Innovation and Recoverable Slack Interaction: How Does It Affect Firm Performance?

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This paper investigates the impact of the interaction effect between a slack variable and innovation on financial performance. Specifically, the interaction effect between recoverable slack resources and an innovation input on financial performance were analyzed using financial data of U.S firms in aerospace and computer science industries. An extensive review of literature on slack, innovation, and environmental shock develops the conceptual model. This study examines the relationship as representative of a specific bundle of resources governed by the strategic direction of management. The results suggest evidence of a positive and significant interaction effect under certain conditions.

Innovation has been accepted as a necessary and important resource for firm sustainability and growth (Bourgois, 1981; Nohria and Gulati, 1996; Zahra and Covin, 1993) and has been an important topic of interest in organizational theory. Slack is another construct that has garnered the attention of organizational theorists (Bourgeois, 1981; Cyert and March, 1963; Tan and Peng, 2003; Voss et al., 2008). The relationship of excess resources above that necessary to produce a product or service has been argued to both contribute and hinder innovation in firms. It has been theorized that above optimal levels of slack are counterproductive and wasteful while below optimal levels of slack inhibit innovation (Geiger and Cashen, 2002; Nohria and Gulati, 1996). Empirical research has clarified the relationship to be curvilinear. There is also established literature that discusses the relationship of firm-specific factors which would include the slack-innovation relationship to the sustained generation of above normal levels of return or rents (Barney, 1991; Wernerfelt, 1984). As firms increasingly face greater pressures to be both more innovative and to manage resources most efficiently, a possible dilemma arises. If firms maintain lean levels of slack resources, innovation may be inhibited. Decisions for resource allocation are made at a specific point in time, but the environment is not static. Is there justification then for keeping excess above minimum levels of slack resources and if so, what type of slack resources? This presses the question. What happens to this relationship when an event takes place that is outside of the industry norms, such as during an environmental shock?

This study suggests that the slack-innovation relationship represents a specific bundle of resources governed by the strategic direction of management, and as such, testing of this relationship can give further insight into slack innovation allocation strategies (Sirmon et al., 2007). Another purpose of this research was to provide greater insight into what Sirmon et al., (2007) described as the "black-box".

The results of this research provide a model for practitioners making strategic decisions grounded in the resource-based view of the firm. The resource-based view of the firm holds that heterogeneous firm-specific bundles of resources and capabilities provide sources for sustained competitive advantage (Barney, 2001, 1991; Conner, 1991; Dierickx et al., 1989; Sirmon et al., 2007). Resources and capabilities within the firm can be categorized into tangible assets, such as physical and financial capital resources and intangible assets, such as human and organizational capital resources (Barney, 1991). Generally, resources are considered available assets that can be traded in the market place; alternatively capabilities are considered firm-specific attributes. Amit and Schoemaker state: "capabilities are based on developing, carrying and exchanging information through the firm's human capital" (1993: 36). As noted in the literature, it takes more than just the presence of resources to provide a firm with a distinct competitive advantage (Prahalad and Hamel, 1990; Priem and Butler, 2001; Sirmon et al., 2007; Van de Ven, 1986). It is the identification and bundling of specific resources in combination with the effective and efficient use of capabilities that can ultimately create a sustainable competitive advantage (Amit and Schoemaker,

1993; Pralahad and Hamel, 1990). Sirmon et al., state, "Bundling refers to the processes (i.e., stabilizing, enriching, and pioneering) used to integrate resources to form capabilities" (2007: 273).

Competitive firms design organizational systems to operate under industry specific environmental pressures (Anand and Ward, 2004; Sharfman, 1985). Optimal slack resources would then be expected to be maintained to create environments that support and protect innovation during environmental turbulence. Ruiz-Moreno et al., state, "The key issue is not whether slack is good or bad for innovation, but that the managers, depending whether or not they have slack, organized and managed differently the resources that the organization can bundle and apply to the maintenance and development of competitive advantage" (2006: 520). Following the resource-based tradition, the allocation of slack resources designed to create an optimal amount of innovation meet the empirical construct of a valuable resource (Amit and Schoemaker, 1993; Barney, 1991). There has been recent interest in the dynamic capability framework as a way to explain why some firms are better able than others at bundling resources and capabilities to address rapidly changing environments. (Danneels, 2008; Teece et al., 1997). Teece et al., (1997) argue competitive advantage can be attained through the exploitation of existing internal and external firm-specific capabilities and developing additional ones (Prahalad and Hamel, 1990). Danneel classified "competence to build new competencies" as the first form of dynamic capabilities. The study also identified specific organizational antecedents that had an effect on firm's dynamic capabilities including organizational slack. The findings suggested surplus resources be set aside to "foster second-order competences, which will allow the firm to engage in exploration to avert the threat of environmental shifts or to take advantage of new opportunities (2008, p.536). Therefore, this study contributes to the existing research in the following ways: Firstly, it offers a model to test the recoverable slack-innovation interaction effect on financial performance. Secondly, two industries with different investment horizons will be examined for industry effects on the recoverable slack-innovation relationship's effect on financial performance.
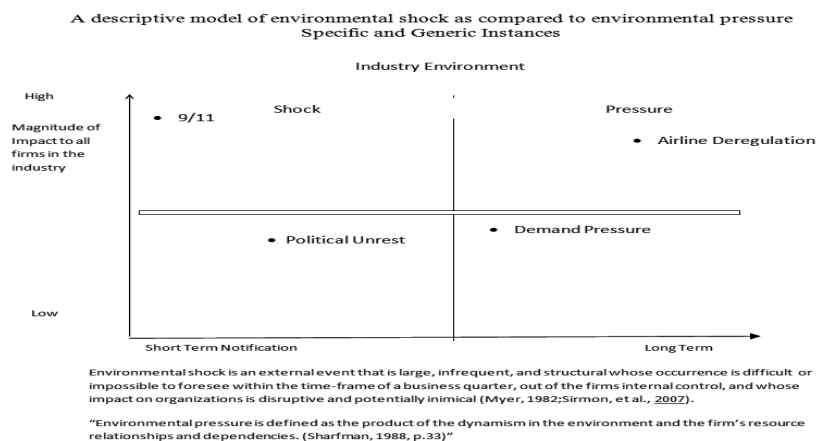
In the sections that follow, a literature review summarizing the relationship between the multiple dimensions of slack and innovation are discussed, followed by associated hypotheses. It considers various aspects contributing to the measures used in our research for slack resources, innovation, and environmental shock. The methodology, analysis, and implications of the study follow. In the final section, a discussion of the findings and the potential for future research is offered.

LITERATURE REVIEW

Environmental Shock

This study proposes that subtle yet important differences exist between the concept of environmental shock and the notion of environmental pressure (Anand and Ward, 2004; Dess and Beard, 1984; Meyer, 1982; Porter, 1980). Figure I provides a graphical comparison between the two concepts.

FIGURE I

A descriptive model of environmental shock as compared to environmental pressure
Specific and Generic Instances

Industry Environment

Environmental shock is an external event that is large, infrequent, and structural whose occurrence is difficult or impossible to foresee within the time-frame of a business quarter, out of the firms internal control, and whose impact on organizations is disruptive and potentially inimical (Myer, 1982; Sirmon, et al., 2007).

"Environmental pressure is defined as the product of the dynamism in the environment and the firm's resource relationships and dependencies. (Sharfman, 1988, p.33)"

Environmental pressure has been discussed in the literature from both economic and organizational theory perspectives (Dess and Beard, 1984). There is agreement in the literature on the constructs of the environment reflected by Sharfman's definition of environmental pressure, "Environmental pressure is defined as the product of the dynamism in the environment and the firm's resource relationships and dependencies" (1988: 33).

Research indicates firms are less able to cope with unpredictable demands and rapid changes in technologies than with predictable normal business pressures (Anderson and Tushman, 2001). Firms in dynamic industry environments can create coping strategies with the allocation of resources allowing for greater flexibility as a response to discontinuous change. One cause for a lack of capability to respond has been related to inertia resulting in an inability to adapt. Cheng and Kesner (1997) argued that firms will target slack resources as a response to environmental pressure depending on the firm's strategic focus. The response will either be one of applying greater available slack as an external response or one of applying adjustments to recoverable slack to gain greater internal efficiencies. Anand and Ward (2004) argued firm structure should be designed to fit the dynamics within an industry. A review of the literature has shown a need to more clearly define the terms "environmental pressure" and "environmental shock" to gain greater understanding of the effect of organizational strategies, structures, or outcomes (Dess and Rasheed, 1991).

Environmental pressure stems from changes to market factors resulting in a change to economic equilibria. An example has been noted in the technological change that took place in the photographic manufacturing industry with the introduction of consumer digital imaging systems (Christensen, 2002). Although the probability for the introduction of a new competitive technology was known by the firms, they did not react with successful business strategies in the short-term in part because of inertia or internal political concerns.

As stated previously, the nuances between environmental pressure and shock are subtle, yet important for clarity in environmental research findings. Sirmon et al., refer to the occurrence of an environmental shock as, "the introduction of discontinuous innovation or a major political catastrophe as in the event of 9/11" (2007: 287). However, there is no commonly referred to definition for environmental shock. It has been argued in the literature that organizations can allocate resources and design organizational forms to be responsive to dynamic environments (Anand and Ward, 2004; Barney, 1991). Thus, the introduction of discontinuous (radical) innovation may cause an increase of dynamism or reduce munificence, while not necessarily cause an environmental shock (Sirmon et al., 2007). In Meyer's (1982) study of hospital administrative reactions to policy changes, he distinguished normal business surprises from environmental shocks as: "environmental events that were transient perturbations whose occurrences are difficult to foresee and whose impacts on organizations are disruptive and potentially inimical" (1982: 515).

Criteria for an environmental shock would comprise events that are difficult or impossible to foresee within the timeframe of a business quarter and out of the firm's internal control. For example, it could be reasonably argued that deregulation or privatization are political processes that give some advance notification of potential change, and therefore provide some measure of strategic decision making. This paper suggests the basis for environmental shock is one where there is minimal warning for an event that brings about a radical and disruptive change.

This study presents a definition that builds upon the work of Meyer (1982) and Sirmon et al., (2007) using the events of 9/11 as a reference point for analysis. Environmental shock is defined as an external event that is large, infrequent, and structural, whose occurrence is difficult or impossible to foresee within the timeframe of a business quarter, out of the firms internal control, and whose impact on organizations is disruptive and potentially inimical.

Slack Resources and Innovation

The notion of slack resources as having a relationship to innovation has been widely discussed (see Bourgeois, 1981, for a review). Nohria and Gulati offer a definition that presents the common notion of

slack as excess resources: "the pool of resources in an organization that is in excess above the minimum necessary to produce a given level of output." (1996: 32). It is from this definition that perceptions of the term, "excess above the minimum", vary. Proponents of slack resources argue that slack is a positive and a significant determinant of performance outcomes as slack provides a cushion that protects the firm from environmental shocks (Bourgeois, 1981) as well as acts as a facilitator of creative behavior (Bourgeois, 1981; Cyert and March, 1963). Alternatively, this reserve or cushion has been argued to reflect inefficiencies and waste (Nohria and Gulati, 1996; Sharfman, 1985) as well as poor internal control practices (Jensen, 1993).

Most recently, research indicates the relationship between organizational slack and innovation to be curvilinear. In essence, limiting slack resources may negatively impact firm capabilities to innovate, while an excess over a certain amount may result in inefficiencies (Bourgeois, 1981; Bourgeois and Singh, 1983; Cheng and Kesner, 1997; Geiger and Cashen, 2002; Nohria and Gulati, 1996). Most common measures of slack resources are framed as available, potential, and recoverable.

Available Slack. The term "available slack" reflects the readily available (unabsorbed) nature of the resource for use by management. A common example is cash or credit lines (Voss et al., 2008). This category of resource holds the greatest level of discretionary use and thus is considered highly accessible in a short time frame. Ease of accessibility may act as a buffering mechanism against environmental variability (workflow variability) and function as a catalyst for innovation and strategy formulation (Bourgeois, 1981). Alternatively, as optimum levels are exceeded, control mechanisms may become lax resulting in inefficiency and waste (Jensen, 1993).

Potential Slack. The literature presents an alternative dimension of slack, "potential slack", which measured the amount of debt available to the firm. The findings are range from a positive linear relationship between potential slack and innovation (Geiger and Cashen, 2002) to a relationship that does not appear to be direct nor predictive (Herold et al., 2006). Findings indicate further research is needed to investigate the impact of the different debt structures on R&D intensity as modeled in this study (David et al., 2008).

Recoverable Slack. Firms also hold recoverable (absorbed) resources or excess overhead that has been absorbed into the system with the potential to be recovered or redistributed. Studies that have examined operational slack have indicated recoverable slack acts very similarly to available slack in relationship to innovation as both a buffering mechanism and catalyst for innovation, and alternatively as a potential for inefficiencies. At optimal levels, it fulfills the purpose of slack which is to absorb irregularities and shocks in the environment (e.g. Bourgeois, 1981; Cyert and March, 1963; Thompson, 1967). Proponents of slack argue for high levels of uncommitted resources while also stating the need for finding the balance between buffering levels that would protect the core with associated costs. As such, prior research suggests recoverable slack and innovation will have a curvilinear relationship (Geiger and Cashen, 2002; Nohria and Gulati, 1996; Singh, 1986). Examples range from additional employees kept on the payroll during slower economic times to additional distribution channels that serve as buffers in dynamic environments.

One example of recoverable slack is redundancy. The importance of redundant and diverse systems was evident after the 9/11. Organizations that had a physical presence at the World Trade center on September 11, 2001 suffered tremendous, immediate and incalculable loss. Managers reported after addressing critical concerns for employee their attention needed to focus on restoring capabilities within their departments. Those companies maintaining backup systems and shared services with offsite departments were able to respond in innovative ways to meet the needs of the organization more quickly (Gallagher, 2001; Yossi, 2001).

Innovation. Interestingly, there has not been equal development or agreement for multiple measures of innovation based on specific determinants. The main criterion that differentiates innovation from mere change is the introduction of something new, something rare and unique (Gopalakrishnan and Damanpour, 1997; Nohria and Gulati, 1995; Schumpeter, 1939). The various dimensions of innovation that contribute to outcomes of the innovation process have been an important focus of the literature on innovation since Schumpeter (1939). This research has evolved into a rich area of interdisciplinary study

resulting in heterogeneity of concepts, yet with no consistent model linking various disciplines. Contributing researchers from various disciplines and even within the same discipline conceptualize innovation from different dimensions. To this point, an integrated concept has not been introduced (Castellacci et al., 2005; Gopalakrishnan and, Damanpour, 1997; Johannessen et al., 2001). Therefore, there is a need to discuss or identify which dimension of innovation is being addressed and at what level of analysis. For example, Herold et al., (2006) argued for the use of patent-based statistics as a proxy for innovation. Although patent-based activity can be considered an important determinant of innovation, it specifically looks at innovation output. Helfat states, "This focus on patents, however, obscures the fact that in many industries, an important part of developmental research in particular entails alterations and enhancements to existing firm assets, production processes, and products." (1994: 176). Thus it is important to address which factor is being examined within the innovation process. Alternatively, a variable commonly used to measure innovation, R&D intensity, is a well-respected measure of an innovation input.

Previous studies have identified R&D intensity as an input to innovation within the innovation process at the firm level (Bourgeois and Singh, 1983; Geiger and Cashen, 2002; Hitt et al., 1996; Hambrick and Macmillan, 1985). This paper reflects the spirit of Schumpeter's definition of innovation to include positive outcomes with respect to customers, stakeholders, and the organization with the creation of new products within the firm (Geiger and Cashen, 2002; Rainey, 2005; Schumpeter, 1939). As such, innovation was conceptualized in this study as R&D intensity and operationalized as (R&D/sales). This is reflective of the investment the firm makes in research and development as a percent of sales (R&D/sales) (Baysinger and Hoskisson, 1989; Geiger and Cashen, 2002; Hitt et al., 1996; Hambrick and Macmillan, 1985).

Immediately following an environmental shock, firms will seek to deploy both available and recoverable slack resources. Under some circumstances, firms with additional cash resources may be able to respond more vigorously than those who have not maintained such available slack resources. At other times, the resources needed will not be available at any price. Firms with recoverable slack resources may have the competitive advantage. Research analyzing multiple dimensions of slack resources using regression analysis has shown recoverable slack to have the most significant relationship to innovation (Geiger and Cashen, 2002). Therefore, based on the research findings discussed regarding the resource-based view of the firm, the relationship between recoverable slack and innovation was chosen as the most salient measure to examine the slack-innovation relationship as it relates to firm financial performance.

Relationship between Recoverable Slack - Innovation and Financial Performance

No previously published research studies have examined the recoverable slack-innovation relationship as it relates to firm financial performance. The recoverable slack-innovation relationship is representative of a specific bundle of resources governed by the strategic direction of management (Barney, 1991; Sirmon et al., 2007). Recoverable slack includes excess overhead that has been absorbed, but has the potential to be recovered or redistributed. Testing of this relationship can give further insight into what has been termed the "black box" of the resource-based view of the firm (Sirmon et al., 2007). It is expected the interaction effect between recoverable slack-and innovation will have a positive influence on financial performance Recoverable slack has features that can be categorized as ease of implementation and the time it takes to implement (Sharfman et al., 1988; Singh, 1986). The identification and bundling of recoverable resources in combination with the effective and efficient use of innovation can ultimately create a sustainable competitive advantage (Amit and Schoemaker, 1993; Pralahad and Hamel, 1990). Based on research findings discussed regarding the resource-based view of the firm, slack and innovation, the following hypothesis is offered:

Hypothesis 1: The interaction effect between recoverable slack and innovation will be positively related to firm performance.

There is an emerging literature addressing the organizational effects from the tragic events of September 11, 2001. Findings specifically looking at the Aerospace Product and Parts Manufacturing industry showed the industry suffered a significant demand shock (and Lee, 2004). Gittell et al., (2006) presented a model that clarified the role between relational reserves (people) and financial reserves during a crisis. The study analyzed the effects to organizational resilience in airline industry post 9/11. The authors concluded: "…financial reserves coupled with a strong commitment to employees are pivotal to an organization's ability to cope with environmental jolts" (2006, p.325).

Hypothesis 2: The interaction effect between recoverable slack and innovation will be positively related to firm performance in the aeronautics industry, but diminish after an environmental shock.

According to Standard and Poor's industry reports, every product segment in the computer science industry was negatively affected by the events on 9/11 in both business and consumer sectors. Although business conditions caused a decline in demand earlier in the year following September 11, 2001, the global economic recession negatively affected world-wide computer sales (Bouwman et al, 2003; Graham-Hackett, 2002; Rudy, 2002)

Hypothesis 3: The interaction effect between recoverable slack and innovation will be positively related to firm performance in the computer science industry, but diminish after an environmental shock.

Methods

The sample was drawn from secondary data from Standard and Poor's Research Insight (Compustat® North America) database (Davis and Duhaime, 1992; Venkatraman and Ramanujam, 1986). This sample was drawn from the following industry sectors: (33641) Aerospace Product and Parts Manufacturing, (334) Computer and Electronic Product Manufacturing sectors and (511210) Software Publishers. The Aerospace Product and Parts Manufacturing sector was reported to be directly affected by environmental shock on September 11, 2001 (Ito and Lee, 2005). In addition, the Computer and Electronic Product Manufacturing, and Software Publishers industry are representative of innovation. Firms represent both short and long cycle industries with differing R&D investment horizons. It is also likely these firms would have reported research and development expenditures in the 1999 - 2005 period. Two additional conditions for selection were: the firms providing data must be listed as a United States Fortune 1000 company from the years 1999 through 2005, and the firms must report R&D expenditures for all years included in the study. The following assumptions were made to determine appropriate sample size for statistical analysis. An alpha level of .05, a power level of .80, and a medium effect size of .05 was used and predictor variables were set at 15 as a conservative sample size (Cohen, 1992; Green, 1992; Geiger and Cashen, 2002). It was determined in that study that a sample size of at least 138 firms would be necessary. In order to capture the effects of environmental shock, the years 1999 through and inclusive of 2005 were captured.

Dependent Variable

Performance. Return on Assets (ROA) was used as an indicator of firm performance. ROA is defined as net income plus interest expense divided by sum of total assets.

Independent Variables

Innovation. The input to innovation (IN) is conceptualized as R&D intensity of the firm and was operationalized using the ratio R&D/sales (Zachariadis, 2003; Geiger and Cashen, 2002; Hitt et al., 1991).
Recoverable Slack. It is common in slack-innovation relationship research to use financially derived data to conceptualize slack (Herold et al., 2006; Geiger and Cashen, 2002; Bourgeois and Singh, 1983; Bourgeois, 1981). Recoverable (absorbed) slack (RS) captures resources within the firm that can be

identified as excess costs, but can be utilized to respond in times of financial difficulty or to take advantage of new opportunities (Singh, 1986; Bourgeois and Singh, 1983). Recoverable slack has been conceptualized using selling and general administrative expenses divided by sales (SG&A/sales) of the firm (Geiger and Cashen, 2002; Bourgeois and Singh, 1983; Bromiley, 1991).

Interaction Effect. Empirical studies regarding the slack innovation relationship relied upon accounting performance measures to operationalize recoverable slack and innovation (Geiger and Cashen, 2002; Cheng and Kesner, 1997; Baysinger and Hoskisson, 1989; Hitt et al., 1996; Hambrick and Macmillan, 1985). This study used the interaction effect between recoverable slack and innovation as an indicator of a specific bundle of resources governed by the strategic direction of management (Sirmon et al., 2007; Barney, 1991). Also, Lin et al., 2006 used an interaction effect to model the relationship between commercial orientation, R&D intensity, and firm performance. The interaction in this paper was calculated as the ratio of SGA (selling, general and administrative) to total sales multiplied by the ratio of R&D expense divided by total sales (Agresti and Finlay, 1986).

Control Variables

Relying on methods from prior studies, the variables of firm size, risk, product diversification, industry characteristics, and time were included in this study. Research has shown a positive relationship between size and R&D spending (Baysinger and Hoskisson, 1989). As such, firm size would be directly related to innovation. Sorenson (2000) suggested that as large firms have the advantage of economies of scale and size, these would act as buffers from short term shocks. One could reasonably argue firm size may have an impact on the slack-innovation relationship. This study measured firm size by using the log of total sales. Systematic risk is a common measure to assess firm risk (Geiger and Cashen, 2002; Chatterjee and Lubatkin, 1988). Information on firm beta was retrieved from the Compustat® database. The level of unrelated product diversification has been shown to have a significant and negative relationship to innovation (Hoskinsson and Hitt, 1988; Hitt et al., 1996). Product diversification was calculated using an entropy measure that takes into account the number of segments in which a firm operates weighted by sales in each segment (Palepu, 1985; Hitt et al., 1996; Geiger and Cashen, 2002). The formula $= \sum P_j \times \ln (1/P)$, where P_j represents the percentage of firm sales in segment j and $\ln (1/p)$ is the weight for each segment (Hitt et al., 1996).

Firms were divided into Computer Science and Aerospace industries to control for industry characteristics (Damanpour and Gopalakrishnan, 1998; Hitt and Ireland, 1985). A Time trend variable was included to test for long and short term structural sifts.

Data and Analysis

An initial panel data least squares series was conducted to test the significance of the control variables as they related to the innovation recoverable slack relationship. The nature of the data - a cross section of firms, each with a few periods worth of observations (years 1999 - 2005) makes panel estimation the natural technique for estimates (Wooldridge, 2002). To capture fixed individual differences for each firm, a fixed-effects or 'dummy variable' formalization was used, where the intercept is different for every firm and does not change over time.

In addition to the panel data formation, strong evidence of serial correlation and unit roots for many of the variables made it desirable to pursue an approach that takes account of cointegrated series. A Vector Error Correction model (VEC) was able to handle most of the panel data. The longer-term trends are accounted for in the error-correction (EC) portion of the equation, showing stable relationships between key variables. In earlier specifications of the VEC model shown in Table 1, it was noted that constant and residual terms were highly significant in the V portion of the VEC, but most other coefficients were not. Nonetheless, the R-squared was fairly high, suggesting significant multi-collinearity between these nominally 'independent' right-hand-side variables. By eliminating most of the control variables, this problem was mitigated in the specification shown in Table 1. That is, of the three control variables, RS was the only one reporting consistently significant coefficients in the V portion of the equation when, as

in Table 1, both aeronautics and computer science industries were included in the dataset. Prior research also confirms a lack of demonstrated significance of additional control variables (Latham and Braun, 2009).

Table 1 Dependent Variable Change in Innovation D(IN) Cointegrating Equation:	(A) 1999-2005 Inc. Per. = 7 C.S. = 214 Obs. = 812	(B) 1999-2005 Inc. Per. = 7 C.S. = 214 Obs. = 812	(C) 1999-2005 Inc. Per. = 7 C.S. = 214 Obs. = 812
IN(-1)	1,000	1,000	1,000
Constant	-0. 2063 [-3.427]***	0.0359 [0.689]	-0.1492 [-2.220]**
RISK(-1)	-0.1164 [-3.305]***	-0.0723 [-1.749]*	-0.1440 [-3.276]***
SIZE(-1)	0.0769 [4.824]***	0.0145 [1.549]	0.0643 [3.859]***
RS(-1)		-0.3521 [-4.021]***	
POST01(-1)	-0.0149 [-5.162]***		
R-squared Adjusted R-squared	0.8256 0.7767	0.8537 0.8127	0.8196 0.7693
Independent Variables:			
Cointegrating Equation	-0.9167 [-6.371]***	-0.9708 [-6.392]***	-1.0316 [-7.732]***
Constant	0.0036 [3.170]***	-0.0012 [-1.414]	0.0034 [3.988]***
D(IN(-1))	0.1818 [2.308]**	0.0535 [0.657]	0.1865 [2.587]***
D(RISK(-1))	-0.0677 [-1.301]	-0.0820 [-1.456]	-0.0472 [-0.948]
D(SIZE(-1))	0.0351 [2.168]**	0.0861 [4.388]***	0.0258 [1.759]
D(RS(-1))		0.0383 [0.776]	
D(POST01(-1))	-0.0097 [-4.306]***		
R-squared Adjusted R-squared	0.5279 0.3543	0.4851 0.2958	0.6007 0.4548
Log likelihood F-statistic	1849.723 3.0413		
Akaike AIC Schwarz SC	-4.0166 -2.7491	-3.9298 -2.6624	-4.1866 -2.9249

t-statistics in [ ]; *** -- p-val < 0.01, **-- p-val < 0.05, * -- p-val <0.10.
Inc. Per – Included Periods, C.S – Cross Sections, Obs. - Observations

The Wooldridge-Wald test on the regressions in Table 1 rejects the null of no serial correlation at the 5 percent level. Thus serial correlation is likely to be a serious problem. To mitigate this problem, however, in Table 1 the authors are using White (1980) period estimators, which Arellano (1987) shows to be robust to within-cross-section serial correlation.

The analysis will now turn to the "interaction effect" regressions. A single-equation method was used to test the hypotheses. A model of the interaction of Residual Slack (RS) and Innovation (IN), and their effect upon Return on Assets (ROA) in the final period was based on the average levels of RS and IN over the entire period - 1 to 7 years. Thus, the authors relied on a simple cross-sectional data set, as this test did not require panel methods. Ordinary Least Squares was sufficient. As the R-squared was little changed by removing the control variables, this invites the option of removing all the control variables other than RS, as was done for each of the regressions below (Latham and Braun, 2009; Geiger and Cashen, 2007).

Hypothesis 1 proposes that the interaction effect between recoverable slack and innovation will be positively related to firm performance. It can be seen that the interaction effect between innovation and recoverable slack has an overall positive effect on financial performance. In a larger sense the interaction is positive, that the effect of the individual terms is positive, and there is just a small corrective for the joint effect (see Table 2). By adding the interaction term, the authors transform the combined influence of IN and RS from a linear to a non-linear effect - which the R-squared statistics in column A of Table 2 show to be much more accurate than the other specifications.

Table 2					
Dependent Variable:	(A) 2005	(B) 2005	© 2005	(D) 2005	(E) 2005
Return on Assets (ROA)					
	Inc. Per. = 1 C>S> = 136 Obs. = 136	Inc. Per. = 1 C>S> = 136 Obs. = 136	Inc. Per. = 1 C>S> = 136 Obs. = 136	Inc. Per. = 1 C>S> = 136 Obs. = 136	Inc. Per. = 1 C>S> = 136 Obs. = 136
Independent Variables: Constant	3.5908 [3.054]***	11.5206 [9.1694]***	10.2144 [8.8068]***	6.9575 [8.5618]***	9.2884 [13.8292]***
IN	34.2077	-0.6630	-29.0976		
RS	11.5743 [2.3889]***	14.1850 -[2.45888]***		-02313 [-1.5773]	
IN*RS	-76.3984 [-10.8063]***				-40.9424 [-9.9041]***
R-SQUARED Adjusted R-squared	0.546586 0.536281	0.145466 0.132616	0.6622 0.099955	0.017836 0.010667	0.422640 0.418331
Log likelihood F-statistic	-444.8075 53.04154	-487.9025 11.32021	-490.9253 15.99251	-508.8770 2.487968	-461.2404 98.09081
Akaike AIC Schwarz SC	6.60011 6.68578	7.219154 7.2834404	7.248902 7.291735	7.350748 7.392971	6.812359 6.855192

Hypothesis 2 proposes that the interaction effect between recoverable slack and innovation will be positively related to firm performance in the aeronautics industry, but diminish after an environmental shock. The results as shown in Table 3 support a positive and significant relationship between the recoverable slack and innovation interaction effect and financial performance. This result is significant even after accounting for the combined effect. The significance of these results is impressive, and the Wooldridge-Wald test can only reject the null of no serial correlation for the regression in column A at the 15% level. Thus, serial correlation is not likely to be a serious problem.

Hypothesis 3 suggests the interaction effect between recoverable slack and innovation will be positively related to firm performance in the computer science industry, but diminish after an environmental shock. The results as shown in Table 3, show that over the long term (i.e., in the EC equation) the interaction effect is positive and significant in aerospace (Column A), but not in computer science (Column B).

Table 3		
Dependent Variable: Change in Return on Assets (ROA)	(A) 1999-2005 Inc. Per. ≤ 7 C>S> = 42 Obs. = 163	(B) 1999-2005 Inc. Per. ≤ 7 C>S> = 96 Obs. = 423
Industry	0	1
Cointegrating Equation:		
ROA(1)	1.00000	1.00000
Constant	-12.28649 [-7.2106]***	-34.2151 [-3.8280]***
IN(-1)	92.9082 [4.0073]**	-26.8449 [-0.4122]
RS(-1)	40.3497 [2.5297]***	92.1327 [-4.0930]***
IN(-1)*RS(-1)	*-449.9306 [-2.7194]**	-24.9587 [-0.7868]
@TREND	0.3125 [1.8869	0.5878 [2.0920]**
R-squared Adjusted R-squared	0.574777 0.448971	0.4138 0.2758
Independent Variables		
Cointegrating Equation		
Constant	-0.32006 [-6.70922]***	-1.0505 [-3.1852]***
RES_ROA(-1)	-1.19794 [-13.0600]***	-1.3256 [-42.8084]***
D(ROA(-1)	0.18376 [1.7922]*	0.5764 [14.0125]***
D(IN(-1)	35.54318 [2.51888]***	100.2749 [0.7509]
D(RS(-1))	21.63838 [2.3769]**	4.9062 [0.0689]
D(IN(-1)*RS(-1))	-213.33300 [-3.7337]***	-25.5237 [-1.8486]*
R-squared Adjusted R-squared	0.57799 0.41064	0.624537 0.507933
Log likelihood F-statistic	-384.4050 3.45382	-1842.699 5.356074
Akaike AIC	5.29331	9.190066
Schwarz SC	6.18538	10.15646

Please note that coefficient signs are reversed in the form of the EC equation. Thus the original equation behind the EC term shows a coefficient on the interaction term in column A that is positive, significant, and very large. The interaction coefficient is negative in the V part of the regressions, however, and is again quite large and significant in the case of column A. The post 2001 shock effect shows a significantly negative trend in both columns.

DISCUSSION

The implications of this study provide greater insight into conditions under which recoverable slack resources have on organizational functioning (Cheng and Kesner, 1997). This research provides empirical evidence that recoverable slack and innovation allocation decisions can affect financial performance. These findings indicate - specifically in the aeronautics industry - investments in this particular bundle of resources can provide a competitive advantage after an environmental shock. The authors presented a model with three hypotheses and conducted an empirical study of U.S. aerospace and computer firms. The testing of the relationship between the recoverable slack, innovation and financial performance presented in this research has given further insight into what has been termed the "black box" of the resource-based view of the firm (Sirmon et al., 2007). This model has implications for future research in

the area of the resource-based view by providing an additional measure that can be used to predict the relationship of firm-specific resources to financial performance. The results support a positive and significant relationship between the recoverable slack and innovation interaction effect and financial performance in the long term for aeronautics industry. Investments in innovation and recoverable slack in this industry can provide a competitive advantage after an environmental shock. Consequently, this analysis will assist managers to make more informed decisions with regard to investments in buffering mechanisms against environmental variability (workflow variability), and the return on investments in innovation.

In addition, industries included in this study were both long and short cycle. For example, aerospace firms can have R&D cycles of twenty years while software companies can have short-term R&D requirements of nine months. The recoverable slack-innovation relationship presented in this research model is representative of a specific bundle of resources governed by the strategic direction of management. Implicit in the innovation variable used in this study is R&D investment. A consequence of this investment is a contribution to the knowledge-base within the firm that ultimately translates to goodwill (David et al., 2008; Helfat, 1994). Helfat (1994) suggests R&D's value is in large part linked to the nature of the cumulative learning that takes place both corporately and individually. Management may find decisions to reduce funding in R&D will inadvertently affect the routines that take place in the organization. Learning that is disrupted may not be preserved (Dosi, 1988; Dougherty, 1992; Helfat, 1994). As managers in this industry must have long term investment horizons these results have practical implications. The results suggest the aeronautics industry did see a change in the relationship between the interaction effect and financial performance over time. Although the industry was severely affected by the events of September 11th, the interaction effect played a positive role in financial performance outcomes in the long term. However, the results are quite different for the computer science industry. The interaction effect between recoverable slack and innovation did not have a significant relationship to financial performance in either the short or long term. The results could be interpreted as a tendency toward greater short-term instability post 2001. There may have been other factors. The industry was feeling the effects of poor business conditions. Even before the events of September 11th, the computer industry was expecting dramatically slowing growth (Graham-Hackett, 2002; Rudy, 2002). These findings suggest industry characteristics are an important factor in this stream of research.

Further, this paper offers insight into the differences between environmental pressure and environmental shock. It has been suggested within this paper that the basis for environmental shock is one where there is minimal warning for an event that brings about a radical and disruptive change. Having the benefit of more precise definitions of environmental events will assist researchers in developing and testing models using explicit criteria (see Figure I).

It has been acknowledged in the literature that additional measures are needed to predict the relationship between the use of firm resources and competitive advantage (Sirmon et al., 2007). This paper presented an important contribution in this area of research. However, future research can continue to add value by assembling additional data to test this interactivity.

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