The role of routines in reducing pervasive uncertainty

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Abstract

Remarkably little advice has been offered in the way of helping management develop appropriate strategies to cope with different forms of uncertainty. In an effort to fill this gap, the present article combines extant research from economics and strategy to identify two broad classes of uncertainty and the generic strategies that are appropriate to handle each class of uncertainty. We point out that organizational routines are ways to reduce pervasive uncertainty in decision making, whereas increasing the available information is appropriate when other, less demanding forms of uncertain situations arise. The argument is supported by empirical tests.

Keywords: Routines; Risk; Uncertainty; Pervasive uncertainty; Decision making

1. Introduction

One of the central problems faced by management today is how to cope with the uncertainties arising from the internationalization of competition, increasing pressures to innovate, new communication technologies, and other sources of turbulence. With a few exceptions (Baumol, 2002), business scholars and economists have offered remarkably little advice in the way of helping management cope with the different forms of uncertainty that arise from alternative sources of turbulence. In an effort to fill this gap, the present article combines extant research from economics and strategy to identify two broad classes of uncertainty and the generic strategies that are appropriate to handle each class of uncertainty. We point out that organizational routines are a way to reduce pervasive uncertainty in decision making, whereas increasing the available information is appropriate when other, less demanding forms of uncertain situations arise.

According to standard approaches in economics, the problem of choice under uncertainty may essentially be remedied by increasing the amount of information available to the decision maker (Luce and Raiffa, 1957). In the organization literature, this idea is mirrored in the understanding that organizations process information to reduce uncertainty and adapt their structures to better cope with uncertain environments (Thompson, 1967; Galbraith, 1973). In the strategy literature, related ideas surface under the terms scanning or information processing (Khandwalla, 1973; Miller, 1987) and in the marketing literature as coordinated decision making under uncertainty among marketing channel members (Achrol and Stern, 1988).

While these streams of literature mention that situations exist in which uncertainty prevails despite organizational adaptation and despite increases in information, the situations where information processing strategies are appropriate are usually not distinguished from the situations where alternative strategies must be used. The present article identifies a criterion that distinguishes such situations of uncertainty where increasing information will help reduce uncertainty from such situations where it will not. We use the term pervasive uncertainty to denote the situations in which uncertainty prevails because it is impossible to associate point probabilities with events. In the organization literature, the term equivocality denotes a similar condition (Weick, 1979; Daft and Lengel, 1986). As reported in the following section, our review of the economics, organization, and strategy literatures makes clear that a distinction between forms of uncertainty promises to clear up contradictory research findings. Milliken (1987, 1990) previously...
made a similar point and provided a useful distinction between three forms of uncertainty. In this article, we add a distinction between forms of uncertainty that is of fundamental importance as a complement to Milliken’s (1987).

In view of the contrasting and unsolved issues that remain in the research literature on uncertainty (McNamara and Bromiley, 1997; Milliken, 1987), the purpose of the present paper is as follows: (1) to clarify the difference among risk, uncertainty, and pervasive uncertainty, (2) and to build on this clarification to formulate and test hypotheses that indicate how decision makers can use routines to successfully cope with pervasive uncertainty.

The present article contributes in a number of ways to the body of knowledge on coping with uncertainty. First, we identify distinct forms of uncertain situations and distinct strategies to cope with each situation. A second advantage of the present analysis is that empirical research can be designed to include treatments that take the distinct differences in uncertain situations into account. A third advantage is that prescriptive studies as well as practitioners can take heed of the argument that distinct classes of uncertain situations require distinct remedies. Whereas organizational routines are a way to reduce pervasive uncertainty, it is appropriate to increase information when other, less demanding forms of uncertain situations arise. Finally, from a theoretical viewpoint, the proposed classification of uncertain situations can be used as a conceptual foundation that cuts across the economics and management literatures. This provides the advantage that a broader literature can be used as a basis for theory development.

2. Conceptualizations of uncertainty

In economics, uncertainty arises when a decision can lead to more than one possible consequence (Radner, 1994). Uncertainty thus frustrates intentional choice. The standard conceptualization of uncertainty is based on Luce and Raiffa’s (1957) tripartite classification, which differentiates the realm of decision making under certainty, risk, and uncertainty. Risk and uncertainty are distinguished by the nature of probabilities assigned to the different possible outcomes. The situation is typically envisioned in terms of a subset of alternatives, a corresponding set of consequences, and an index function, which reflects the decision maker’s utility for the consequence associated with alternative \( X \) when nature is in state \( Y \). The decision-making problem then consists of choosing the subset of alternatives associated with optimal expected utility.

In the realm of certainty, there is no real problem since specific outcomes are secured per definition. In the realm of risk, the probabilities of outcomes are assumed known. The decision maker can therefore proceed by computing the expected utility of the alternatives and choose those with the largest value. In the case of uncertainty, the problem is more challenging, i.e., to deduce the existence of a function whose expected value controls choice, a problem solved by von Neumann and Morgenstern. Given the existence of such a function, the decision maker can generate a subjective probability distribution for outcomes by using statistical information to generate and update an a priori probability distribution (Savage, 1954; Luce and Raiffa, 1957). Thus, objective probabilities are associated with risk, whereas subjective probabilities are associated with uncertainty. In the realm of risk, all the possible consequences and the likelihood (probability) of each consequence are known, while in a situation of uncertainty there is a set of possible specific outcomes, but the likelihood of each outcome is initially unknown (Savage, 1954). The trick then is to use information to deduce a well-behaved index function whose expected values control choice. The general strategy is therefore to increase the amount of information, improving the basis for estimation of subjective probabilities and their accuracy.

As opposed to this conceptualization of uncertainty, some authors argue that also a much stronger, pervasive form of uncertainty must be considered (Knight, 1921; Keynes, 1973; March and Simon, 1958). For those authors, uncertainty corresponds to an absence of measurable probabilistic knowledge. The implications are profound. Situations that are so ill structured that the possible outcomes will remain unknown despite any attempt to remedy the situation (pervasive uncertainty) call for different strategies than situations, which may be remedied by increasing the amount of available information.

In the organization literature, responding to uncertainty has surfaced as a problem of organizational design. The organization literature distinguishes uncertainty from equivocality. Uncertainty is defined as the absence of information (Downey and Slocum, 1975). Equivocality, by contrast, is defined as a condition where the underlying meaning of a signal is not clear or leads to ambiguity in the interpretation of the message (MacKay, 1969; Daft and Lengel, 1986). Even if there is a clear distinction in meaning, the two concepts are related. Because of ambiguity, new data may be confusing and may even increase uncertainty (Weick, 1979). In the strategy literature, yet another aspect of responding to uncertainty is emphasized. This literature has primarily been concerned with the complications of managerial choice caused by perceived environmental uncertainty (Downey and Slocum, 1975). Although the organization and strategy literatures both support the distinction between uncertainty and pervasive uncertainty, unfortunately, different forms of uncertainty are usually not clearly distinguished in these literatures.

Milliken (1987, 1990) previously made this point and provided a useful distinction among state, effect, and response uncertainty. State uncertainty refers to the nature of the environment, effect uncertainty to the lack of information about actual effects on the organization, and response uncertainty to the lack of information about the organization’s response options. Milliken’s (1987) distinction is particularly important in the realm of pervasive uncertainty but of little
importance in the realm of risk. In the realm of risk, state uncertainty refers to the assignment of point probabilities. When point probabilities are known, effect uncertainty becomes the optimal expected utility (or profit) and response uncertainty becomes a single preferred alternative. In the realm of risk, effect and response uncertainty are of little importance. In the realm of pervasive uncertainty, by contrast, it becomes critical for the decision maker to distinguish between Miliken’s (1987) three forms of uncertainty. That is to say, the present work offers a fundamental distinction between forms of uncertainty that complements Miliken’s (1987). Contrasting and unsolved issues remain in the research literature on uncertainty (McNamara and Bromiley, 1997). In order to make further progress, we believe that the organization literature should heed the fundamental distinction among risk, uncertainty, and pervasive uncertainty.

In summary, the representations of uncertainty in the economics, strategy, and organization literature have much in common. The framing from economics is more precise, however, in specifying the problem underlying pervasive uncertainty or equivocality: The function that connects alternatives to outcomes is not well defined or not defined at all. This clarifies that the challenge for the decision maker to infer this function cannot be solved simply by more information processing because this requires that the function is already in place. We therefore apply the economics representation of the problem throughout this paper. This representation establishes a distinction between three concepts commonly associated with choice under uncertainty: (1) risk, where the possible outcomes and their probabilities are known, (2) uncertainty, where the possible outcomes are in principle known but their probabilities can only be subjectively estimated, and (3) pervasive uncertainty, where neither the possible outcomes nor their probabilities are known. Because of the difference between these forms of uncertainty, different strategies are appropriate to deal with their presence. In the following, we point out that organizational routines are a way to reduce pervasive uncertainty in decision making, whereas increasing the available information is appropriate when the other, less demanding forms of uncertain situations arise.

3. Hypotheses

This section introduces the hypotheses that are elements of the research model tested in the present study. This research model is presented in Fig. 1.

3.1. Intelligence dissemination and uncertainty

As indicated in the previous section, risk and uncertainty can be resolved by gathering and increasing the spread of information throughout the organization, but pervasive uncertainty cannot be remedied in this way. In the present study, we use the concept of intelligence dissemination established in the marketing literature to define the spread of information throughout the organization. Our point of departure is the following three components of the influential market orientation construct of Kohli et al. (1993). Intelligence generation is the collection and assessment of information on market actors and the forces impinging on these actors. Intelligence dissemination is the process and extent of information exchange that takes place within and between departments, and it occurs both formally and informally. Responsiveness is the action taken in response to the intelligence that is generated and disseminated. In the case of pervasive uncertainty, intelligence dissemination does not help because a decision maker by definition allocates attention to an impossible problem. Based on this premise, we now argue that increasing intelligence dissemination will lead to an increase in the decision maker’s experience of pervasive uncertainty.

Increasing the amount of information will not decrease pervasive uncertainty but neither can it be made worse. It is here necessary to establish a distinction between pervasive uncertainty as a relation between a decision maker and the

Fig. 1. Research model of the proposed relations among constructs. The solid lines are hypothesized effects. The dashed lines are controls.
environment and the decision maker’s experience of this situation. Even if the pervasive uncertainty itself is a situation that cannot be altered, the decision maker’s experience of pervasive uncertainty will vary according to the allocation of attention. When more attention is allocated to problems that cannot be solved, the degree to which decision makers experience pervasive uncertainty will increase. In addition to this direct effect, there is a further possible indirect effect. Allocating limited information processing resources to a problem that is impossible to solve will further reduce the cognitive resources available to deal with such problems that can be solved. And when more attention is allocated to deal with problems that cannot be solved, the general state of uncertainty is likely to increase. This argument holds if one or more domains (e.g., the costs resulting from environmental demands required by law) are characterized by pervasive uncertainty whereas at least one domain is not (Milliken, 1987).

In the strategy literature, pervasive uncertainty is often described by its implications, typically in terms of some sort of ambiguity (Lippman and Rumelt, 1982; March and Olsen, 1976). According to this literature, causal ambiguity, equivocality, and other descriptions of what we here refer to as pervasive uncertainty reduce the control of outcomes when firms invest in resources. The reason is that a situation characterized by pervasive uncertainty has too little structure for information to be helpful. In this case, luck is the decisive factor, determining how a new firm develops and acquires resources that can sustain competitive advantage (Barney, 1986).

By definition, pervasive uncertainty implies that it is impossible to assign point probabilities to outcomes. In theoretical terms, this describes a situation where a unique mapping of alternatives to outcomes cannot be defined. Therefore, increasing the amount of information will not have the slightest effect on reducing pervasive uncertainty. The underlying empirical reasons for such situations include confounding of multiple causes, interference of third variables, and the appearance of novel elements in the choice set.

It is therefore necessary to clarify the distinction between general uncertainty and pervasive uncertainty. According to our definition of pervasive uncertainty, this is a situation where point probabilities cannot be associated with outcomes because the function that connects alternatives to outcomes is ill defined. By contrast, a general state of uncertainty refers to the scope of uncertainty, whatever its nature. Conceptually, it is conceivable that one domain (e.g., the costs resulting from environmental demands required by law) is characterized by pervasive uncertainty whereas other domains are not (Milliken, 1987). Pervasive uncertainty can be restricted to a particular domain; it does not need to be present in each and every domain. A general state of uncertainty is one in which every domain is merely characterized by uncertainty. Because information can resolve risk and uncertainty, it is likely that intelligence dissemination will reduce a general state of uncertainty. By contrast, in the presence of pervasive uncertainty within a particular domain, increasing intelligence dissemination related to this domain will increase the experience of pervasive uncertainty.

**H1:** Increasing intelligence dissemination leads to an increase in the decision maker’s experience of pervasive uncertainty related to environmental issues.

As explained in the Methods section, we measure pervasive uncertainty within the particular domain of environmental issues (i.e., issues related to the greening of industry). We therefore narrow down the scope of H1 to reflect the type of uncertainty studied in the empirical test of the present article.

### 3.2. Routines and uncertainty

If increased intelligence dissemination does not reduce pervasive uncertainty, what then are the viable strategies? A whole range of possible alternative responses to deal with risk, uncertainty, or pervasive uncertainty can be extracted from the literatures reviewed above: (1) behavioral adaptation (muddling through, promoting emergent strategies, and logical incrementalism; Mintzberg, 1978; Quinn, 1980); (2) structural adaptation (increasing the flexibility of the organization, group decision making, cooperation, formal structural devices such as rules and procedures, reliance on precedents and tradition, parallel rather than serial organization of projects, divesture of organizational units, interlocking directorates, and vertical integration; Khandwalla, 1973; Miller, 1987); and (3) hedging and commitment adjustment (investing in real call options rather than undertaking large sunk cost investments, increasing commitment as rivalry increases, hedging through marketing differentiation, or product innovation; Miller, 1987, 2002).

Since most of the mentioned works do not clearly distinguish between pervasive uncertainty and other forms of uncertainty (including risk), it is unclear whether the mentioned responses are viable under conditions of pervasive uncertainty. A promising starting point for progress in that direction is recent work in finance (Lien, 2000) that clearly makes a distinction between pervasive uncertainty and uncertainty (risk) and then proceeds to outline the difference in hedging strategies between the two situations. According to the proposed solution, hedging under pervasive uncertainty must be based on inertia in behavior (Lien, 2000), which implies some form of routinization. Whereas the decision under uncertainty (risk) is whether to hedge or not, the problem under pervasive uncertainty is to choose the right degree of hedging. The role of inertia or routinization is to limit the possible set of options that are considered and thereby enable better decisions.

More generally, various literatures support the idea proposed in the present paper that routines can enable decision making in situations that are characterized by environmental...
turbulence (Baumol, 2002; Paswan et al., 1998; Eriksson and Sharma, 2002; March and Simon, 1958; Cyert and March, 1992; Miller, 1987; Nelson and Winter, 1982; Richardson, 1960). According to these works, decision makers would better be able to cope with pervasive uncertainty if their strategic responses were constrained by routinized behavior. Based on these sources, routinization must be viewed as a necessary requirement to cope with situations of pervasive uncertainty. In an influential work in economics, Heiner (1983, p. 570) has offered the important hypothesis that “greater uncertainty will cause rule-governed behavior to exhibit increasingly predictable regularities, so that uncertainty becomes the basic source of predictable behavior.”

Arguments can be found that turn the direction of causality so increases in routinization may be viewed as an uncertainty decreasing strategy. By fixing certain parameters, firms may (1) increase predictability and at the same time (2) free limited cognitive resources. As emphasized by Baumol (2002), Hodgson (1988), and North (1990), institutions and routines are sources of regular and predictable behavior in the face of uncertainty, complexity, and information overload. The classical statement is Knight’s (1921) suggestion that firms may prefer relatively predictable lines of activity to more speculative operations. Later, Knight and Merriam (1948) suggested that the tendency to follow routines increases predictability, and Richardson (1960) suggested that various restraints introduce the necessary friction for the working of the economic system. More recently, it has been emphasized that routinization reduces systems level uncertainty associated with competition and technological risk (Shapiro and Varian, 1999). Apart from introducing predictability at the systems level, a number of authors (March and Simon, 1958; Nelson and Winter, 1982; Simon, 1947) have emphasized that routines also greatly reduce individual level cognitive demands. Routines allow managers to cope with pervasive uncertainty under the constraint of bounded rationality because they can be used to save on mental efforts and thus preserve limited capacity required to deal with nonroutine events (March and Simon, 1958). Because routines introduce predictability by fixing certain parameters and by freeing cognitive resources, we hypothesize the following relationship between routinization and uncertainty:

H2: Increasing routinization will decrease the decision maker’s experience of pervasive uncertainty related to environmental issues.

3.3. Intelligence dissemination and routines

In the case of an ill-structured environment, it will be impossible to derive a function that can support the ordering of outcomes (Simon, 1955). Therefore, a countermeasure has to be designed that will simplify and structure the decision problem so it can be handled within the decision maker’s cognitive limitations. Earlier studies have indicated that organizational routines affect what information decision makers collect (McNamara and Bromiley, 1997; Eriksson and Sharma, 2002). As argued in the previous section, routinization provides a general solution to this problem. Routines greatly reduce the cognitive demands on individuals and thus preserve limited decision-making capacity (March and Simon, 1958). Routinization serves the further purpose of supporting increases in the level of the organization's intelligence dissemination by reducing the time cost of choosing among possible receivers. Routinization leads to a more effective channeling of information throughout the organization. As the level of intelligence dissemination increases, more aspects of intelligence dissemination therefore must be routinized to obtain the same level of effectiveness of dissemination of information.

H3: Increasing intelligence dissemination leads to an increase in routinization.

3.4. Routines and responsiveness

According to the definition given earlier, responsiveness refers to actions taken in response to intelligence that is generated and disseminated throughout the organization. This definition was based on the marketing literature (Kohli et al., 1993). A literature survey of the strategy literature uncovers a similar definition of responsiveness as the organization-wide ability to react to changes (Milliken, 1987). The strategy literature emphasizes three aspects of the responsiveness construct: (1) the willingness and the readiness in reacting to changes (Guiso, 1998), (2) reaction speed (Zaheer and Zaheer, 1997), and (3) responsiveness to local signals as opposed to global integration (Taggart, 1997). We now argue that routines increase the organization-wide ability to react to changes.

As indicated earlier, routines increase the potential for focused attention by preserving limited information processing and decision-making capacity (Simon, 1947; Postrel and Rumelt, 1992; March and Shapira, 1987). In order to better use limited capacity, attention is usually focused on nonroutine events whereas recurring events are dealt with semiconsciously (Postrel and Rumelt, 1992; Simon, 1947). Since the semiconscious processing of repetitive events requires less or almost no cognitive resources, this procedure, when established, leads to an increase in the available cognitive potential that may be used to attend to nonroutine events (Reason, 1990). This argument holds only if one or more domains are characterized by pervasive uncertainty whereas at least one domain is not (Milliken, 1987). In this case, routinization must be used in the domains characterized by pervasive uncertainty, and the free attention must be used in other domains characterized by less demanding forms of uncertainty. That is to say, if the decision maker lives in a sea of pervasive uncertainty, everything should be routinized and the free attention should solely be used to devise new routines. Routinization frees cognitive resources, but these resources must be used to deal with such
problems that can be solved, i.e., problems in the realm of risk or uncertainty (but not pervasive uncertainty).

In the case of change, events are always novel in some sense and thus require nonroutine response. Routinization introduces a division of labor where trivial, frequently occurring events are handled with very limited resources. The resources, which would otherwise be employed in the absence of routinized behavior, are then free to respond to nonroutine events. The firm’s responsiveness, its ability to react to changes, should therefore increase as the degree of routinization is increased.

**H4:** Increasing routinization leads to an increase in responsiveness.

### 3.5. Detecting changes and responsiveness

In the previous section, we argued that routinization would increase the firm’s responsiveness. Since reacting to changes and reaction speed are directly related to the speed of detecting changes (Guiso, 1998), both regarding customers and general business conditions, we expect a positive correlation between detecting changes and responsiveness. This hypothesis builds on the assumption that the firm has the necessary free resources available to respond to change once it is detected. That is, we expect that intelligence dissemination will increase routinization (H3) and that routinization, in turn, will increase (the potential for) responsiveness (H4). Thus, given H3 and H4, we hypothesize,

**H5:** Increasing the speed of detecting changes increases responsiveness.

### 3.6. Intelligence dissemination, uncertainty, and the detection of changes

Information is a necessary prerequisite for detecting changes. Without information, one cannot get an impression of the state of the world that can be compared against the state of the world at a later point in time. As intelligence dissemination increases, the organization members’ information on changes in customer preferences and more fundamental changes in the conditions of trade will be made available to top management (Thompson, 1967; Galbraith, 1973). Intelligence dissemination increases the flow of information throughout the organization and thereby increases the likelihood that important changes are detected and can be responded to (Kohli et al., 1993). In consequence, the correlation between intelligence dissemination and the detection of changes should be positive.

**H6:** Increasing intelligence dissemination leads to faster detection of changes.

Finally, we believe that increasing pervasive uncertainty will decrease the firm’s responsiveness. As argued above, an increase in pervasive uncertainty has a direct and an indirect effect. The direct effect is that pervasive uncertainty leads to a lack of overview and a state of confusion where nobody knows what to do. The indirect effect consists in allocating limited cognitive resources to problems that cannot be solved, thus leaving such problems that can be solved unattended. Both effects have the additional implication that managers are less responsive to changes in the environment. Similar arguments are found in Milliken (1990). According to the distinction of pervasive uncertainty and a general state of uncertainty established above, it is possible that increasing pervasive uncertainty will not influence the firm’s responsiveness (Miles and Snow, 1978; Milliken, 1987; Duncan, 1972). In the present study, this would be the case if the pervasive uncertainty related to environmental issues does not influence the firm’s responsiveness to market data. With this caveat in mind, it is hypothesized,

**H7:** Increasing pervasive uncertainty related to environmental issues leads to a decrease in responsiveness.

### 4. Methods

#### 4.1. Data and measures

##### 4.1.1. Data

Data were obtained from a survey on selected Danish industries conducted in 1999. The industries were chosen according to the criterion that they experience different levels of emissions of waste and pollutants, and therefore different levels of uncertainty related to environmental issues. Included were the chemical, medical, paint, electronics, textile, and dairy industry. According to the literature on the greening of industry, uncertainty at the firm level arises because of complex and often conflicting stakeholder claims that are partly driven by the firm’s or the industry’s level of emission (Hoffman, 1999; Sharma and Vredenburg, 1998). On this basis, we used the industry’s level of emission as a criterion to select firms that experience different levels of uncertainty related to environmental issues. The chemical, medical, and paint industry experience high levels of emission and have a history of being at the center of attention of stakeholder claims. Firms in these industries were assumed to experience high levels of uncertainty related to environmental issues. The textile and dairy industries were included as industries with medium to low emissions and thus medium to low uncertainty related to environmental issues. In operational terms, the industries were identified on the basis of the firms’ NACE code for 1999 as registered in the publicly available database CD-Direct. A limit of employees >10 was used as cut-off point. Using these criteria resulted in a sampling frame of 1007 firms with more than 10 employees.
According to an initial contact procedure (telephone interview), the sampling frame was adjusted to 908 firms. Out of these, 545 firms accepted to participate in the survey and were mailed a self-administered questionnaire. Non-respondents were subsequently contacted by telephone in order to inspire response or, alternatively, elucidate a reason for nonresponse. Of the 545 firms accepting participation, 146 were large- or medium-sized firms with 50 or more employees. This delimitation of 50 employees was based on the European definition in the area of industrial business now established in the empirical literature (Loecher, 2000).

The large- or medium-sized firms were mailed two different questionnaires: one mailed to the firm’s CEO, regarding information on the strategic level, and a different questionnaire mailed to the firm’s environmental manager, regarding the firm’s environmental practices. These questionnaires were more detailed than the ones sent to the small firms. Because only the questionnaires for the large- and medium-sized firms contain the more detailed information required to test the hypotheses of the present study, we only report results from the data on the large- or medium-sized firms.

The response rate for the sample of the 146 large- or medium-sized firms used in the present analyses was 42.5% (62 firms). Because of item nonresponse, the effective sample used in the present study was further reduced to 56 firms. In view of the rather large material that had to be completed, this result compares favorably with the response rates commonly reported in similar surveys.

4.1.2. Measures

Multiple-item composite scales measured all the constructs in order to increase reliability. All items were scored on a five-point scale ranging from “strongly disagree” to “strongly agree.” If possible, we used existing scales that had a proven good track record in terms of reliability. Thus, the scale of Kohli et al. (1993) was used to measure the three constructs: intelligence dissemination, detecting change, and responsiveness. It should be noted here that “detecting change” is a scale that uses a subset of two items of the construct “intelligence generation” by Kohli et al. (1993). These two items measure the speed in discovery of demand side and industry-wide changes. The constructs “intelligence dissemination” and “responsiveness” were adopted in unaltered form from Kohli et al. (1993). The reason that only two items were used in the scale “detecting change” is that the original construct “intelligence generation” by Kohli et al. (1993) was not reliable. By contrast, as can be seen in Table 1, the other two constructs, as well as the modified construct “detecting change,” had values of Cronbach’s Alpha between .81 and .87, which is satisfactory.

In the case of pervasive uncertainty (related to environmental issues), we refined a two-item scale previously developed by one of the authors and added three items that were selected according to a literature review of empirical studies (e.g., Lewis and Harvey, 2001). According to the reviewed studies, firms experience complexity, risk, and uncertainty from environmental problems. Different causes for this state of affairs have been identified. A number of empirical studies have inferred that lacking institutionalized practices and an unstable regulatory regime are prominent causes of firm-level uncertainty related to environmental issues (Hoffman, 1999). It has further been reported that environmental problems have an inherent complexity (Lewis and Harvey, 2001). Due to complex and often conflicting stakeholder claims, the firm-level uncertainty related to environmental issues will tend to be aggravated (Hoffman, 1999; Sharma and Vredenburg, 1998). The form of uncertainty related to environmental issues has thus been described as pervasive as defined in the present article. Our construct captures the decision maker’s experience of pervasive uncertainty. The experience aspect is captured in all items of the uncertainty scale used here. The three items that were added to the uncertainty scale (Items 2, 4, and 5 as reported in Table 1) were selected to better tap pervasive uncertainty associated with environmental issues. This scale now included five items, and the computed value of .73 for Cronbach’s Alpha indicates a sufficient degree of scale reliability.

The routines scale was developed anew on the basis of theoretical considerations. The five selected items capture routinization as frequent social interaction (use of task groups), frequent use of fixed goals (for cost control), and frequent use of comparative cost analysis. The opposite of frequent is infrequent. While repetitiveness is a key characteristic of routines (Nelson and Winter, 1982), the frequency of repetition has been used in psychology for operationalizing the strength of routines (Betsch et al., 1998). The computed value of .74 for Cronbach’s Alpha indicates a sufficiently high scale reliability and thus suggests that this scale is a useful basis from which a routinization scale can be further developed.

4.1.3. Unidimensionality and discriminant validity

We used a series of principal components analyses in order to test for unidimensionality. Since only one component had an eigenvalue above 1, the scales are sufficiently unidimensional. We then assessed discriminant validity by testing the hypotheses that the correlation coefficients for any of the possible pairwise combinations of all five constructs did not deviate from unity. Since this hypothesis was rejected in all 10 tests, we obtained sufficient discriminant validity.

4.1.4. Controls

We do not find compelling reason that the organization’s detection of change will influence organizational routines but avoid stating the null hypothesis. We include the path from detecting change to routinization as a control. Since new employees are likely to cause a temporary decrease in routinization and increase in uncertainty and perhaps have
less ability to detect important changes, we controlled the number of new managers hired. Because “old” managers that leave the firm have the same effects on routinization, uncertainty, and ability to detect changes, we also controlled for the number of “old” managers leaving. The full research model, including controls, is shown in Fig. 1.

## 5. Results

The research model presented in Fig. 1 was tested with path analysis, employing a series of nested models as suggested by Anderson and Gerbing (1988). In view of the relatively small sample size, we use path analyses on
multi-item composite scales, i.e., additive conjunctive scales that are composed of the items selected for each construct, as described above. As shown in Table 2, five models were estimated. The overall model fit was compared by sequential chi-square difference tests and by incremental fit indices that are all corrected for degrees of freedom, an important requirement for the test of nested models.

We used maximum likelihood estimation and subsequently evaluated the fit of the models. Table 2 presents a summary of the results. To identify Models 1 and 1*, we fixed the weights of seven error terms to unity. The difference between Models 1 and 1* is that the latter assumes identical variance over the three constructs: intelligence dissemination, uncertainty, and detection of change. The sequential chi-square difference test showed no significant difference in fit between Models 1* and 1, nor were there great differences in the fit indices. Both models provide excellent fit.

Comparing Models 1* and 2* shows that the controls, “new managers hired” and “old managers leaving,” play a significant role in explaining routinization and detection of change. These control variables are positive and significantly correlated, which is plausible. That is, new managers tend to be hired as old ones are leaving. Moreover, when new managers are hired, uncertainty increases; routinization and detection of change decrease (see Fig. 1). All effects seem intuitively plausible. That old managers who leave have the exactly opposite effect is interesting since it may be viewed as the positive effect of getting rid of a problematic situation. Thus, uncertainty decreases, routinization increases, and detection of change increases as old managers leave (see Fig. 1). Note, however, that only the routinization effect of old managers leaving is significant (at \( P = .05 \)).

We next turn to the target model (Model 2*) and the test of the hypotheses. The sequential chi-square test did not show any significant difference in fit between our target

### Table 2

**Model estimation and goodness of fit statistics**

<table>
<thead>
<tr>
<th>Path</th>
<th>Model 1</th>
<th>Model 1*</th>
<th>Model 2*</th>
<th>Model 3*</th>
<th>Model 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard coefficient</td>
<td>P</td>
<td>Standard coefficient</td>
<td>P</td>
<td>Standard coefficient</td>
</tr>
<tr>
<td>H1: Intelligence dissemination → uncertainty</td>
<td>.17</td>
<td>.05</td>
<td>.14</td>
<td>.07</td>
<td>.16</td>
</tr>
<tr>
<td>H2: Routinization → uncertainty</td>
<td>– .19</td>
<td>.04</td>
<td>– .17</td>
<td>.05</td>
<td>– .19</td>
</tr>
<tr>
<td>H3: Intelligence dissemination → routinization</td>
<td>.21</td>
<td>.03</td>
<td>.19</td>
<td>.04</td>
<td>.18</td>
</tr>
<tr>
<td>H4: Routinization → responsiveness</td>
<td>.14</td>
<td>.03</td>
<td>.14</td>
<td>.03</td>
<td>.14</td>
</tr>
<tr>
<td>H5: Detecting change → responsiveness</td>
<td>.25</td>
<td>.00</td>
<td>.27</td>
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<td>H6: Intelligence dissemination → detecting change</td>
<td>.20</td>
<td>.03</td>
<td>.18</td>
<td>.04</td>
<td>.16</td>
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<tr>
<td>H7: Uncertainty → responsiveness</td>
<td>– .05</td>
<td>.15</td>
<td>– .05</td>
<td>.15</td>
<td>– .05</td>
</tr>
</tbody>
</table>

**Controls**

- Detecting change → routinization
- New managers hired → uncertainty
- New managers hired → routinization
- New managers hired → detecting change
- Old managers leaving → uncertainty
- Old managers leaving → routinization
- Old managers leaving → detecting change

**Correlations**

- Intelligence dissemination → responsiveness
- Detecting change → uncertainty
- New managed hired → old managers leaving

**Goodness of fit**

<table>
<thead>
<tr>
<th>df</th>
<th>4</th>
<th>.93</th>
<th>6</th>
<th>.89</th>
<th>2</th>
<th>.62</th>
<th>1</th>
<th>.35</th>
<th>1</th>
<th>.35</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \chi^2 )</td>
<td>.89</td>
<td>2.31</td>
<td>.96</td>
<td>.89</td>
<td>.89</td>
<td></td>
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<tr>
<td>Cmin/df</td>
<td>.22</td>
<td>.39</td>
<td>.48</td>
<td>.89</td>
<td>.89</td>
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<tr>
<td>NFI, IFI, TLI, CFI</td>
<td>.99</td>
<td>.98</td>
<td>.98</td>
<td>.98</td>
<td>.85</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Squared multiple correlations**

- Routinization
- Uncertainty
- Detection of change
- Responsiveness

Two-tailed probabilities.

Models 1*, 2*, 3*, and 4*: variance of intelligence dissemination, uncertainty, and detection of change constrained to identical values.

All Hoelter 0.05>200, but RFI < . 90 for Models 3* and 4*.
6. Discussion and conclusion

The most important result is that H2, Heiner’s (1983) hypothesis, was supported: increasing routinization will decrease uncertainty. While H2–H6 were supported, H1 and H7 were rejected. Even though the estimate has the right sign and is significant at \( P<.05 \), however, the effect is not significant. Strictly speaking, neither can H1 be supported at \( P<.10 \). At \( P<.10 \), however, the effect is significant and the positive sign supports H1. Finally, all the remaining effects are significant and have the expected sign. That is, our results support H2–H6, whereas H1 and H7 are rejected.

According to Kohli et al. (1993), the two constructs “intelligence dissemination” and “responsiveness” should be positively correlated. As can be seen from Table 2, this is indeed the case. As an additional piece of information, it should be noted that the path that controls for the possible influence of “detecting change” on “routinization” is not significant. Moreover, we included a covariance term to control for the interaction between “detecting change” and “uncertainty.” As can be seen from Table 2, there is a significant negative correlation between the two constructs. Next, we examined the more parsimonious Models 3* and 4*. According to the sequential chi-square difference tests, it cannot be rejected that they fit the data as well as Models 1 and 1*. What happens though is that the explanatory power decreases dramatically and the fit indices for Model 4* are clearly poorer than those estimated for the previous models. However, since the estimated effects remain remarkably stable across the five models, the validity of the results is strengthened.

Model 2* and 1*. The fit indices in Table 2 also show an excellent fit for Model 2*. Both models fit the data equally well. Turning to the test of the hypotheses, we begin by noting the rejection of H7. Although the sign is as hypothesized, the effect is not significant. Strictly speaking, neither can H1 be supported at \( P<.05 \). However, the effect is significant and the positive sign supports H1. Finally, all the remaining effects are significant and have the expected sign. That is, our results support H2–H6, whereas H1 and H7 are rejected.

The present article contributes in a number of ways to the body of knowledge in coping with uncertainty. First, on the basis of the strategy and economics literature, we have identified two broad classes of uncertainty and the generic strategies that are appropriate to handle each class of uncertainty. Whereas organizational routines are a way to reduce pervasive uncertainty in decision making, we pointed out that the second generic strategy of increasing the available information is appropriate when other, less demanding forms of uncertain situations arise. The empirical test supported the hypothesis that organizational routines are a way to reduce pervasive uncertainty. This result provides an important basis for future empirical research that aims to uncover in more detail how organizational routines mitigate pervasive uncertainty. A second advantage of the present analysis is that such future empirical research can be designed to include treatments that take the distinct differences in uncertain situations into account.

A third advantage is that prescriptive studies as well as practitioners can take heed of the argument that distinct classes of uncertain situations require distinct remedies. It is clearly important for management to distinguish between uncertainty (risk) that can be reduced and pervasive uncertainty that cannot be influenced in any way. In the latter case, we have argued that routinization is a viable strategy that enables decision makers to direct limited cognitive resources at problems that can actually be solved. In consequence, the decision maker will experience less pervasive uncertainty, and the quality of the decisions that get made increases because the ineffective use of limited cognitive resources has been diminished.

The practical value of our argument lies in providing a theoretically sound basis for distinguishing two very different situations of uncertainty. The distinction between uncertainty and pervasive uncertainty is important in evaluating the recent effects of the internationalization of competition, increasing pressures to innovate, new communication technologies, and other sources of turbulence. Distinguishing situations of uncertainty from situations of
pervasive uncertainty provides managers with a much more fine-grained understanding of the problems they are facing. Our argument not only supports the idea that different strategies are appropriate in each situation. It also identifies a strategy not usually considered for coping with uncertainty, namely, routinizing decision making. In consequence, managers are provided with a basis for choosing the most appropriate generic strategy: In situations of uncertainty, increase the information available. In situations of pervasive uncertainty, increase the routinization of decision making. Because this is a generic strategy, there are additional issues related to the actual content of the organizational routines. While this issue deserves mention, a detailed consideration of the selection of organizational routines leads beyond the scope of the present article.

The empirical tests generally support the theoretical argument that routines help managers cope with pervasive uncertainty by freeing cognitive resources. Fixing the recurring and relatively unimportant parameters in a decision problem by routinization seems to be a viable strategy in coping with pervasive uncertainty. It also implies that semiconscious mechanisms deal with recurring problems so attention can be freed to focus on the problems that can be solved. This result is somewhat surprising in view of the widespread idea that the organizational flexibility must be increased in order to cope with uncertainty (Dreyer and Gronhaug, in press). Our results build on and extend recent research that questions this opposition of routine and change. Rather than having to break routines in order to solve the remaining error was produced without help.

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References
