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R&D Investment that enhances IT Firm Survival  
*Work in Progress*

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**ABSTRACT**

IT industry is a research-intensive industry. IT firms focus on advanced research activities to stay relevant. Their survival depends on value creations from innovations based on the research. Source of fund to these innovation-related activities are commonly expressed in terms of R&D investment. However, this investment is not the direct indicator of innovation outcomes. Research and development (R&D) investment can be used as a tool to mitigate the risk. Interestingly, the investment does not directly suggest innovation outcomes. Researchers and practitioners have classified R&D investment as a risky investment because the return on investment often mismatch the cost of investment (Xin & Choudhary, 2019). Yet, research-intensive firms are aggressively investing in R&D because R&D investments generally have positive effect on firms’ performance (Kuo, Wu, & Lin, 2019).

Given the intensity and the general effects of R&D investment, several IT firms did not survive the competition. One may argue that failures of these firms could be function of risks introduced by R&D investments. Other may suggest that factors are numerous related to firm’s demise including but not limited to strategic misdirection, disruption by certain technology, or internal mismanagement. This study seeks to clarify the linkage, if there is any, between R&D investment behavior and firm survival. Therefore, the first research question is posted.

**RQ1:** Is general R&D investment behavior significantly contribute to IT firm survival?

Like others, IT firms are facing uncertainties. These uncertainties present risks to the firms. Innovation-related competitive risk is among uncertainties that may adversely affect future of any IT firm. R&D investment could be a tool to mitigate this risk. However, the investment may introduce additional risks to the firm because successful innovation is ex post phenomenon. Innovation is invented and is exploited by the firm. Then, success of the exploitation could be materialized. These arguments present dilemma to the management team regarding the R&D investment. This study aims to understand relationships between R&D investment and innovation-related competitive risk in the context of firm’s survivability. This discussion points to the second research question.

**RQ2:** How do innovation-related competitive risks contribute to R&D investment behavior in the context of survived and of not-survived IT firms?

Two research questions are posted. This study proceeds with hypothesis building, data collection, and hypothesis testing respectively. Finally, it reports findings and makes a conclusion to the research questions.

**HYPOTHESIS BUILDING**

This study formulates hypothesis to address RQ1 by reviewing literature and connecting dots between R&D investment and firm survival. The literature suggests a chain of events below.

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**Keywords:** IT industry, R&D investment, Competitive risk mitigation.
Investment R&D commonly initiates by top management. Custódio, Ferreira, & Matos (2019) discover certain top executive can lead firm to higher innovation outputs. One reason for their successes is their skill to balance risk and opportunity across R&D initiatives. However, having more innovations does not directly connect to firm’s survival. Case-study in highly innovative firms by Urbina et al. (2019) highlights the importance of opportunity recognition and product value creation connecting innovation to survival. Even then, to survive the competitive is still not an easy mission. Opportunity in the market itself can be a source of firm’s misfortune. Khanagha et al. (2018) reveals that innovation-to-market process in technology-driven firm is complex with multi-dimensions and potentially conflicting priorities. Market demand heterogeneity is the source of this complexity. Firm counters this heterogeneity by modifying innovation process to accommodate variety of technological advances. However, this modification causes unintended consequence. Firm’s product portfolio is weakened because innovations are simultaneously pushed forward in multiple directions. As a result, firm cannot sustain competition under high market heterogeneity.

Given this chain of events, the failure of decision-maker at any point cannot be known ex ante. Executive may successfully encourage a wide range of innovations but few of them were commercially viable. Hence, failure of a firm cannot be predicted ex ante by R&D investment decision. Failure to R&D investment is ex post. This study expects not-survived firms to behave during their “alive” periods very similar to their survived counterparts. Taking current discussion and RQ1 into account, H1 is proposed.

H1: R&D investment behavior is similar between survived and not-survived IT firms.

Based on RQ2, this study recognizes differences between survived and not-survived states of firms and proposes two hypotheses for each state. Competitive risk is not having access to critical resources to satisfy competitive requirements (George, Wiklund, & Zahra, 2005). Therefore, innovation-related competitive risk is the missing of essential innovations to sustain firm’s competitiveness. When risk is severe, its effect can be devastated to the firm. Consistently exposed to severe competitive risks is the threat to firm survival. In context of this study, IT firm failed to delivery competitive values from innovations for a period may not survive. Risk mitigation is to prepare organization for potential threats. This study makes distinction between R&D project risk mitigation and competitive risk mitigation based on R&D investment. The former is to enhance success rate of the project. This type of mitigation, however, does not directly mitigate competitive risk (Calof & Smith, 2010). The latter is to enhance survivability of the firm. Executives in high technology firms are better incentivized to undertake risk mitigation executions rather than to exercise risk aversions (Makri, Lane, & Gomez-Mejia, 2006). Absent of risk taking hinders firm’s performance. While moderate risk taking enhances the performance. If R&D investment were the risk mitigation mechanism for survived firms, observed innovation-related risks should positively correlate with R&D investment. The more risks are observed, the better the risk mitigation can be initiated by executive. Therefore, survived firm’s executives increase the firm’s R&D investment. Hypothesis 2a is proposed.

H2a: Innovation-related competitive risks positively affect R&D investment behavior in survived IT firms.

R&D is an important part of innovation process. Investment in R&D creates core innovation capability. According to Pérez et al. (2019), this capability creates positive feedback loop for greater innovations in successful firms but produces no effect for unsuccessful firms. A reason of the ineffectiveness is ‘competency trap’. Levitt and March (1988) notes that this trap is when firm keeps doing the same activities, experiencing diminishing returns of its performance. R&D activity is carried out, but it does not produce desired outcomes. R&D investment indirectly measures innovation. It provides input to innovation activities but is not direct indicator of innovation outcome. Nonetheless, R&D investment can be interpreted as firm’s willingness to innovate (Dziallas & Blind, 2019). Furthermore, innovations from R&D activity is not easily judged for their competitive worthiness because of their high degree of relatedness to the business (Qian et al., 2017). Risk is commonly associated with innovation (Keizer & Halman, 2007). This risk is based on incomplete information and bounded rationality during decision making process (Goes & Park, 1997). This discussion suggests that executives in not-survived firm may keep investing in R&D but fail to realize influences of competitive risks based on innovation. Therefore, hypothesis 2b is proposed.

H2b: Innovation-related competitive risks do not affect R&D investment behavior in not-survived IT firms

METHODOLOGY

Controls
This study controls for firm size and for changes in operating expenses. The effects of uncertainty are not similar across firm sizes (Doshi, Kumar, & Yerramilli, 2018). Larger firms differently behave from smaller firms do when they face quite similar risks. Firm size, therefore, must be controlled. Furthermore, operating expenses indicate over-all firm day-to-day operations. Changing in this expense could signify change in strategic direction of the firm (Ramaswamy, 1997). Controlling for this change is to normalize effects of any change in the direction.
Measures
This study measures the R&D investment behavior by year-to-year growth rate of the R&D expenditure in percentage. Changes in firm operating expenses are captured in percentage terms of year-to-year growth rate of the operational expenditure, excluding R&D expenditure. Size of a firm is measured by its natural logarithm of sales.

The innovation-related competitive risk is defined in terms of degree of innovation-related threats recognized by firm in its annual report. It is measured in percentage of number of sentences with innovation-related word over number of all sentences in item 1a risk factors section of firm’s 10-K annual report. The extraction of the numbers of sentences is done by a custom-built python program with the help of Natural Language Tool Kit (NLTK) package version 3.4.5. Sentences are identified using PunktSentenceTokenizer routine in nltk.tokenize.punkt library. The following terms are used to identify innovation-related threats: innovation, technology, creativity, creative, research, development, new, and patent. This study carried out synonymization of the terms using the synsets routine in nltk.corpus.wordnet library before identification of sentences. The pipeline to obtain the innovation-related risk is visualized in figure 1.

Data collection
This study carried out a cross-section research design. Data record format is in firm-year. Annual financial data of IT firms was collected from Compustat-North America database. IT firms are identified by NAICS industry code 51. Data is extracted between January 2008 and June 2019. The extraction is filtered by R&D expenditure more than zero and CIK (i.e., Central Index Key) is not empty. The extraction yielded 826 firms with 4,544 firm-year records in both active and inactive firms.

Annual reports form 10-K during the data extraction period of the 826 firms were downloaded from EDGAR system of U.S. security and exchange commission. Two thousand eight hundred eighty-two firm-year reports were successfully downloaded, which is equal to 63.4% of firm-year records from Compustat database. The reason for unsuccessful download is that the 10-K reports of those firm-year were not presented on the EDGAR system.

Item 1a risk factors of each report are extracted using a custom-build pattern recognition program. The program successful extracted 2,517 firm-years (87% of downloaded 10-K reports). Examination of the unsuccessful extractions reveals two major reasons. First, for the majority, the item 1a was omitted form the reports. Second, the programs failed to recognized patterns due to unusual report layout.

The calculation of year-to-year grown in R&D investment behavior and in normal operation behaviors are performed on the 2,517 firm-years. Growths of 315 firm-years could not be calculated because of the missing data in prior years. This brings valid data down to 2,202 firm-years. There are 84 firm-years with year-to-year growth of R&D investment more than 100%. These records are removed because they unduly influence the distribution of the variable. The negative-growth is theoretically limited to only -100%. Therefore, positive-growth is administratively limited to 100%. Following the same argument, twenty-two firm-years are removed because year-to-year growth of normal operation expenditure are more than 100%. Examining sale figures reveals 9 firm-years with zero dollar reported. These nine firm-years are removed because natural logarithm of sales calculation cannot be performed. A total of 430 firm-years is removed from the 2,517 firm-years, which is amount to 17%. Therefore, eighty-three percent (83%) or two-thousand eighty-seven (2,087) firm-years are left for hypothesis testing.

This study makes distinction between two groups of IT firms: survived and not-survived. The survived firms are identified by the active status in the Compustat database. While, the inactive status indicates not-survived IT firms. Inactive status in the database is a result of firm’s bankruptcy or liquidation (Swift, 2016).

Hypothesis Testing
Descriptive statistics of both survived and not-survived IT firms are in table 1 and table 2 respectively. Skewness and kurtosis statistics are mostly within the recommended boundaries -2 and +2. There are few instances where kurtosis statistics are over the boundary. Nonetheless, these statistics indicate that the variables are largely normally distributed.
This study seeks to uncover relationships between R&D investment and innovation-related risk of IT firms. It focuses on the investment behavior of survived and not-survived IT firm when innovation-related competitive risk is considered. Two research questions are posted, and three hypotheses are formulated from the literature. A cross-sectional dataset is collected from Compustat database and from 10K annual reports. The data consists of two-thousand eighty-seven IT firm-years and is used to test hypotheses. Statistical results reveal the following.

1. There is no difference in terms of R&D investment growth rate between survived and not-survived IT firms.
2. Innovation-related competitive risk has positive effect on R&D investment growth rate of survived IT firm.
3. Innovation-related competitive risk has no effect on R&D investment growth rate of not-survived IT firm.

DISCUSSION

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Above findings shed lights on the two research questions. The first question, is general R&D investment behavior significantly contribute to IT firm survival? The findings reveal no ex post difference between the two types of IT firms. The implication is that IT firms could not ex ante predict that their R&D investment behaviors would either make or not make them stay on the competition. Executive of IT firms should not expect R&D investment as the silver bullet that increases chances of firm’s survival. This finding agrees with a recent investigation on innovation value chain by Chen, Liu & Zhu (2018). They find that commercialization process is significant in the making of successful innovation, which is responsible for superior return on R&D investment and for firm’s bottom line.

The second research question, how do innovation-related competitive risks contribute R&D investment behavior in the context of survived and of not-survived IT firms? Testing of hypothesis 2a and hypothesis 2b suggest that the risks have positive effects on R&D investment of survived firms but no effects on that of not-survived firms. Yoon et al. (2020) recently reveal that R&D investment involve product’s quality that leads to customers’ satisfaction should be given higher priority. Their finding suggests a specific area of competitive risks where executive must emphasize. Future research could help reveal more specific areas. Nonetheless, this discussion is a note to any IT executive. The executive must be able to connect competitive risks in these areas to actual R&D investment in order to survive competition. Connecting competitive risks with R&D investment advances an argument by Bromiley, Rau, & Zhang (2017) that R&D investment cannot be used as indicator of risk-taking investment. This study suggests that R&D investment is considerably a risk mitigation investment by making firm better handling innovation-related uncertainties.

Literature reviewer earlier suggests a chain connecting R&D investment to firms’ survival as depicted here again.

![Diagram](image)

Insights form this study shed light that the “exploitation to gain competitive edge” could be explicatied in terms of “mitigating innovation-related risks”. Therefore, a refined chain of events is depicted as the following.

![Diagram](image)

CoVID-19 pandemic increase business uncertainty. However, several IT firms have demonstrated their resilience during the pandemic. These firms are well-positioned with products and services, which support social distancing activities. However, these firms cannot rest on their laurels because the new-normal world has yet established. Innovation must move forward. IT firm should not irrationalily follow a paradigm that increasing R&D investment somehow equate to increasing chances to survive. This study finds no such relationship. This insight is particularly relevant in post pandemic world. The resources are sacred because the prolonged and reduced economic activities. Any investment must be made carefully. To survive, IT firm should focus and prioritize its R&D investment on areas where innovation-related competitive risk is expected, particularly in the area where customer satisfaction is involved. Investing in R&D to reduce competitive risks is effectively increasing chances of the firm’s survival.

REFERENCES


