

Original Article

# Combining central planning and decentralization to enhance effective risk management outcomes

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**Abstract** Enterprise risk management has gained in prominence as official regulations emphasize implementation of formal practices to safeguard against adverse corporate events. Whereas this development has increased general risk awareness, the adoption of centralized integrative frameworks is not necessarily sufficient in dealing effectively with uncertainty and unexpected events that seem to characterize contemporary business environments. In this context, we discuss the need to combine integrative risk management approaches with decentralized response capabilities that both allow management to better understand the intricate risk landscape and at the same time enable adaptive initiatives throughout the organization. Analysis of a corporate sample supports the proposition that a combination of central planning and decentralized decision making is associated with both higher economic performance and lower variation in performance outcomes.

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## Introduction

The enterprise-wide risk management perspectives influence managerial thinking and emphasize the need to consider corporate exposures across a range of major risk events (DeLoach, 2000; Muelbroek, 2002; Lam, 2003). The development of related enterprise risk management (ERM) practices has so far been influenced by a number of formalized frameworks including the COSO, FERMA and AS/NZS standards. However, the inclusion of operational and strategic risks in formal risk management paradigms that deal with financial and economic

exposures is challenged by the integration of different quantitative and qualitative approaches (Power, 2005). Accordingly, a critical examination of the formalized risk management frameworks indicates that the claimed alignment with corporate strategy development processes remains rather lucid (Henriksen and Uhlenfeldt, 2006). As strategic risks often are highly uncertain and constitute some of the biggest corporate exposures, the ability to deal with them represents a fundamental challenge when implementing effective risk management practices (Slywotzky and Drzik, 2005). The more formalized risk management approaches often remain focused on identifiable exposures whereas they are less suited to deal with many of the unexpected economic and strategic events that characterize contemporary business environments.

It has been proposed that combinations of variance-reducing strategic planning processes and variance-increasing autonomous initiatives can be an advantageous corporate approach to dealing with uncertain environmental conditions (Burgelman, 2005). In compliance with this idea, we identify central planning practices and decentralized decision making as essential strategic management modes that combine an ability to analyze and monitor a dynamic environmental context with an ability to take responsive initiatives when conditions in the environment change unexpectedly. We then analyze the risk-return effects among 229 corporate entities with varying emphasis on these management modes. The investigation reveals that simultaneous emphasis on central planning and decentralization is associated with both higher economic performance and lower variance in performance, which is an appealing risk management outcome.

In the following, we first outline the predominant ERM frameworks and the premises behind the proposed managerial approach including the implied risk-return effects. We then describe the empirical study, present the findings and discuss their implications for risk management practice.

## Enterprise Risk Management

The conceptualization of more comprehensive ERM frameworks evolved from practice during the late 1990s<sup>1</sup> (DeLoach, 2000; Lam, 2003). The Committee of Sponsoring Organizations (COSO) ERM framework was introduced in the United States in September 2004 as an extension of the internal control framework from 1992.<sup>2</sup> The current AS/NZS standard also dates back to 2004 extending a prior version from 1999 introduced jointly by the Australian and New Zealand standards organizations. The Federation of European Risk Management Associations (FERMA) risk management standard was published in 2003 incorporating the frameworks from preceding UK-based professional standards.<sup>3</sup> At the time of writing, the International Standards Organization is working on a new updated risk management standard, ISO 31000. These frameworks have strong roots from the auditing, accounting, and insurance

professions partly induced by earlier government initiatives promoted by standardization bodies and various interest groups.

The risk management frameworks, one way or another, consider the treatment of strategic risks and the engagement of the full organization. However, they assume that strategy only happens through the instigation of top management. For example, COSO (2004) states that 'management establishes strategic objectives, selects strategy and sets aligned objectives cascading through the enterprise'. It is further argued that ERM serves to assure that 'the board in its oversight role, are made aware, in a timely manner, of the extent to which the entity is moving toward achievement of the objectives'. In other words, it expresses a view that reporting on strategic objectives is essential and should be monitored by top management. The FERMA (2003) standard claims that risk management should be a 'developing process which runs throughout the organization's strategy and the implementation of that strategy'. It further states that 'it must translate the strategy into tactical and operational objectives' implying that the monitoring of strategic objectives is a central aspect of the risk management process. This again reflects a view that strategy arises from the executive office and the organization subsequently implements that strategy. Similarly, the proposed ISO 31000 standard 'implies a top-down approach where risk management become[s] a key process to enable the organisation to determine and achieve its objectives' (Purdy, 2008). That is, the standards reflect a singular view of a top management driven strategy process based on formulation, implementation and control.

However, the COSO framework further argues that effective risk management involves 'people at every level of an organization' as the FERMA standard argues that risk management is 'concerned with both positive and negative aspects of risk'. Hence, there is an assumption that pursuit of central strategic objectives is important and that all members of the organization somehow should engage in risk conscious behaviors to this end. Yet, the frameworks are not very explicit about how to conceptualize these dispersed risk management activities and how this may enable the organization to deal with unexpected events that represent opportunities and threats. Despite the dual aims implied by the language adopted in the ERM frameworks it is not clear what the implications are for effective risk management practices. To compensate for this, we seek insights from strategic management, a field that over time has scrutinized the duality between centralized and dispersed elements of the corporate strategy development process.

### The Integration of Risks

A long-standing view in strategic management is that of the chief executive officer whose aim is to understand and orchestrate all aspects of the corporation to achieve longer-term superior performance outcomes (for example,

Andrews, 1980). Accordingly, corporate management should engage in comprehensive analyses to assess the environmental conditions that affect strategic outcomes under turbulence (Ansoff, 1965, 1988; Schendel and Hofer, 1979). These perspectives encourage an integrated view of the corporation where executives act as the prime instigators of strategic initiatives and coordinators of organizational activities.

The enterprise-wide risk perspective is also partially inspired by financial management practice where aggregate market exposures of different geographically dispersed assets typically are expressed in a single value-at-risk metric derived from analyses of co-variation in asset returns. Similarly, shorter-term financial exposures and longer-term economic exposures can be related in indirect ways that require more thorough corporate analyses across different risk factors and time horizons (Oxelheim and Wihlborg, 2005). It is noted that environmental hazards, market-related vulnerabilities, and operational disruptions can interact even though these diverse risk areas are handled by specialized functional departments (Andersen and Terp, 2006). Hence, a basic premise of enterprise-wide risk management is to avoid that risks are handled in isolated functional silos but are considered within a more holistic depiction of the corporate risk profile (DeLoach, 2000; Muelbroek, 2002).

The ERM frameworks generally embrace the holistic risk management perspective and propose formalized procedures to ensure that all important risks are considered by a central administrative entity reporting to top-management. The integrative duties of this entity makes sense in the case of related risks but must also be balanced with the need to hone specialized risk management expertise while considering that some risks remain independent. The argument for risk integration is supported by a portfolio theoretical logic claiming that less than perfectly correlated events diversify exposures and lead to lower aggregated volatility of outcomes. That is, a simple aggregation of identified risk events may overestimate the corporate exposure. Conversely, when operations become more tightly connected in efficient corporate processes, they can also be more vulnerable to unexpected events that may evolve in highly complex and unpredictable ways (Perrow, 1999). Hence, the diversity of risk events and their potential relationships emphasize a requirement for integrative corporate risk management combined with a certain degree of structural decoupling that can facilitate autonomous responses to the unexpected.

## A Changing Risk Landscape

Many indications shape the perception of a business environment that is becoming more complex, dynamic and unpredictable. We have witnessed a global financial crisis with an unprecedented drop in economic activity and international trade. All along there have been a progressing number of natural and man-made catastrophes, political conflicts and socio-economic confrontations

around the globe.<sup>4</sup> These kinds of turbulent and hypercompetitive conditions leave corporations exposed to unforeseeable economic events, technology shifts, competitive moves and so on. (D'Aveni, 1994; Thomas, 1996). This development also indicates that the corporate risk environment is becoming increasingly uncertain where outcomes are hard to predict and illustrating that effective risk management practices also must be able to deal with the unknown.

In view of this changing competitive landscape, there is general consensus that corporate adaptability and a capacity to respond to unexpected changes constitute an important source of competitive advantage (Bettis and Hitt, 1995; Teece *et al*, 1997). Organizational research points towards decentralized non-hierarchical structures as being more responsive to dynamic change and thus suggests that some power dispersion and autonomy can decouple organizational processes sufficiently for adaptive initiatives to emerge (Galbraith, 1995; Castells, 1996). All the while, other management scholars observe that effective organizations also must engage in integrating processes embedded in more rigid organizational structures (Jelinek and Schoonhoven, 1990; Hill *et al*, 2000). These research contributions reiterate the need for conjoint emphasis on central integration and decentralized actions.

### Risk Management Organization

The preceding discussion uncovers two important aspects of the environmental context that may help us understand the nature of potential risk effects, namely the degree of unknowns and the risk interrelatedness (Figure 1). Uncertain environments where risk factors are difficult to identify, measure and foresee are characterized by a large degree of unknowns in future risk events. At the same time, multifaceted environments where events are intertwined and tightly coupled display considerable risk interrelatedness. Accordingly, if the underlying parts of a corporate business system interact in linear and predictable ways, then uncertainty and the degree of unknowns is low. Conversely, if the business system is complex, it may react in unpredictable ways displaying a high degree of unknowns. If one event has little influence on other corporate exposures then risk interrelatedness is low. Conversely, if events exert substantial influences on other exposures then risk interrelatedness is high. Therefore, when the degree of unknowns is low and risk effects are predictable, it is relatively easy to control exposures centrally whereas this becomes more ambiguous when the degree of unknowns is high, which then calls for more decentralized responses. If risk interrelatedness is high, there is a need for central coordination to assess the agglomerated corporate risk effects whereas this function may be superfluous when risk interrelatedness is low.

However, the general risk landscape across industries seems to be moving towards an environmental context characterized by a high degree of unknowns where some risk factors are strongly interrelated. That is, positioned in a direction

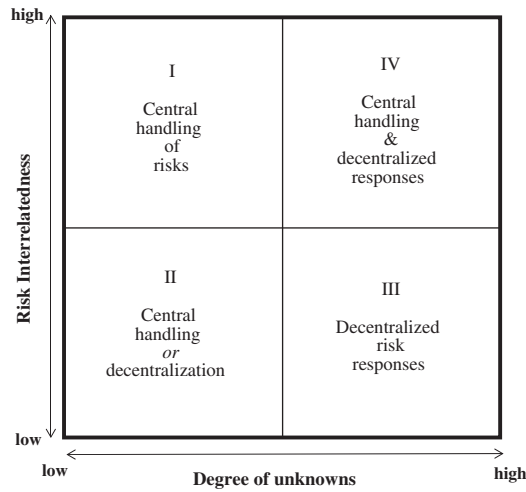


Figure 1: Risk management organization by unknowns and interrelatedness.

towards quadrant IV in Figure 1. This environmental assessment indicates a need for decentralized risk responses to deal with uncertainty combined with a central function to assess interrelated exposures and develop a more holistic view of the corporate risk universe. In short, the new environmental context urges a need to establish more nuanced managerial approaches to risk management that combine central handling of risks with decentralized risk responses. Indeed, this is also what the ERM approaches seem to claim through the communicated dual focus on central monitoring and wider organizational engagements in the risk management process. However, with the singular focus on top-down strategy in the formalized frameworks, it becomes incomprehensible as to how this can be accomplished in practice. Consequently, we turn to the strategy field in search for some useful insights.

### An Integrative Strategy Approach

Hence, effective risk management in the changing competitive environment seems to require combinations of organizational processes that drive central control functions as well as more spontaneous and dispersed risk responses. To this end, we offer an integrative strategy approach that considers the dual concerns for coordination of related risk phenomena and the ability to take responsive actions in the face of unexpected events. The proposed approach is derived from insights developed in organizational studies and strategic management research. It combines central planning practices with decentralized decision structures where sufficient autonomy lets managers take initiatives in response to observed changes. This duality captures elements of the so-called

Bower–Burgelman model according to which strategic initiatives can be instigated at lower levels of the organization and where the prime role of top management is to shape the organization that enables this (Burgelman, 1996). Central planning provides corporate management with the opportunity to identify and analyze various risk influences exerted in a complex competitive environment and coordinate corporate activities in view of these perceived conditions (Ansoff, 1988; Lorange and Vancil, 1995). Conversely, a decentralized decision structure allows managers throughout the organization to take responsive actions and adapt business activities as unexpected events arise (Bettis and Hitt, 1995; Teece *et al*, 1997).

A high-performing organization accomplishes its primary operational tasks efficiently while adapting its organizational functions effectively. This organization is able to manage corporate exposures, including identifiable risks as well as events that are hard to foresee, and thereby achieves excess performance levels with lower volatility in the performance outcomes. That is, we contend that outcomes from the proposed integrative strategy approach will materialize as economic performance is improved through the coordinated handling of interrelated exposures and is stabilized through the ability to adapt corporate activities as exposures emerge. Together these effects serve to reduce the variance in periodic earnings as they curb downside risk outcomes and allow pursuit of new opportunities that arise when the environment changes and thereby at the same time lead to higher average performance.

### Central planning

Central planning integrates the action plans of organizational sub-units in accordance with the overarching corporate intent (Andrews, 1980; Ansoff, 1988). The corporate planning practices comprise a logical sequence of concerns ranging from mission, goals and comprehensive environmental analyses to more concrete strategy, business and contingency plans together with subsequent control systems (Schendel and Hofer, 1979). Hence, we see central planning as a set of activities that systematically discuss mission, values and goals, explore the corporate risk environment, analyze strategic options, integrate business contingencies and coordinate corporate actions. The planning process is central in the sense that it considers environmental risk factors and exposures from a corporate perspective and, therefore, typically is monitored by a central administrative entity on behalf of top management.

### Decentralization

Decentralization arises when decision power is dispersed to managers that operate throughout the organization many of which have specific functional responsibilities (Mintzberg, 1983). This reflects decentralized decision making where lower-level managers have authority to take initiatives in response to



observed environmental phenomena that could not be uncovered in preceding planning exercises. Hence, decentralized decision making captures the managers' ability to take responsive actions without prior approval from higher up in the organization. The practical execution of planned business activities can uncover new important environmental insights and form the basis for responsive solutions (Floyd and Wooldridge, 1996). That is, new influences can arise from the individuals that execute the plans and bring the corporate aims to fruition through concrete actions. Managers located closer to the actual business transactions are the first to observe signals of environmental change while possessing the detailed situational information necessary to develop effective responses (Daft, 1992). Hence, a firm with a decentralized decision structure where managers can execute responses may react faster and more effectively to environmental changes.

The following presents an empirical study developed to investigate the proposed outcome effects of the integrative strategy approach comprised by the dual elements of central planning and decentralization.

### **Empirical Study**

The study used the Compustat database to sample businesses operating in different manufacturing and financial industries comprising food processing and apparel, various computer products, and deposit-taking institutions. Only single business firms and corporate business units operating in these industries were considered to discard possible business diversification effects and, therefore, business conglomerates were not part of the sample (Andersen, 2004). This created a list of 456 business entities where questionnaires were mailed to the sales and marketing executives engaged in the strategy process (Mintzberg, 1994). They returned 229 useable questionnaires corresponding to a response rate of 50.2 per cent. The sample was tested for different non-response biases and compared to secondary responses. For a detailed discussion of the sample testing please refer to Andersen (2004).

Central planning indicates the organization's emphasis on the integrative analytical elements of the firm's environmental context (Boyd and Reunning-Elliott, 1998). Decentralization indicates if managers are authorized to take responsive initiatives without top management approval (Price, 1972). Economic performance indicates the level of sales growth and economic returns compared to close competitors (Dess and Robinson, 1984) adopting scale measures that are independent of industry context. These measures were validated through comparisons against archival data and through factor analysis of item responses. For a detailed discussion of the validation analyses please refer to Andersen (2004).

The proposed effects from the integrated managerial approach of central planning and decentralization were assessed on the basis of multiple regression



**Table 1:** Descriptive statistics and correlation coefficients<sup>a</sup>

	<i>Mean</i>	<i>SD</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1. Economic performance	7.58	2.309	—	—	—	—
2. Industry dummy	0.38	0.487	-0.108	—	—	—
3. Central planning	18.03	4.723	0.300***	-0.134***	—	—
4. Decentralization	13.04	4.424	0.168**	0.157**	0.054	—
5. Organizational size	4.09	2.825	0.116	0.051	-0.064	0.215***

<sup>a</sup>N=229.\*\**P*<0.05; \*\*\**P*<0.01.**Table 2:** Multiple regression analyses<sup>a</sup> (standardized regression coefficients)

<i>Model</i>	<i>Economic performance</i>			
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>
<i>Dependent variable</i>				
Organizational size	0.144**	0.144**	0.110*	0.107*
Industry dummy	-0.150**	-0.086	-0.102	-0.104
Central planning	—	0.289***	0.282***	0.292***
Decentralization	—	—	0.144**	0.139**
Central planning × Decentralization	—	—	—	0.082
Multiple <i>R</i> <sup>2</sup>	0.043	0.111	0.133	0.140
Adjusted <i>R</i> <sup>2</sup>	0.026	0.099	0.111	0.114
<i>F</i> -significance	0.024	0.000	0.000	0.000

<sup>a</sup>N=229.\**P*<0.10; \*\**P*<0.05; \*\*\**P*<0.01.

and split sample analyses. In the regressions, we controlled for potential influence of organizational size on performance outcomes (Aldrich, 1999). Analysis across industry sub-samples did not reveal material differences in emphasis on central planning and decentralization across the industry groups of food and apparel firms (household goods), computer products and financial services. However, we controlled for differences in general performance level by including industry dummies for household goods and computer products firms in the regressions as performance can be influenced by industry-specific contexts (Wholey and Brittain, 1989). Only the computer products dummy revealed significant performance effects on the regression coefficients and is, therefore, included in the reported results.

Descriptive information and correlation analysis of variables are shown in Table 1. The regression analysis using economic performance as the dependent variable indicates that central planning and decentralization display significant positive direct relationships to performance but show no interaction effect between the two (Table 2).

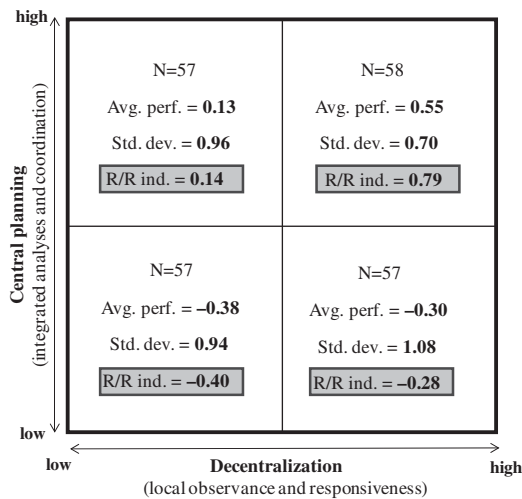
Table 3: Description of sub-samples

	<i>Number of firms</i>	<i>Average performance</i>	<i>SD</i>
<i>Sub-samples</i>			
<i>Central planning</i>			
Above median	115	8.42	1.821
Below median	114	6.94	2.209
<i>Decentralization</i>			
Above median	115	7.98	2.095
Below median	114	7.37	2.173
<i>Central planning and decentralization</i>			
Above both medians	58	8.86	1.469
Below both medians	171	7.25	2.222
Full sample	229	7.65	2.173

Split sample analyses of above and below median observations show that average performance is higher among entities emphasizing central planning and they also display lower variation in performance outcomes (Table 3). Similarly, entities with emphasis on decentralization display higher average performance but only with slightly lower variation in performance outcomes. Finally, the sub-sample of entities with above median emphasis on central planning and decentralization show both significantly higher average performance as well as lower performance variation.

These results are illustrated further in a graphical representation using standardized performance indicators in Figure 2. The performance indicators are standardized across the three major industry groups of household goods, computer products and financial services to eliminate industry-fixed effects. It is evident from this comparative analysis that the 58 entities with above median emphasis on both central planning and decentralization display significantly higher average performance and lower variation in performance. A risk-return indicator (R/R ind.) determined as the relationship between average performance and the standard deviation of performance is significantly higher for entities that emphasize both strategy making approaches at the same time.<sup>5</sup> This data analysis suggests that the ability to integrate central planning and decentralization in an integrative strategy approach is associated with both higher average performance and lower variation in performance outcomes.

Hence, we observe above average performance and lower variation in performance among business entities that combine central analysis of the risk environment and coordination of corporate activities with a decentralized decision structure that allows for responsive actions throughout the organization. These results hold across different industry contexts and thus appear to have general validity.



**Figure 2:** Performance outcomes by groups above and below median (standardized indicator of economic performance).

## Discussion

The dominant ERM frameworks including the COSO, AS/NZS and FERMA standards express the importance of monitoring strategic objectives for top management while emphasizing inclusion at all organizational levels in the risk management process. However, the risk management standards have difficulty conceptualizing how this occurs because they all display a centralized top driven view of strategy that may enforce a focus on central controls at the expense of decentralized responsive actions. This is also the case with the new proposed ISO 31000 standard. In the strategic management field, an emerging literature suggests that combinations of central and decentralized strategy-making modes provide more optimal risk-return outcomes, which may help us overcome this conceptual limitation (Burgelman, 1996, 2005; Andersen, 2004). Accordingly, we propose the adoption of an integrative strategy approach that combines central planning and decentralization.

Central planning has a positive performance relationship suggesting that economic efficiency derives from corporate integration and coordination of business activities. Central planning is also associated with lower variation in performance outcomes. That is, integrative analyses of environmental risk factors and opportunities indeed do seem to reduce the adverse effects of identified exposures and develop new business potential, which tends to stabilize earnings. Decentralization has a significant positive performance relationship whereas the associated reduction in performance variation is relatively modest. The higher effectiveness may derive from delegation of decision power to

managers that are closer to the actual business context and, therefore, are better and more fully informed about the changing conditions. The availability of relevant information can lead to better quality decisions and more effective solutions. Furthermore, managers can take faster responsive actions as they circumvent otherwise cumbersome hierarchical approval processes. When taken together, business entities that adhere to central planning practices combined with decentralized decision making achieve significantly higher average performance levels at lower variation in performance outcomes. Even though the analysis fails to show significant interaction effects between central planning and decentralization, the evidence clearly indicates that a combination of both strategy-making modes is associated with superior risk-return outcomes.

Therefore, the point is that although an emphasis on central analysis, monitoring and control displays positive risk management effects, it is significantly more effective when combined with an ability to take decentralized initiatives that can increase responsiveness to unexpected events. For example, we may observe a field operative, say a sales manager, who is faced with a sudden customer problem that requires a solution. In some organizations, all operations are determined by central guidelines that reduce flexible response in this situation whereas in others there is delegated authority that allows improvisation and a decentralized response. Although the former organization may try to gain standardization benefits, this approach clearly hampers responsiveness and may counter possible gains from adaptation to immediate needs. What is more, central analysis, monitoring and control processes do not preclude decentralization of decision power to dispersed operatives. In fact, the ability to establish insights about environmental risks while monitoring this on an ongoing basis can both provide a good overview for top management and at same time provide an informed basis for effective decentralized decisions. It is also obvious then, that some organizational structures and embedded cultures are more inclined to accommodate both central planning and decentralization and we have to be aware of that.

The study has some practical constraints that should be taken into consideration. As the data reflect outcomes for a given time period, the risk-return measures are based on cross-sectional variation as opposed to dynamic longitudinal performance variations. Furthermore, the model constructs are developed on the basis of responses to questionnaires that may be subject to common response biases. However, we compared sub-samples of primary and secondary respondents and found no discrepancies between them. We also cross-validated the self-assessed performance measure with secondary performance data from financial statements, which failed to reveal any discrepancies. Finally, the results are consistent with observations in other risk-return studies that report inverse relationships between average returns and standard deviation in returns across industries (Andersen *et al*, 2007). Hence, we may have uncovered a plausible explanation for the existence of favorable risk-return

effects as some business entities engage in integrative strategy approaches that combine central planning practices with a decentralized decision structure.

The implication of these results is that we concur with the dual claims communicated by the common risk management standards as they emphasize central monitoring of strategic risks and wider involvement in the risk management process. However, we claim that the prevailing singular view of strategy as a top-down process in line with a conventional formulation, implementation, and control framework puts severe limitations on the viability of the proposed emphases. One way to circumvent this limitation is to import contemporary conceptualizations of strategy where strategy making is conceived as combinations of central planning and decentralized decision-making processes. This obviously does not provide a complete depiction of the highly complex strategy development processes that comprise many other intricate elements of an organizational structure, such as, communication channels, information systems, incentive schemes, corporate values and so on. Nonetheless, it provides a conceptual framing to better understand the many aspects of risk management mentioned in the standards, such as, accountability, authority, communications, decision making, effectiveness, efficiency, integrity, opportunities, people, reliability, threats, volatility and so on.

## Conclusions

The present study shows how an integrative strategy approach emphasizing central planning and decentralization can achieve both higher average performance and lower variation in performance outcomes. The results provide a useful conceptual framing to understand how effective risk management can combine monitoring of strategic risks with wider organizational involvement as is generally promoted by current ERM frameworks. The findings also outline a plausible explanation for observed inverse risk relationships across industries and stipulate how they can arise through the combined effects of central risk monitoring and decentralized responses. Hence, a combination of central planning and decentralization seems to constitute an effective integrative strategy approach in dealing with contemporary risk environments characterized by uncertainty and unexpected events.

## Notes

- 1 This more holistic treatment of corporate risks emerged from active practitioners operating in professional advisory firms counting institutions, such as, Marsh, Deloitte, Tillingast-Towers-Perrin and others while DeLoach (2000) was a partner with Arthur Andersen at the time.
- 2 The COSO is formed by the American Accounting Association, the American Institute of Certified Public Accountants, Financial Executives International, the Institute of Management Accountants and the Institute of Internal Auditors. The COSO framework was authored by principal contributors

- from PricewaterhouseCoopers and the complete ERM guide can only be acquired on commercial terms.
- 3 The standard of the FERMA is based on the frameworks introduced by the Institute of Risk Management (IRM), Association of Insurance and Risk Managers (AIRMIC), and the National Forum for Risk Managers in the Public Sector (ALARM) in 2002 and adheres to the risk terminology established in the ISO/IEC guide 73.
  - 4 See, for example, the EarthTrends information sources maintained by the World Resources Institute.
  - 5 This comparative ratio corresponds to the so-called Sharp-ratio used in modern portfolio analysis to assess the expected return obtained for a given level of risk.

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