

# Dynamics of Organizational Routines in Declining Firms when Compared to their Matched Survivors

In the US chemical and allied products industry (SIC 2800)

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## Abstract

How does organizational decline affect organizational search routines? Do search routines change differently in declining firms than in surviving firms? This paper uses threat rigidity theory to arrive at the hypotheses. It measures search routines by the research and development expenditure. It also examines the role of the time to bankruptcy. Results indicate that declining firms in the US chemical and allied products industry exhibit rigidity in their organizational search routines. Interestingly, the time to bankruptcy did not matter. This paper shows that declining firms did not change their year to year search routines in the five years preceding bankruptcy.

Overall, there are two interesting contributions of this paper. First, it questions the dominant wisdom in the literature that organizational decline is associated with continued and accelerated deterioration within firms. Surprisingly, the search routines did not continue deteriorating during the last five years before bankruptcy. Second, organizational search routines are dynamic routines that are supposed to change. However, in this dissertation, these dynamic routines exhibit no change in the five years before bankruptcy. This stimulates further research thought on under what conditions do dynamic routines change and under what conditions do dynamic routines remain stable.

## Introduction

Are failed firms different than surviving firms? As the process of failure unfolds over time, failed firms may behave differently than survivors. If this is true, the cause of failure might rest in the different behavior. However, failed firms may behave in ways similar to surviving firms. In this instance, interpretations about the causes of failure become more complicated. While failed and failing firm have been studied from a financial perspective and a managerial perspective, scholars on organizational decline have not directly examined specific organizational routines within declining firms. The financial and managerial perspectives tend to explicitly assume that routines are malleable, or subject to management control. In contrast, the routines literature is less encumbered by assumptions of direct managerial control. In this study, we link literature on organizational decline and organizational routines in an attempt to develop increased understanding of the behaviors and issues relevant to firm decline.

In this study, we focus on organizational routines. We examine how search routines within declining firms change or not change in the five years prior to bankruptcy when compared with those within surviving firms that are similar. We also examine changes in the routines across time for failed firms. We examine declining firms in the US SIC 2800: Chemical and allied products industry. We draw on the threat rigidity theory (a theory drawn from psychology) to empirically examine the changes in the search routines of declining firms with respect to those of surviving firms and across time. In this study, we address the following questions: How do failing firms change their search routines when compared with their matched surviving firms? Is this change a function of calendar time?

This study is one of the first to directly examine search routines within declining firms. McKinley (1993) has pointed out that there is a dearth of dynamic models of the internal dynamics of failing firms. We cater to this gap. To date, very few studies (D'Aveni, 1989a; Hambrick and D'Aveni, 1988) have examined the contingent role of time in declining firms. Out of these two studies, only one (Hambrick and D'Aveni, 1988) examined how domain initiatives change in declining firms and their matched surviving firms with respect to annual calendar time. The second study (D'Aveni, 1989a) identified patterns of decline with respect to annual calendar time. D'Aveni (1989a) found that not all firms have the same pace of deterioration of their financial performance with respect to annual calendar time. These studies hint at the variety of responses that exist in declining firms, and how these responses might change across time. In turn, this study will show how patterns of change in search routines contribute to this variance.

In the organizational routine literature, prior scholars have studied higher-level routines such as meta-routines (Adler, Goldoftas and Levine, 1999; Grant, 1996; Peng, Schroeder and Shah, 2008; Zollo and Winter, 2002). But, none of these scholars have studied higher-level routines in the context of failing or declining firms. In fact, there is a dearth of empirical studies on the evolution of organizational routines in failing firms. Here, we address this gap in the existing literature.

The rest of the paper is organized as follows: First, we discuss the existing literature on organizational decline and organizational routine. We then develop hypotheses. Next, we discuss the sample and how it is prepared. We, then, talk about measures, methods and analysis. Finally, we end with a discussion and conclude the paper with limitations.

### **Theory Organizational decline**

Organizational decline has been widely studied since the late 1970s (e.g. Argenti, 1976; Rubin, 1979; Whetten, 1980). Along with scholars of strategic management and organizational theory, scholars in the allied fields of accounting (Beaver, 1966, Ohlson, 1980) and finance (Altman, 1968; Altman, 1984) have also examined organizational decline. Within strategic management, two main theoretical perspectives that have been used to study organizational decline are: threat rigidity theory (Staw, Sandelands and Dutton, 1981) and the behavioral theory of a firm (Cyert and March, 1963). A third perspective, prospect theory (Kahneman and Tversky, 1979) addresses similar issues. These theoretical lenses predict and find evidence of different responses (adaptive or rigid) within declining firms.

Threat rigidity theory (Staw, Sandelands and Dutton, 1981) suggests that declining firms become rigid. Rigidity inhibits innovation (Cameron, Whetten and Kim, 1987),

strategic change (D'Aveni, 1989a), risky initiatives (Greenhalgh, 1983) and domain change (D'Aveni, 1989a). Hence, threat rigidity theory paints a conservative picture of declining firms.

### **Organizational routines and their modifications**

Organizations have been described as repositories of routines (Nelson and Winter, 1982). Here we define organizational routines as activities that require particular inputs and equipment, in order to produce a product or a service that involves particular inputs and equipment. Scientific and technological understanding guides the organizational routines (Nelson, 2009). Here, we adopt this definition because we do not directly observe the motivation of the multiple actors of the routine. Instead, we assume that behaviors are the consequences of mental models of the routine actors (Egidi in Cohen et al., 1996:686). We plan to consider the search routine as a black-box and examine its inputs and a few chosen characteristics. For the purpose of this study, we define a search routine as a dynamic routine that enables change in organizational routines (Dosi, Teece and Winter, 1992). A search routine involves a meta-routine (Adler, Goldoftas and Levine, 1999; Grant, 1996) that enables change in operating routines by suggesting alternative solutions that are improvements on the existing solutions (Cohendet and Llerena, 2003:275). This search is guided by “boundedly rational” organizational members (Cyert and March, 1963).

In discussing the potential for change in routines, Winter (1964:263) suggested that an organizational routine is a “pattern of behavior that is followed repeatedly, but is subject to change if conditions change”. Several empirical studies found that routines are not inert and typically change over time (Feldman, 2000; Feldman, 2003; Narduzzo, Rocco and Warglien, 2000; Pentland and Rueter, 1994; Adler, Goldoftas and Levine, 1999). Organizational routines change mainly through any of the following mechanisms: selection, learning and ad-hoc problem solving.

In this study, we focus on the debate of whether routines promote stability or change by proposing if and when firm decline is likely to change search routines. Ex ante, we may not know if the change is due to selection, learning, or ad hoc problem solving. Ex post, we will know that firms have failed, and therefore demonstrate adverse selection. Our research focuses on the firm's responses prior to the selection event (rigidity or learning), and the distinctions (or lack there-of) in responses observed in surviving firms.

### **Threat rigidity in failed firms and surviving firms**

Declining firms face the threat of failure and therefore, rely on its habituated ways of action and on existing organizational routines (Staw, Sandelands and Dutton, 1981). Under the conditions of impending bankruptcy, managers of declining firms reduce the number of alternatives considered. Such reduction in alternatives leads to restriction in information processing, and conservation of resources.

Prior scholars find evidence of the following three types of threat rigidity within declining organizations: (1) Restriction in information processing: by reducing newer paths of search and by sticking to existing ways of doing things, (2) Constriction of control: by increasing centralization within the organization, which in turn introduces hurdles for making changes if, when and where needed, and (3) Conservation of resources: cost cutting and

efforts to not increase spending in new developments (Sutton and D'Aunno, 1989). Each of these seems to suggest that search routines of declining firms will be less than those of surviving firms. Confirming their theory, D'Aunno and Sutton (1992) found evidence of threat rigidity in seventy two randomly selected drug abuse treatment organizations when these organizations faced financial adversity. They found that these declining organizations used existing procedures more rigidly and conserved their resources. Such rigid use of procedures led to restriction of information processing.

Many organizational decline studies seem to suggest that declining firms inhibit innovation and instead concentrate on efficiency improvement (Cameron, 1983; Hambrick and Schecter, 1983). Declining firms show signs of strategic paralysis (D'Aveni, 1989a) and maladaptation (Greenhalgh, 1983). They take few domain initiatives. For example: they engage in few mergers and acquisitions (D'Aveni, 1989a). They also downsize their operations by liquidations and divestitures (D'Aveni, 1989a). Cameron, Whetten and Kim (1987) found that declining organizations reduce their innovation and they resist change by rejecting new alternatives. They also found that declining organizations cater to short-term needs and avoid long-term planning. Perceived threats of failure lead managers of firms to be more conservative and to take more internally directed actions (Chattopadhyay, Glick and Huber, 2001). Managers of declining firms then act in domains in which their organizations have greatest control. Managers within declining firms try to stick to their well-learned responses and avoid change in their organizational routines. We can expect, then, that declining firms have fewer search routines when compared to surviving firms.

In sum, managers of declining firms stick to learned responses or reduce their organizational routines. Therefore, we offer the following hypothesis.

**Hypothesis 1:** The search routines of declining firms will be less than the search routines of surviving firms in each of the five years immediately preceding bankruptcy of failed firms.

### A threat rigidity perspective on the effect of time

According to the threat rigidity theory (Staw et al., 1981) declining firms perceive bankruptcy as a threat. Therefore, the closer in time to bankruptcy that the declining firms are, the greater is the threat of bankruptcy. Therefore, managers of declining firms are likely to respond differently with the passage of time towards bankruptcy.

A wide variety of prior scholars have found evidence of increased rigidity in declining firms (Mone, McKinley and Barker, 1998). Such firms usually resist any kind of change (Denrell and March, 2001). Managers of declining firms adopt weathering-the-storm strategies by sticking to prior responses and routines that worked well (Nystrom and Starbuck, 1984). Declining public organizations restricted domain definition (Bozeman and Slusher, 1979). Further, declining firms reduced their R&D search intensity (Johnson, 1996) when they came close to bankruptcy (Chen and Miller, 2007).

Deterioration increases over time in declining firms. Hambrick and D'Aveni (1992) found that the declining firms deteriorated at a non-linear, accelerating rate. They also found that declining firms have fewer top managers with core function expertise than surviving firms. They mainly measure deterioration in terms of top management characteristics of these firms. They found that such top management team deficiencies aggravate corporate deterioration. D'Aveni (1989b) found that over time declining firms worsen in terms of prestige, liquidity and leverage.

In keeping with the threat-rigidity perspective, we propose that the declining firms will decrease their search routines over the last five years prior to their bankruptcy filing.

**Hypothesis 2:** The search routines of declining firms will decrease from each year to the next in the last five years prior to bankruptcy filing.

### Preparing the sample

We used two distinct stages to prepare the final sample of firms that includes declining firms as well as surviving firms. In stage 1, we collected the set of bankrupt firms by using the following steps. First, we found out all bankruptcy filings (this includes both Chapter 11 and Chapter 7 filings) between January 1, 1980 and January 1, 2012 (the time of data collection). We chose this time period based on the specific laws and regulations related to bankruptcy in the US. We also chose this time period in order to get a sufficiently large sample size of bankrupt firms. The Bankruptcy Reform Act of 1978 went into effect on October 1, 1979. A majority of the provisions for Chapter 11 and Chapter 7 filings by organizations in the US court as incorporated in the 1978 Act continued under the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) of 2005. The 2005 Act heavily affected consumer (i.e. personal) bankruptcies (Altman and Hotchkiss, 2006). Therefore, this longer time frame is suitable for the purpose of our study where we consider US manufacturing firms that file for bankruptcy (Chapter 7 for liquidation and Chapter 11 for reorganization).

In addition, we included only publicly listed firms. This is for the convenience of collecting all financial data. Further, we included only firms that filed in the US bankruptcy courts as the bankruptcy laws differ from nation to nation. Additionally, we included firms that are large sized (i.e. have more than hundred employees). This allowed me to control for “the liability of smallness” which is one of the main reasons for firm failure. Also, we included only manufacturing firms. Finally, we tried to focus on a single industry. However, we did not get sufficient number of bankrupt firms for any of the four-digit SIC levels. Finally, we found a sufficient number of bankrupt firms in the Chemical and allied products industry (two-digit SIC of 2800). Out of the total number of bankrupt firms, we excluded firms that do not have publicly available financial data (10-K reports) for the six years prior to the year of bankruptcy filing. Additionally, we excluded firms that filed for bankruptcy a second time, a third time or a fourth time. Only one firm that filed for bankruptcy twice is Cobalis Corp. This firm was then removed from the final sample. Firms that file for bankruptcies multiple times may have traits that differ from firms that file for bankruptcy only once. Further, we excluded firms that filed for bankruptcy “intentionally”. Intentional bankruptcies are called “strategic bankruptcies” (Delaney, 1992). Eight strategic bankruptcies were identified. An example of a strategic bankruptcy is Ceragenix Pharmaceuticals, Inc. (that filed for bankruptcy in order to preserve its exclusive license agreement with a university). These strategic bankruptcies were identified by reading extensive comments and news item on each company around the time of bankruptcy filing from the bankruptcy database, Factiva and Thomson Reuters. Such news items typically mentioned why the firms filed for bankruptcy. Such firms can be the focal theme of a different research paper. For each of the included firms, we listed down the primary and the secondary NAICS and SIC codes.

After completing stage 1, we created the comparison sample of matched surviving firms by following these steps. First, for each bankrupt firm, we identified a single matched

surviving firm. In the fifth year before bankruptcy (i.e. for year  $t-5$  where  $t$  is the year of bankruptcy filing), we used the matching criteria of: (1) the same 4-digit SIC code, (2) the same product-market presence, (3) roughly the same sales volume as the bankrupt firm, and (4) firm size (measured by the total number of employees). These criteria are mainly based on prior studies on organizational decline that have used a matched pair design (Hambrick and D'Aveni, 1988; D'Aveni, 1989a; Daily, 1996; Daily and Dalton, 1994). In addition, we also ensured that financial data are available for each of these firms in available and established databases. For the matching process, we wrote a simple computer program in Microsoft Visual Basic 6.0 using a Microsoft Excel Macro (If requested, the authors can provide the detailed algorithm of this program). Finally, we arrived at the dataset that includes thirty six bankrupt firms and thirty six surviving firms in the US chemical and allied industry (SIC: 2800). This dataset includes data on each firm for each of the five years immediately preceding the bankruptcy filing by the bankrupt firms. In other words, the dataset includes data from  $t-5$  to  $t-1$  where  $t_0$  is the year of bankruptcy filing.

Many prior scholars have used a matched pair sample design (D'Aveni, 1990, Hambrick and D'Aveni, 1992, Daily and Dalton, 1994). The main advantage of such a matched pair design is that the sample provides controls for confounding factors, such as: industry conditions and positions of the firms within the industry (D'Aveni, 1989a). Also, in many cases, such as bankruptcy studies, it makes sense to use a matched pair sample design because bankruptcy is a rare phenomenon (Daily, 1996). The costs and availability of data prohibit large random samples in these cases (Zmijewski, 1984). One disadvantage of the matching design is that it involves sampling on the dependent variable (Berk, 1983 as cited in D'Aveni and MacMillan, 1990: 641). However, in this study, the matched pair design does not involve sampling on the dependent variable. Here, we are not predicting bankruptcy. The dependent variable in this study is the total research and development (R&D) spending of each firm. Therefore, in this study, the matched pair design allows to conveniently create two comparative groups for analyses: the group of bankrupt firms and the group of surviving firms that are similar.

## Measures

In this study, the dependent variable is: a natural logarithm of the research and development (R&D) expenditure of each firm in each of the five years in the sample. The independent variables in this study are: (1) firm type (bankrupt or survivor), and (2) time (measured by the number of years before bankruptcy).

For the first independent variable: firm type, we used a categorical variable that acts as an indicator of the firm type. It takes a value of 1 if the firm is a survivor. And, it takes a value of 0 if the firm is a bankrupt. We measured the second independent variable, time by using a dummy variable for four of the five years ( $t-5$  to  $t-2$  where  $t_0$  is the year of bankruptcy filing) included in the dataset. And, we created the following dummy variables: (1) a dummy variable for year  $t-5$  where  $t$  is the year of bankruptcy filing. This variable takes a value of 1 when the year is  $t-5$ . For all other years, it takes a value of 0; (2) a dummy variable for year  $t-4$ ; (3) a dummy variable for year  $t-3$ ; and a (4) a dummy variable for year  $t-2$ .

## **Methods**

Hypothesis 1 proposes that the R&D expenditure of declining firms will be less than the R&D expenditure of matched surviving firms in each of the five years immediately preceding bankruptcy of declining firms. In order to empirically examine these two hypotheses, for each of the years: t-5, t-4, t-3, t-2 and t-1, we conducted t-tests to check for the differences in the mean values of: R&D expenditure. We used the Stata 12 command ttest [var], by(firm type) unequal. Here firm type is of two categories: (1) bankrupts, and (2) survivors. We used the unequal option because the two groups of firms: bankrupts and survivors have unequal variances of R&D expenditure.

Hypothesis 2 proposes that the R&D expenditure of declining firms will decrease from each year to the next in the last five years prior to bankruptcy filing. In order to empirically examine these two hypotheses, we conducted two-sample t-tests only for bankrupt firms comparing the mean R&D expenditure of two consecutive years. There are four sets of comparisons involved here: (1) the mean R&D expenditure of bankrupt firms in the year t-5 versus the mean R&D expenditure of bankrupt firms in the year t-4, (2) the mean R&D expenditure of bankrupt firms in the year t-4 versus the mean R&D expenditure of bankrupt firms in the year t-3, (3) the mean R&D expenditure of bankrupt firms in the year t-3 versus the mean R&D expenditure of bankrupt firms in the year t-2, and (4) the mean R&D expenditure of bankrupt firms in the year t-2 versus the mean R&D expenditure of bankrupt firms in the year t-1. In addition to these, we also conducted exploratory analyses to empirically examine the effect of time to bankruptcy on the search routines of declining firms versus the search routines of surviving firms. We conducted regression analyses using mixed models on panel data using the xtmixed command in Stata 12. In this model, time (i.e. t-5, t-4 t-3, t-2 and t-1) is treated as an independent categorical variable. We used the raw values of R&D expenditure as the dependent variable. We then computed the predicted mean of R&D expenditure for each calendar year. Next, we tested for the overall null hypothesis that the average R&D expenditure is not the same across all years. We tested this using the contrast [variable] command in Stata 12. We also conducted tests of year-to-year comparison of the average predicted R&D expenditure using the contrast ar.[variable name] command in Stata 12.

## **Analyses**

Based on the threat rigidity perspective (Staw et al., 1981), Hypothesis 1 proposes that the research and development (R&D) expenditure of declining firms will be less than the research and development expenditure of surviving firms in each of the five years immediately preceding bankruptcy of declining firms. The results of the two sample t-tests with unequal variances indicate that in all the five years considered here (from t-5 to t-1), bankrupt firms have lower amounts of R&D expenditure than their corresponding surviving firms (Refer: Table 1). However, for the years t-5, t-4 and t-3, this difference is weakly statistically significant (i.e. significant only at the 10% level). For the years, t-2 and t-1, this difference is strongly statistically significant (i.e. significant at the 5% level). Therefore, Hypothesis 1 is supported.

-----Insert Table 1-----

Hypothesis 2 proposes that as per the threat rigidity theory perspective (Staw et al. 1981), the R&D expenditure of declining firms will decrease from each year to the next in the last five years prior to bankruptcy filing. The results of the t-tests indicate that the averages of R&D expenditure of bankrupt firms do not statistically significantly differ from each other in the consecutive years (Refer: Table 2). In other words, the average R&D expenditure of bankrupt firms in the year t-5 does not statistically significantly differ from the average R&D expenditure of bankrupt firms in the year t-4. Again, the average R&D expenditure of bankrupt firms in the year t-4 does not statistically significantly differ from the average R&D expenditure of bankrupt firms in the year t-3. Similarly, the average R&D expenditure of bankrupt firms in the year t-3 does not statistically significantly differ from the average R&D expenditure of bankrupt firms in the year t-2. Finally, the average R&D expenditure of bankrupt firms in the year t-2 does not statistically significantly differ from the average R&D expenditure of bankrupt firms in the year t-1. These results indicate no support for Hypothesis 2.

-----Insert Table 2-----

### **Discussion and Conclusion**

The results of this study indicate support for the threat rigidity perspective (Staw et al., 1981). In each of the two years prior to bankruptcy, declining firms engage in less search than their matched surviving counterparts. Therefore, in declining firms in the US Chemical and Allied Products industry, declining firms exhibit threat rigidity when compared with other similar firms that survive. Interestingly, all the firms in the sample dataset of this study belong to mature industries at the four-digit SIC code level. The results of this study also indicate that there are no changes in search routines in declining firms over the five years immediately preceding bankruptcy. This no change is again evidence of rigidity within the declining firms. However, it is interesting to note that all the firms in the sample dataset of this study are publicly-listed firms. Therefore, the declining firms in this sample pay heed to shareholders. Institutional shareholders among the many shareholders that these firms have are often found to focus on short-term goals at the cost of long-term goals such as investing in search routines (Wu, 2012). This may be one of the reasons why the declining firms in this sample do not increase their search routine activities.

What is interesting about these findings is the fact that the focal routines that we study here, search routines, are dynamic (Dosi, Teece and Winter, 1992). These routines themselves change often and they also bring change in other operating routines (Nelson and Winter, 1982). However, the results of this study indicate that the search routines of the declining firms do not change over the last five years before bankruptcy. Therefore, the dynamic routines that are supposed to be dynamic are showing indications of being static. The results of this study indicate that the search routines of declining firms are smaller than those in surviving firms. However, the search routines of declining firms do not shrink as time progresses towards bankruptcy. This is good news in one sense that decline conditions do not indicate continued deteriorations of search routines within the declining firms. This is again surprising because prior scholars (Hambrick and D'Aveni, 1988; Hambrick and D'Aveni, 1992) have found that declining firms are associated with accelerating deteriorations in many aspects, such as, the top management team, unused borrowing capacity, resource conditions and profitability conditions. However, this study's results do not find any continued deterioration of search routines within declining firms. Also, many organizational routine scholars have found evidence of changes in routines (including search

routines) with respect to time pressures (Betsch et al., 1998; Lehman, Hahn, Ramanujam and Alge, 2011). However, the time to bankruptcy did not affect the declining firms in this sample dataset in any significant way. This finding suggests that these firms do not sense threat. When rigidity does occur, it might be because the firm lacks resources to correct problems, or the firm management lacks the ability to perceive or correct the problems. These causes, though, are quite different than threat, and deserve further consideration.

Overall, this study contributes to the understanding of organizational decline and organizational routines. It contributes to the current literature on organizational decline by suggesting that it is important to examine organizational routines within the context of declining firms. The results of this study seem to hint at the fact that declining firms in a mature industry like the US Chemical and allied products industry are likely to be rigid. The results further suggest that large publicly listed firms are likely to be rigid. Also, this study questions the dominant assumption in the decline literature that decline is associated with deteriorating conditions within the firm. There is a lack of evidence of deterioration of search routines over time in this sample of firms. Finally, the concept that threat becomes larger as time to bankruptcy approaches thereby leading to accelerating deteriorations within declining firms is also to be questioned. This study's results find that the time to bankruptcy do not affect the search routines of declining firms.

This study contributes to the literature on organizational routines by suggesting that dynamic routines that are expected to be changing often can also be unchanging. The search routines examined here do not change within declining firms in the five years immediately preceding bankruptcy. Again, this study seems to question the dominant wisdom in the routines literature that routine shrinkage is a mandatory response to failure (Nelson and Winter, 1982). However, even under conditions of decline, the firms in this sample do not exhibit routine shrinkage.

## **Limitations and future research**

The main limitation of this study is that the major part of the work is based on publicly available secondary data. Therefore, this study cannot explicitly identify all the probable reasons of the resulting differences in search routines between declining firms and surviving firms. Such secondary data examination limits the possibility of rich and fine grained analysis (Becker, Lazaric, Nelson and Winter, 2005). In the future, researchers can compare and contrast the differences in search routines of publicly listed firms and private firms to examine whether one set of firms promotes rigidity while another set of firms promotes adaptive change.

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**Table 1. Two-sample t-tests with unequal variances on the variable of interest: R&D expenditure as tests for Hypothesis 1**

Variable: R&D expenditure in US dollars		t-5			t-4			t-3			t-2			t-1		
Group		Obs	Mean	Std. Dev.												
bankrupt		34	13600000.00	18400000.00	36	12700000.00	16800000.00	35	12900000.00	17500000.00	31	12300000.00	18000000.00	24	14800000.00	21100000.00
			(3156815.00)			(2792273.00)			(2958043.00)			(3232361.00)			(4304809.00)	
survivor		35	111000000.00	361000000.00	35	117000000.00	385000000.00	35	115000000.00	363000000.00	35	115000000.00	346000000.00	35	120000000.00	360000000.00
			(61100000.00)			(65000000.00)			(61400000.00)			(58400000.00)			(60800000.00)	
combined		69	62800000.00	260000000.00	71	64300000.00	274000000.00	70	63900000.00	260000000.00	66	66500000.00	256000000.00	59	77500000.00	281000000.00
			(31300000.00)			(32500000.00)			(31100000.00)			(31500000.00)			(36500000.00)	
difference			-96900000.00			-105000000.00			-102000000.00			-102000000.00			-106000000.00	
			(61100000.00)			(65100000.00)			(61500000.00)			(58500000.00)			(60900000.00)	
t-value			-1.58			-1.61			-1.66			-1.75			-1.73	
Satterthwaite's degrees of freedom		34			34			34			34			34		
p-value for Ha: mean(bankrupt) < mean(survivor)			0.06 †			0.06 †			0.05 †			0.04 **			0.05 **	
p-value for Ha: mean(bankrupt)!= mean(survivor)			0.12			0.12			0.11			0.09 †			0.09 †	
p-value for Ha: mean(bankrupt) > mean(survivor)			0.94			0.94			0.95			0.96			0.95	
Standard errors are within parentheses just below each mean																
† p-value < 0.1																
** p-value < 0.05																
*** p-value < 0.001																

**Table 2. Results of two-sample t-tests with unequal variances on the variable of interest: Research and development expenses as test of Hypothesis 2**

Variable: R&D expenditure in US dollars	t-4 to t-5				t-3 to t-4				t-2 to t-3				t-1 to t-2			
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs
Group																
Group 1 (succeeding year i.e. in the case of t-4 to t-5 comparison, Group 1 is t-4)	36	12700000.00	16800000.00	35	12900000.00	17500000.00	31	12300000.00	18000000.00	24	14800000.00	21100000.00				
		(2792273.00)			(2958043.00)			(3232361.00)			(4304809.00)					
Group 2 (preceding year i.e. in the case of t-4 to t-5 comparison, Group 2 is t-5)	34	13600000.00	18400000.00	36	12700000.00	16800000.00	35	12900000.00	17500000.00	31	12300000.00	18000000.00				
		(3156815.00)			(2792273.00)			(2958043.00)			(3232361.00)					
combined	70	13100000.00	17500000.00	71	12800000.00	17000000.00	66	12600000.00	17600000.00	55	13400000.00	19300000.00				
		(2086188.00)			(2017878.00)			(2166444.00)			(2597210.00)					
difference		-950801.70			173391.30			-590022.20			2550897.00					
		(4214530.00)			(4067776.00)			(4381573.00)			(5383265.00)					
t-value		-0.23			0.04			-0.13			0.47					
Satterthwaite's degrees of freedom		66.47			68.64			62.57			45.22					
p-value for Ha: mean(Group 1) < mean(Group 2)		0.41			0.52			0.45			0.68					
p-value for Ha: mean(Group 1) != mean(Group 2)		0.82			0.97			0.89			0.64					
p-value for Ha: mean(Group 1) > mean(Group 2)		0.59			0.48			0.55			0.32					
Standard errors are within parentheses just below each mean																
† p-value < 0.1																
** p-value < 0.05																
*** p-value < 0.001																