979**	–.011	–.047	.054	.022	.022	–.187	–.016	.017
V2	–.012	**.985**	.105	–.042	–.085	–.059	.065	–.023	.029
V3	–.048	.109	**.972**	–.083	–.109	–.010	.089	.103	.053
V4	.053	–.043	–.081	**.981**	.078	–.126	.060	–.020	.026
V5	.024	–.096	–.120	.086	**.947**	.028	–.057	–.029	.260
V6	.022	–.060	–.010	–.128	.024	**.977**	–.087	–.116	–.063
V7	–.202	.071	.093	.065	–.053	–.093	**.955**	–.051	.120
V8	–.015	–.023	.099	–.019	–.027	–.113	–.047	**.984**	–.065
V9	.018	.034	.058	.027	.257	–.069	.124	–.072	**.950**
Eigenvalue	1.794	1.663	1.010	1.086	.500	.732	.346	1.253	.615
Variance accounted for	19.933	18.482	11.227	12.069	5.555	8.130	3.848	13.918	6.838

Uncorrelatedness is not required for formative constructs, but because formative models are based on multiple regression, multicollinearity among indicators is a serious problem. This problem arises because excessive collinearity would make it impossible to assess the distinct influence of the separate aspects on the construct of industry dynamics (Diamantopoulos and Winklhofer (2001)). To check for collinearity, we first compute the inter-item correlation matrix and look for very high correlations. *Table 2* shows that from the total 36 correlation coefficients only six are significant and resemble only small to medium-level correlations. However, inter-item correlations can only display pairwise linear dependencies. To identify collinearity among more than two variables, the variance inflation factor (VIF) is the correct statistic to use, since it declares how much of an indicator's variance is explained by sets of other indicators. Usually, collinearity is assumed for variables with a VIF exceeding ten (Hair et al. (2010)). *Table 2* shows that the maximum VIF is 1.581, so multicollinearity is obviously not a problem.

Table 2: Inter-item correlations and VIF of aspects of industry dynamics

	V1	V2	V3	V4	V5	V6	V7	V8	V9	VIF
V1	1									1.217
V2	–.044	1								1.124
V3	–.119	.228*	1							1.253
V4	.098	–.087	–.171	1						1.182
V5	.072	–.188	–.233*	.174	1					1.580
V6	.055	–.119	–.043	–.246*	.039	1				1.220
V7	–.378**	.156	.196	.111	–.091	–.195	1			1.426
V8	–.032	–.029	.194	–.038	–.084	–.214	–.082	1		1.164
V9	.015	.057	.084	.083	.476**	–.129	.235*	–.134	1	1.581

* Correlation is significant at the .05 level (2-tailed); ** Correlation is significant at the .01 level (2-tailed).

Belsley (1991) criticizes the VIF method for not revealing information on the number of dependencies and on the variables involved. Moreover, the decision for a specific threshold (e.g., ten) is arbitrary. To overcome these shortcomings in collinearity diagnostic, Belsley develops a method based on condition indexes and variance decomposition. Condition indexes are derived from the eigenvalues in a multiple regression model and measure the tightness of dependence of one variable on the others. *Table 3* again confirms that collinearity is not a problem, because no condition index approaches the critical value of 30 and none is associated with high variance proportions of more than one variable. We conclude that industry dynamics is a multidimensional construct that comprises nine distinct formative aspects.

Table 3: Condition indexes and variance proportions of aspects of industry dynamics

Dimension	Eigenvalue	Condition index	Variance proportions									
			(Constant)	V1	V2	V3	V4	V5	V6	V7	V8	V9
1	6.007	1.000	.00	.00	.01	.01	.01	.01	.01	.00	.01	.01
2	1.007	2.442	.00	.00	.04	.21	.01	.09	.00	.00	.05	.08
3	.780	2.774	.00	.01	.01	.13	.00	.00	.15	.00	.01	.25
4	.626	3.098	.00	.00	.02	.06	.04	.00	.27	.00	.29	.01
5	.522	3.393	.00	.00	.37	.16	.04	.04	.08	.01	.14	.01
6	.359	4.090	.00	.00	.34	.16	.25	.03	.01	.03	.22	.02
7	.264	4.767	.00	.35	.01	.14	.00	.02	.08	.18	.06	.01
8	.240	5.005	.00	.13	.09	.14	.02	.65	.01	.00	.03	.43
9	.159	6.142	.02	.11	.08	.00	.60	.08	.26	.24	.08	.16
10	.035	13.066	.98	.40	.04	.00	.03	.07	.15	.54	.12	.03

6 Discussion

What remains to be discussed are aspects of construct validity. Therefore, it is very important to be aware of the construct's formative character. When Dess and Beard (1984) demanded that their array of indicators all be a reflection of industry dynamics, they followed the paradigm introduced by Churchill (1979) and searched for highly correlated variables that loaded on a single factor and rejected those variables that did not correlate with the remaining. This method is in sharp contrast to our formative measurement model, where inter-item correlation is not a prerequisite and even negatively related variables can serve as meaningful indicators of a construct. Hence, the misuse of reliability and internal consistency analysis for formative constructs could lead to excluding valid indicators, and thus effecting a significant change in the construct's essential nature (Williams, Vandenberg, and Edwards (2009); Podsakoff, Shen, and Podsakoff (2006); Jarvis, MacKenzie, and Podsakoff (2003); Diamantopoulos and Winklhofer (2001); Edwards and Bagozzi (2000)). Because of these differences, traditional approaches for validity assessment as proposed by Venkatraman and Grant (1986) are not applicable to formative constructs. Therefore, Diamantopoulos and Winklhofer (2001) suggest an alternative procedure to assess the validity of formative constructs which consists of (1) exhaustive content and indicator specification, (2) indicator collinearity diagnostic, (3) external (predictive) validity assessment.

First, since a formative construct is caused by its indicators and not vice versa, one should devote highest efforts to construct definition to ensure not to omit relevant aspects of the underlying construct. We develop our construct definition from an extensive review of literature on industry dynamics; hence, content validity should be beyond question. Second, as we noted earlier, collinearity is a serious problem for formative measurement models, since such models are based on multiple regressions. But the collinearity diagnostic we apply ensures that indicator collinearity is not a problem for our model. And third, because there is no need for items to correlate, formative models are statistically underidentified and internal consistency cannot be assessed. Hence, the only meaningful way to assess the validity of formative constructs is to focus on predictive validity. Therefore, the model must be placed within a larger framework that incorporates dependent variables. Nonetheless, due to Rossiter (2002) even the assessment of predictive validity is inappropriate. This is because in its usual sense, high predictive validity is reached when the correlation between the construct and a certain outcome construct is maximized. The problem associated with this is that the true construct-to-construct population correlation is almost never known and could be either low or high in reality. If predictive validity is desired in addition to content validity, it should be an option only if the true construct-to-construct population correlation is known. We agree with Rossiter (2002) and do not assess predictive validity, since the development of the necessary framework would go beyond the scope of this paper.

Rossiter (2002) also discards the assessment of convergent validity (i.e., proving high correlation with other concepts to measure the same construct), because a weak correlation coefficient would not show which of the two measures is valid; it could be either the old or the new one. For the same reason, discriminant validity (i.e., estimating to what extent a measurement concept differs from other concepts) would not be conclusive. However, for specific aspects of industry dynamics we partly adopt existing measures developed by other scholars. Hence, they are convergent within their specific domain by definition. Moreover, we are able to replicate the results of Wholey and Brittain (1989), which further substantiates the validity of our construct specification.

7 Conclusion and Implications

The impact of industry dynamics on organizations is a major concern in almost any field of organization theory and strategic management. However, serious deficiencies are evident in the conceptualizations of this environmental construct, which stands in sharp contrast to its high relevance. Our answer to the inadequacy of this situation is a detailed debate on a more comprehensive composition of the construct of industry dynamics, one that can reach an utmost degree of content validity.

Using factor analysis on a sample of 82 different industries we demonstrate that industry dynamics has a multidimensional character and that it is composed of changes in customer preferences, the competitive situation, and technologies. In addition, these changes are independent in their frequency, their magnitude, and their irregularity.

An additional contribution of our study is the presentation of a simple but comprehensive measurement concept based on archival data. This concept facilitates both large sample sizes and high objectivity. However, it goes without saying that the validity of our results can be substantiated if they are cross-validated on a new set of data. No matter whether formative or reflective construct specification is applied, the importance of replicating results on different samples is still apparent (Diamantopoulos and Winklhofer (2001)). Furthermore, even though Rossiter (2002) recommends developing exactly one good item for each first-order construct, the development of additional measures with a high level of internal consistency on the underlying aspects of industry dynamics might be useful to enhance model quality.

We have also not addressed the possible linkages among the different aspects of industry dynamics over time. Even though our results indicate that dynamism aspects are independent from one another, there might be time-delayed cause-and-effect relations. For example, Garg, Walters, and Priem (2003) assume that through technological changes, new products emerge, which in turn might change customer preferences, and provoke reactions from competitors. Investigating such possible linkages between the multiple facets of industry dynamics is an interesting topic for future research, which requires longitudinal comparisons across different time intervals. Also interesting in this context is whether the dynamics itself changes significantly over the life-cycle of an industry. A possible proposition on the "dynamics of the dynamics" might be that young industries are characterized by a high level of dynamism, which slows down as an industry matures (Castrogiovanni (2002)). Additionally, the construct of industry dynamics should be embedded into larger models that include specific "effects" to dismantle the relative importance of the particular aspects of industry dynamics in explaining different dependent variables. This would also help to assess predictive validity of our dynamism construct. As indicated in the introduction, the number of possible research fields is immense. And finally, researchers should observe the congruence between the certain objectively measured aspects of industry dynamics and its relative perception by managers. Examining which of the different dynamism aspects entail the heaviest perceptual distortions and thus require a more intensive monitoring effort to not miss out on imperative opportunities or threats and endanger a timely organizational response, might be an interesting future research topic as well as an important managerial application area of our measurement concept.

When applying our measurement concept, we strongly discourage researchers from constructing an index by aggregating across dimensions to obtain an overall dynamism score. We do so because averaging the independent aspects would mask crucial information on the relative importance of each of the different dynamism aspects (McCarthy et al. (2010)). We suggest that if researchers include industry dynamics into their frameworks, then they should check for the separate contributions of each dimension on various outcome variables and thus refine their hypothesized relations. The specific and distinct importance of each of the different dynamism aspects in explaining dependent variables can, for instance, be dismantled by applying structural equation models. In such models, the particular effects that certain aspects have on a dependent variable are expressed through separate path coefficients and significance levels. On the other hand, if the researcher needs reduced model complexity, then frameworks can be kept simple by not including the whole dynamism construct. Instead, the researcher might consider ex ante what dynamism dimensions might probably be relevant within the particular investigation context. The clear differentiation of nine distinct dimensions provided in this paper can be used as an agenda.

The call for a differentiated conceptualization and an applicable model to measure the construct of industry dynamics is apparent from the work of several researchers. For example, Nadkarni and Narayanan (2007b) argue that conflicting results between the managerial cognition view and the industry velocity literature are due to incompatible conceptualizations of industry change. The former only captures the frequency of change, the latter both frequency and irregularity. Our measurement concept might achieve clarification by testing the joint and separate effects of frequency and irregularity of change. Davis, Eisenhardt, and Bingham (2009) give another example. They did a computer simulation to discover how different dimensions of industry dynamism affect the optimal degree of organizational structure. Verification of their results on a large sample of real organizations would benefit from the application of our dynamism measures. Yin and Shanley (2008) propose that the dynamic-contingent merger-versus-alliance decisions depend especially on the underlying irregularity of technological change. They argue that obtaining new technologies under high technological irregularity requires alliances instead of acquisitions in order to reduce misinvestment risk, since alliances are easier to arrange and reverse. These examples make it clear that providing a comprehensive conceptualization and measurement model of the industry dynamics construct provides an important contribution to theory building as well as theory testing.

Appendix A: Research on Impact of Industry Dynamics[11]

Author(s)	Topic	Method	Key findings related to industry dynamics
Andersen (2004)	Strategies and strategic planning	Survey of 185 executives from North American manufacturing business entities (Single business (SB) firms and business units (BUs))	Both a decentralized decision structure and the appliance of strategic planning activities are associated with higher performance in dynamic environments.
Bergh and Lawless (1998)	Portfolio restructuring	164 Fortune 500 firms, secondary data	The relation between diversification strategy and portfolio restructuring depends on environmental instability. In addition, limits in the hierarchy's governance efficiency in relation to market modes are affected by environmental instability.
Bourgeois and Eisenhardt (1988)	Strategic decision making processes	Interviews of every top management executive from 4 U.S. microcomputer firms	Fast, but highly analytic and comprehensive strategic decision-making processes are successful in high velocity environments.
Boyd and Fulk (1996)	Environmental scanning	Survey of 72 executives from 23 U.S. SB firms	Strategic variability (i.e., sector variability multiplied by sector importance) is positively related to levels of environmental scanning by executives.
Boyd (1995)	CEO duality	192 U.S. firms (excl. heavily diversified); secondary data	Hypothesizes that CEO duality (i.e., a CEO also serves as chairman of the board) is positively related to firm performance in high dynamic environments. Correlations are in the expected directions, but not significant.
Boyne and Meier (2009)	Organizational change	Secondary data on public organizations	Environmental turbulence has a negative performance effect and is compounded by internal organizational change. The harmful effects of environmental turbulence can be mitigated by maintaining structural stability.
Brews and Purohit (2007)	Strategies and strategic planning	Survey of executives from 886 firms worldwide	As environmental instability increases, the appliance of strategic planning activities increases, too. Generative planning and transactive planning are strongest associated with increasing instability.

11 To obtain a representative list of articles investigating the impact of industry dynamics on organizations, we conducted a literature search using the databases "Web of Science" and "EBSCO Business Source Premier". We applied a three-staged search routine: First, we made a keyword search for articles with the expressions of "industry dynamics", "environmental dynamics" and relevant synonyms in the abstract or title. Second, we complemented the result list by those articles that cited the three major articles providing a dynamics measurement concept – Tosi, Aldag, and Storey (1973b); Dess and Beard (1984); and Wholey and Brittain (1989). Third, we read the abstracts of all the identified articles and decided about the inclusion into our example table. The aim of that table is to give an impression on the breadth of the research fields covered and not to provide an exhaustive list of every piece of work concerned with the construct of industry dynamics.

Cannella, Park, and Lee (2008)	TMT characteristics	207 U.S. firms; secondary data	Environmental instability moderates the performance effects of (1) TMT intrapersonal functional diversity, (2) of TMT dominant functional diversity, and (3) TMT member collocation. The three effects become more positive as environmental instability increases.
Carpenter and Fredrickson (2001)	TMT characteristics	207 U.S. firms; secondary data	A top team's characteristics are related to the degree to which its firm internationalizes. Such relations are contingent upon the level of environmental instability confronting the top management team. Yet, the direction of the moderated relationships varies considerably.
Castrogiovanni (2002)	Industry evolution	98 manufacturing industries; secondary data; longitudinal study	Dynamism of industries decreases over the course of time. But on average, dynamism is greater in new industries than in established industries.
Daft, Sormunen, and Parks (1988)	Environmental scanning	Survey of CEOs from 50 small to medium Texas manufacturing SB firms	Customer, economic, and competitor sectors generate greater strategic uncertainty (i.e., sector uncertainty multiplied by sector importance) than do the technological, regulatory, and sociocultural sectors. When sector uncertainty is high, executives report greater frequency of scanning and greater use of personal information sources. Chief executives in high-performing companies scan more frequently and more broadly in response to strategic uncertainty than their counterparts in low-performing companies.
Ebrahimi (2000)	Environmental scanning	Survey of 55 top to medium level executives from Hong Kong firms (mainly service sector)	Hong Kong Chinese executives perceive a higher degree of uncertainty in the competitive, customer, and economic sectors than in the political sector. There is a positive relation between the degree of perceived strategic uncertainty and scanning behavior as measured by frequency and interest.
Eisenhardt and Martin (2000)	Organizational capabilities	Conceptual article	Dynamic markets require other dynamic capabilities (i.e., capabilities that facilitate adoption to environmental changes) to be successful than do stable markets.
Eisenhardt (1989)	Strategic decision making processes	Interviews with every top management executive from 8 U.S. microcomputer firms	To be successful in high velocity environments, managers who make fast decisions have to use more, not less, information; develop more, not fewer, alternatives; and use a two-tiered advice process. They must also engage in conflict resolution and integration among strategic decisions and tactical plans.

Elenkov (1997)	Environ-mental scanning	Survey of ex-ecutives from 141 medium Bulgarian manufacturing and sales SB firms	There are systematic differences between strategic uncertainty perception and environmental scanning behavior of policy-makers in Bulgarian companies on the one hand, and strategic uncertainty perception and environmental scanning activities of U.S. managers on the other.
Ensley, Pearce, and Hmieleski (2006)	Entre-preneur leadership behavior	Survey of 168 managers from 66 new U.S. ventures and secondary performance and dynamism data	Environmental dynamism has a significant positive moderating effect on the relation between transformational leadership and new venture performance, and a significant negative moderating effect on the relation between transactional leadership and new venture performance.
Fredrick-son and Iaquinto (1989)	Strategic decision making processes	Interviews of 56 executives from 17 U.S. firms within one unstable industry and 103 executives from 28 U.S. firms within one stable industry	The differences in the relations between comprehensiveness in strategic decision making and organization performance for stable and unstable environments holds over the course of time.
Fredrickson and Mitchell (1984)	Strategic decision making processes	Interviews of 123 executives from 27 U.S. firms within one unstable in-dustry	There is a negative relation between comprehensiveness (i.e., rationality) in strategic decision making and organization performance in an unstable environment.
Fredrickson (1984)	Strategic decision making processes	Interviews of 164 executives from 38 U.S. firms within one stable industry	There is a positive relation between comprehensiveness (i.e., rationality) in strategic decision making and organization performance in a stable environment.
Garg, Walters, and Priem (2003)	Environ-mental scanning	Survey of CEOs from 116 small U.S. SB firms	CEO attention to the task environment and to innovation-related internal functions is associated with high performance in dynamic environments. In stable environments, higher performance results from increased scanning of the general environment and of efficiency-related internal functions.
Henderson, Miller, and Hambrick (2006)	CEO tenure	98 CEOs in one stable industry and 228 CEOs in one unstable industry; secondary data	In stable industries, firm-level performance improves steadily with CEO tenure, with downturns occurring only among the few CEOs who serve more than 10-15 years. In dynamic industries, CEOs are at their best when they start their jobs, and firm performance declines steadily across their tenures.
Homburg, Krohmer, and Work-man (1999)	TMT con-sensus	Survey of each two top managers from 101 BUs within 3 industries in Ger-many and the U.S.	The positive relation between consensus among senior managers on a differentiation strategy and performance is negatively influenced by increased dynamism of the market.

Hough and White (2003)	Strategic decision making processes	Experiment with executives from one U.S. firm with 3 BUs in different dynamic markets; simulation of 400 decisions	Environmental dynamism moderates the relation between rational-comprehensive decision-making and decision quality. Controlling for the amount of unique knowledge held by decision-makers in stable environments, higher-quality decisions result from ensuring that all decision-makers are well informed. In moderate and dynamic environments, when controlling for availability, pervasiveness is not related to decision quality.
Jansen, Van Den Bosch, and Volberda (2006)	Innovation management and organizational learning	Survey of 283 executives from 115 branches of one European financial service firm	There is a positive relation between exploratory innovation and financial performance when environmental dynamism is high. Organizational units that pursue exploratory innovation in stable environments decrease their financial performance. There is a negative relation between exploitative innovation and financial performance when environmental dynamism is high. The more that organizational units pursue exploitative innovation in stable environments, the more they increase their financial performance.
Jansen, Vera, and Crossan (2009)	Innovation management and organizational learning	Survey of 89 executive directors and 305 senior executives from 89 branches of one European financial service firm	Environmental dynamism moderates the relation between leadership style and organizational innovation. When environmental dynamism increases, there emerges a negative effect of transformational leadership on pursuing exploitative innovation and a more negative relation between transactional leadership and exploratory innovation.
Jaworski and Kohli (1993)	Marketing strategies	Survey of one marketing and one non-marketing executive from 222 BUs	The link between market orientation and performance appears to be robust across contexts characterized by varying levels of market turbulence, competitive intensity, and technological turbulence.
Keats and Hitt (1988)	Diversification strategies	110 Fortune 500 firms; secondary data	Higher levels of environmental instability are associated with lower levels of divisionalization and diversification. Environmental instability is positively related to market determined performance, and negatively related to operating performance.
Kim and Rhee (2009)	Knowledge management and organizational learning	Computer simulation	Vertical socialization, horizontal socialization and turnover do not produce the internal variety required for successful adaptations in highly turbulent environments.

Li and Simerly (1998)	Agency-theoretic incentive systems	39 U.S. firms within one stable industry and 51 U.S. firms within one unstable industry; secondary data	The degree of environmental dynamism moderate´s the positive impact of CEO-stock-ownership on performance. Increased insider ownership leads to better returns under conditions of greater environmental dynamism.
Lichtenthaler (2009)	Absorptive capacity and organizational learning	Survey of two executives each in 175 German manufacturing firms	Although the influence of the learning processes and overall absorptive capacity is positive in all environments, this influence becomes stronger in highly turbulent settings. Absorptive capacity has a strong effect on performance in highly turbulent markets, but the strength of this positive effect is reduced in relatively stable environments.
Mamede (2009)	Labor mobility	Conceptual article	There are both, a direct and an indirect impact of industry dynamics on labor mobility. Moreover, the inverse direction of causality also holds (i.e., the influence of worker turnover on the evolution of firms and industries).
McArthur and Nystrom (1991)	Strategies and strategic planning	109 large manufacturing firms; secondary data	Increased inventory turnover yields a significantly higher return on investment to those companies that operate in more dynamic environments compared with those companies that operate in more stable environments.
McNamara, Haleblian, and Dykes (2008)	Acquisition returns	3,194 completed majority acquisitions; secondary data	The degree of market dynamism moderates the negative trend in returns over the course of a merger wave. The negative relation between acquisition order within a wave and acquirer shareholder returns is stronger when industries are highly stable.
Nadkarni and Barr (2008)	Strategic schemata and managerial cognition	24 SB firms; secondary data; longitudinal study	There is a relation between industry velocity, the structure of top management's cognitive representation of the environment, and the speed of response to environmental events. Industry velocity influences the structure of cognitive representations, which in turn influence the speed of response to environmental events.
Nadkarni and Narayanan (2007a)	Strategic schemata and managerial cognition	225 SB firms; secondary data	Complexity of strategic schemas promotes strategic flexibility and organization success in fast clockspeed industries, but the focus of strategic schemas fosters strategic persistence, which is effective in slow-clockspeed industries.
Nadkarni and Narayanan (2007b)	Strategic schemata and managerial cognition	3 firms from one stable industry and 3 firms from one unstable industry; secondary data; longitudinal study	Industry velocity may not necessarily represent an external contingency to which incumbent firms react. Rather, incumbent firms collectively construct industry velocity by developing social networks, collective assumptions, and feedback mechanisms.

Priem, Rasheed, and Kotulic (1995)	Strategic decision making processes	Survey of CEOs from 101 U.S. manufacturing SB firms	Rationality in strategic decision processes is associated with high firm performance in dynamic environments. There is no relation between rationality and performance for firms facing stable environments.
Simerly and Li (2000)	Capital structure of firms	700 large U.S. firms; secondary data	For firms in a stable environment, greater leverage (i.e., greater debt financing) is related to better firm economic performance. For firms in a dynamic environment, lower leverage (i.e., lower debt financing) is related to better firm economic performance.
Suarez and Oliva (2005)	Organizational change	Interviews of top executives of 11 firms in Latin America	There is a relation between environmental and organizational change in the form that extreme environmental change is associated with similarly extreme forms of organizational change.
Wang and Li (2008)	Knowledge management and organizational learning	570 U.S. manufacturing firms; secondary data	The negative effect of deviation from the optimal knowledge search behavior on organizational performance varies with environmental dynamism. Overexploitation becomes more harmful with an increase in environmental dynamism, and overexploration becomes less so.
Wirtz, Mathieu, and Schilke (2007)	Strategies and strategic planning	Survey of 210 executives from German firms within one dynamics industry	In high-velocity environments, the seven strategy dimensions of product differentiation, image differentiation, focus, proactiveness, replication, reconfiguration and co-operation are applied by firms. Proactiveness, product differentiation and reconfiguration have the highest performance impact.
Wu, Levitas, and Priem (2005)	CEO tenure	84 U.S. biopharmaceutical firms; secondary data	Technological dynamism moderates the relation between a CEO's time in office and company invention activities. Shorter-tenured CEOs engender more invention under highly dynamic technological environments, but longer-tenured CEOs spur greater invention under more stable technologies.
Yin and Shanley (2008)	Merger-versus-alliance decisions	Conceptual article	Alliances are more likely than M&As in industries in which technological uncertainty is high.

Appendix B: Number of Firms for Measure Calculation

SIC code	V1, V2, V3	V4	V7	V8, V9	SIC code	V1, V2, V3	V4	V7	V8, V9
1311	204	1157	227	12	3534	13	44	8	7
1629	75	529	70	22	3537	25	195	24	14
2011	16	145	16	8	3541	38	325	38	25
2033	25	244	23	4	3542	20	202	18	4
2037	13	132	11	1	3545	25	285	24	10
2052	11	123	11	3	3562	17	244	17	10
2063	9	43	7	5	3571	94	910	93	46
2082	56	397	50	6	3612	28	247	27	12
2086	55	470	54	6	3631	11	88	8	5
2111	22	62	21	12	3641	13	76	13	6
2297	9	65	6	2	3672	88	501	87	32
2515	10	50	10	5	3674	327	2033	314	258
2621	63	420	62	17	3679	392	2424	378	246
2761	8	219	8	2	3691	36	185	36	18
2812	19	98	16	3	3711	100	323	95	53
2813	17	101	17	9	3713	16	96	14	9
2819	103	934	96	46	3714	234	995	223	119
2821	106	686	100	45	3721	15	76	16	7
2833	35	466	35	18	3731	32	181	29	6
2834	500	2045	526	294	3732	8	73	7	4
2841	21	163	18	10	3751	37	160	37	9
2844	65	761	61	35	3822	6	209	7	5
2851	59	299	55	28	3823	56	925	56	42
2869	72	912	69	22	3841	120	1918	117	109
2879	46	276	43	19	3842	57	566	57	40
2891	26	284	25	11	3845	75	748	79	68
2893	15	76	15	10	3861	27	223	26	20
2899	99	880	96	42	3873	13	96	12	3
2911	72	296	68	22	3942	6	131	6	3
3011	43	114	40	21	3944	36	250	32	19
3021	15	65	12	6	4512	64	412	61	1
3149	15	85	14	5	4812	82	1407	80	20
3231	11	105	11	7	4813	163	1415	155	28
3312	142	513	131	35	4911	329	1743	298	24
3317	41	249	39	10	5051	36	403	34	2
3325	21	121	20	8	5812	190	1126	174	12
3357	82	531	75	30	7372	449	10327	408	291
3442	16	116	15	9	7373	301	2909	271	148
3497	5	47	5	2	7812	47	300	48	2
3511	17	205	13	8	8711	173	2631	160	27
3519	26	96	26	9	8741	39	891	37	3

Appendix C: Scores of Aspects of Industry Dynamics

SIC code	V1	V2	V3	V4	V5	V6	V7	V8	V9
1311	.476	.164	.040	1.000	.244	.018	.616	.030	.088
1629	.597	.233	.043	.087	.069	.100	.470	.040	.095
2011	.464	.027	.009	.401	.069	.126	.561	.015	.012
2033	.930	.138	.036	.197	.051	.090	.525	.058	.055
2037	.190	.257	.474	.225	.043	.096	.717	.001	.254
2052	.330	.088	.069	.212	.137	.083	.139	.050	.009
2063	.454	.046	.016	.057	.297	.196	.264	.077	.056
2082	.585	.100	.020	.064	.251	1.000	.452	.051	.087
2086	.067	.000	.009	.235	.154	.005	.595	.021	.081
2111	.634	.084	.007	.265	1.000	.047	.379	.047	1.000
2297	.310	.324	.289	.063	.110	.220	.300	.275	.011
2515	.086	.042	.021	.249	.203	.246	.514	.034	.027
2621	.909	.417	.014	.245	.130	.135	.291	.078	.156
2761	.728	.056	.043	.000	.604	.399	.157	.076	.025
2812	.332	.166	.078	.082	.047	.125	.430	.244	.088
2813	.531	.072	.006	.267	.562	.099	.318	.086	.019
2819	.729	.109	.029	.103	.108	.044	.097	.201	.028
2821	.298	.115	.027	.289	.142	.111	.208	.188	.050
2833	.115	.248	.555	.086	.062	.091	.708	.569	.162
2834	.572	.115	.068	.282	.337	.047	.675	1.000	.043
2841	.703	.050	.009	.251	.175	.346	.115	.173	.014
2844	.347	.022	.016	.142	.222	.061	.557	.161	.011
2851	.458	.037	.030	.265	.051	.135	.177	.269	.005
2869	.351	.251	.090	.083	.147	.049	.434	.190	.062
2879	.889	.059	.033	.139	.239	.078	.248	.371	.000
2891	.437	.077	.042	.184	.056	.147	.337	.142	.112
2893	.499	.064	.029	.173	.050	.199	.252	.127	.023
2899	.520	.198	.093	.192	.120	.018	.216	.206	.048
2911	.065	.048	.000	.227	.396	.155	.531	.015	.099
3011	.756	.241	.017	.297	.131	.182	.161	.205	.012
3021	.000	.458	.236	.225	.256	.302	.454	.092	.045
3149	.294	.141	.014	.118	.048	.180	.577	.099	.041
3231	1.000	.211	.023	.192	.340	.160	.178	.131	.005
3312	.085	.210	.028	.286	.329	.075	.572	.053	.083
3317	.152	.120	.058	.104	.123	.153	.622	.054	.068
3325	.596	.217	.046	.502	.183	.111	.251	.035	.075
3357	.250	.135	.069	.095	.082	.115	.349	.216	.054
3442	.631	.094	.021	.364	.036	.056	.425	.083	.021
3497	.478	.194	.020	.060	.048	.263	.624	.026	.021
3511	.469	.983	.030	.209	.135	.110	.182	.110	.043
3519	.545	.426	.137	.247	.026	.152	.482	.126	.116
3534	.969	.095	.020	.679	.133	.156	.119	.093	.041

SIC code	V1	V2	V3	V4	V5	V6	V7	V8	V9
3537	.446	.085	.052	.176	.168	.180	.391	.126	.049
3541	.433	.142	.089	.170	.064	.046	.299	.200	.067
3542	.757	.201	.223	.067	.042	.099	.282	.194	.044
3545	.182	.137	.172	.146	.086	.113	.323	.106	.066
3562	.589	.083	.019	.043	.074	.535	.079	.135	.025
3571	.085	.089	.024	.098	.218	.065	.680	.251	.037
3612	.467	.100	.063	.098	.031	.162	.149	.173	.035
3631	.403	.175	.079	.147	.034	.233	.452	.115	.097
3641	.207	.088	.061	.262	.023	.153	.352	.145	.050
3672	.042	1.000	.040	.102	.011	.053	.692	.050	.052
3674	.614	.229	.094	.186	.120	.019	.328	.887	.057
3679	.459	.228	.119	.059	.037	.039	.537	.250	.077
3691	.228	.271	.160	.104	.057	.120	.492	.212	.053
3711	.676	.028	.002	.441	.210	.054	.446	.233	.020
3713	.740	.094	.007	.207	.019	.123	.512	.191	.056
3714	.633	.071	.019	.283	.091	.029	.221	.290	.026
3721	.630	.025	.003	.373	.316	.170	.346	.293	.018
3731	.230	.154	.031	.326	.069	.177	1.000	.025	.082
3732	.484	.069	.139	.331	.046	.248	.425	.158	.010
3751	.265	.180	.034	.216	.058	.129	.219	.183	.037
3822	.614	.253	1.000	.094	.024	.169	.575	.195	.091
3823	.794	.040	.014	.076	.041	.168	.123	.375	.022
3841	.102	.108	.093	.076	.240	.010	.348	.445	.024
3842	.265	.123	.105	.173	.104	.032	.417	.302	.032
3845	.322	.176	.098	.150	.061	.000	.443	.823	.041
3861	.508	.076	.024	.198	.109	.130	.470	.382	.022
3873	.667	.070	.048	.212	.000	.143	.407	.187	.034
3942	.014	.015	.032	.101	.176	.433	.069	.210	.018
3944	.666	.158	.100	.227	.079	.036	.391	.275	.085
4512	.296	.048	.005	.259	.114	.073	.927	.000	.275
4812	.489	.090	.008	.262	.586	.008	.372	.111	.047
4813	.471	.090	.012	.545	.423	.028	.219	.078	.101
4911	.500	.231	.013	.326	.310	.018	.680	.039	.117
5051	.126	.053	.011	.120	.044	.105	.473	.102	.003
5812	.181	.036	.036	.390	.062	.023	.746	.013	.178
7372	.256	.164	.205	.235	.053	.019	.262	.967	.066
7373	.523	.131	.112	.161	.048	.059	.000	.345	.047
7812	.125	.336	.201	.575	.180	.065	.707	.878	.121
8711	.440	.357	.120	.158	.036	.021	.589	.047	.092
8741	.932	.596	.169	.120	.013	.025	.671	.000	.207
Mean	.448	.167	.082	.216	.152	.132	.407	.196	.072
SD*	.248	.171	.139	.154	.161	.138	.204	.215	.116

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