Impact of Organizational Slack on Innovation Outcomes

John Hill
Abram Walton, Ph.D.
1Nathan M. Bisk College of Business, Florida Institute of Technology
Johnhill1@gmail.com; awalton@fit.edu

Abstract

This research analyzes the relationship between the impact of organizational slack on patent productivity as a proxy for innovation and the resulting firm performance by longitudinally investigating 114 U.S. firms. The role of slack as a moderated measure of innovation was also explored, with its impact on technology and non-technology industry firms compared. In study one, the evidence concluded that slack is positively correlated with innovation productivity, but the company type was not statistically significant. In addition, the study did not find an inversion in the relationship between slack and innovation that would produce a negative correlation as the level of slack in firms reaches a tipping point. Study two demonstrated a positively correlated relationship between the rate of innovation and firm growth. The presence of slack positively moderates this relationship, and this moderation effect increases for technology companies.

1. Introduction

While definitive research has been conducted on the positive relationship between slack and innovation (Singh, 1986; Damanpour, 1987; Marlin & Geiger, 2015), there remain some studies (Nohria & Gulati, 1996; Geiger & Cashen, 2002) that indicate there is an inverted-U type relationship between slack and innovation. When slack and innovation exist at lower levels in the firm, their relationship is positive. However, as the level of slack in a firm increases, a point of diminishing returns is created. Eventually, a tipping point is reached where increases in slack decrease the amount of innovation in the firm. However, these studies used R&D intensity (Nohria & Gulati, 1996; Geiger & Cashen, 2002) to measure innovation which is defined as R&D expense divided by total sales. As a result, these studies reflect merely an inverted U-shaped relationship between innovation effort and slack. This research will seek to test the relationship between slack and innovation using patents, instead of R&D intensity, as the measure of innovation to evaluate if evidence of the supposed curvilinear relationship exists. It is expected that this inverted U-shape relationship will not be present, and instead, a positive correlation between patent productivity and slack will exist.

Much of the research into the relationship between innovation and firm performance has been focused on profitability-type measures. A meta-analysis of 66 studies by Daniel et al. (2004) demonstrated a positive effect of slack on ROA, ROE, or ROI, while none of the studies cited measured the impact on firm growth. The relationship between innovation and firm growth has not received the same level of inquiry and has mixed results, although much of the research indicates a positive correlation between innovation and firm growth (Crepon et al., 1998; Coad, 2009; Ortega-Argiles et al., 2011). However, no study has
been conducted to determine the role of slack in moderating the relationship between innovation and firm growth.

This research set out to re-examine the relationship between slack and patent productivity as a proxy for innovation and to understand the potential as a moderator between innovation and firm growth. The two studies in this research involved a longitudinal analysis of 114 U.S.-based firms that were granted 40 or more patents per year over five years. A further decision was made to analyze the differences between technology firms and non-technology firms across the research questions. Thus, the research aimed to investigate the following hypotheses:

- **H1**: The level of available and recoverable slack in a firm is positively correlated with innovation productivity.
  - **H1a**: Being a technology company increases this correlation
  - **H1b**: There is a positive relationship between slack and innovation
- **H2**: Increases in the rate of innovation productivity within a firm are positively correlated with changes in revenue.
  - **H2a**: Being a technology company increases this correlation
- **H3**: Available slack positively moderates the relationship between innovation rate changes and revenue changes.
  - **H3a**: Being a technology company increases this correlation

### 2. Literature Review

#### 2.1 Innovation and Slack

There have been varying approaches to the definition and measurement of innovation in a firm. One popular method uses R&D intensity as the dependent variable (Hansen & Hill, 1991; Hitt et al., 1996; Hitt et al., 1997; Geiger & Cashen, 2002). However, R&D intensity is simply a measure of the innovation effort, as it reflects the sum of firm expenditures on research and development activities, whereas innovation is better thought of as an output of the efforts of teams and individuals (International Standards Organization, 2020). Other research has used patent quality (Heroold et al., 2006) or product count (Sorescu & Spanjol, 2008) as the dependent variable, but issues remain with these measures as well. Patent quality does not reflect all innovation even within the patent space as it focuses only on patents receiving citations in research. Product count is a problematic proxy for innovation as it only captures new product launches and misses out on expansions to current products that have benefited from innovation, the improvements of which often consume the majority of R&D investments. Finally, another proxy for innovation is the use of patent counts (Acs & Audretsch 1989; Acs et al., 2002). While one could argue that not all patents are worthwhile and that not all innovations are patented, patents do represent a solid proxy of innovation outputs (International Standards Organization, 2019 & 2020), particularly for technology companies.

A firm’s ability to innovate can be adversely impacted due to its resources being fully allocated to operational tasks or other firm initiatives (Voss et al., 2008). The complete absorption of resources in a firm can create an obstacle for firms when they need to react to changing market conditions or innovation opportunities. To enable this adaptive capability, the firm is faced with the need to create slack. Bourgeois defines slack as “that cushion of actual or potential resources which allows an organization to adapt successfully to internal pressures for adjustment or to external pressures for change in policy, as well as to invite changes in strategy with respect to the external environment” (1981, p 30). Another definition of slack defines it as the excess delta between what resources a firm needs to meet a specific objective and those available to them (Geiger & Cashen, 2002). A key characteristic of slack is that it provides the firm a level of discretion on the utilization of the resources and still meets the desired outcomes (Cheng
The creation of slack within a firm can be achieved in several ways; executives can achieve slack by bundling their resources (Sirmon et al., 2011) or deliberately creating a buffer or cancellation of planned activities (Voss et al., 2008).

Slack can be broken down into several types defined by the degree that slack is immediately available. The three types of slack range from those that are readily available (or unabsorbed slack), recoverable (or absorbed slack), and potential slack (Bourgeois, 1981; Cheng & Kesner, 1997; Palmer & Wiseman, 1999; Geiger & Cashman, 2002). Available slack, or unabsorbed slack, refers to resources readily available to the firm but not deployed. Recoverable slack, or absorbed slack, refers to those resources currently deployed within the firm but which could be cut to create financial capacity for the firm in the event of financial distress (Bourgeois & Singh, 1983). It is expected that available and recoverable slack is expected to impact innovation productivity rates given their more immediately deployable (or repurposable) nature. However, for the moderating impact between innovation and firm performance, only available slack is expected to have an impact as the slack must be immediately available during the year. To measure these constructs of slack various firm financial ratios can be utilized, such as the quick ratio as a proxy for available slack, the ratio of general and administrative expense to sales as a proxy for recoverable slack, and the firm’s debt to equity ratio as a proxy for potential slack (Bourgeois, 1981; Cheng & Kesner, 1997; Palmer & Wiseman, 1999; Geiger & Cashman, 2002).

The role of slack in improving innovation outcomes has received significant research attention. Firms can use slack as a method of driving experimentation and innovation (Levinthal & March 1981). An organization can pursue innovation opportunities as the existence of slack protects the organization from adverse impacts from those innovation endeavors (Bourgeois, 1981). However, the correlation between slack and innovation outcomes has produced mixed innovation results. Slack was demonstrated to positively affect innovation in several empirical studies (Damanpour, 1987; Singh, 1986), while inconclusive in determining innovation in others (Zajac, Golden, & Shortell, 1991).

There are contrarian views of slack, and some researchers have argued that its existence is a measure of managerial incompetence (Leibenstein, 1969), a driver of managerial risk-taking (Palmer & Wiseman, 1999), or a precursor to wasteful spending on ill-conceived R&D efforts (Jensen, 1993). There is even an argument that excess slack can lead to poor oversight on portfolio management (Jensen, 1993, Leibenstein, 1969). Low levels of slack can result in firms embarking on riskier paths (Bromiley, 1991; Wiseman and Bromiley, 1996; Palmer & Wiseman, 1999). Several empirical studies indicate that slack and innovation have an inverted U-shaped relationship (Nohria & Gulati, 1996; Geiger & Cashen, 2002), such that too little slack discourages innovation, while too much slack breeds complacency and, as a result, increases the risk of poor projects being pursued; Tan and Peng (2003) found a similar relationship between slack and firm performance.

2.2 Innovation and Firm Growth

The relationship between innovation and firm growth has generally been found to be a positive one (Crepon et al., 1998; Coad, 2009; Ortega-Argeles et al., 2011). However, some research has found that the positive relationship between innovation and firm growth is primarily concentrated in fast-growing firms (Coad & Rao, 2008). Further research has suggested that firm characteristics such as size and approach to patenting are key to the relationship between innovation and firm growth (Demirel & Mazzucato, 2012).

2.3 Slack as a Modifier between Innovation and Firm Growth

The creation of innovative products or services by a firm must be commercialized to extract value. It is expected that the ability to commercialize an opportunity quickly is moderated by the ability of the firm
to pivot and re-align resources. The use of slack resources can be instrumental in providing an opportunity for the firm to react to contingencies or to drive institutional change or innovation (Chandy & Tellis, 1998; Gatignon & Xuereb, 1997). Slack’s specific role in commercialization processes has also been explored. For example, Danneels (2008) demonstrated that slack was vital in building second-order marketing competencies. The presence of slack gives firm management the capacity to react to constraints and redirect lower-order resources to create the higher-order capabilities that are necessary to drive the implementation of a new product or service. The firm must create slack to respond to changes in project priorities and market conditions effectively.

3. Methodology & Results

This research consists of two studies that utilize that same data set of U.S.-based companies on the NASDAQ or NYSE with 40 or more patents each year from 2015 to 2019; excluding those in the medical field. Firms in the medical industry suffer from exceptionally long cycle times on their patent-based innovations, and including those firms would have required a substantially longer longitudinal study-time period, while their results would have been statistically incompatible with firms with shorter patent cycles. While 124 firms met the threshold of >40 patents, which was ultimately reduced to 114 firms after adjusting for mergers and companies that were not publicly traded for all five years. Of the 114 firms, 71 of them were classified as technology firms and 43 as non-technology firms. A technology firm was defined as a firm whose primary business was software development, social networks, telecommunications, I.T. hardware development, I.T. services, or I.T. component-level manufacturing. The patent information was collected from the United States Patent Office website (USPTO, 2021a), and the financial information from the companies’ income and balance sheets was retrieved from Yahoo Finance.

3.1 Study One: Relationship Between Slack and Innovation Productivity

Study one is focused on the relationship between slack and innovation, with:

- **H1**: The level of available and recoverable slack in a firm is positively correlated with innovation productivity.
  - **H1a**: Being a technology company increases this correlation
  - **H1b**: There is a positive relationship between slack and innovation

The dependent variable is patent productivity, which is defined as the number of patents granted per $1B in revenue. The independent variables are the lagged measures of available slack and recoverable slack. The lag was done on a two-year basis as the average time total pendency time is 22.9 months from the time it is filed with U.S. Patent Office (USPTO, 2021b). Total pendency time is defined as the average time from filing to grant or abandonment by the USPTO. Given the difficulty in assigning the variables precisely to a time period, an average over the three years of 2017 to 2019 was used for each of the dependent and independent variables. A quadratic version of the independent variables was used to test the curvilinear relationship. The control variable is the type of company, as either technology or non-technology.

Linear regression was used to predict the impact of available and recoverable slack on the patent productivity rate for a firm. A visual inspection suggested a negative to positive curve for recoverable slack. Therefore, a quadratic version of recoverable slack was added to the model. The results indicate that available slack is positively correlated with patent productivity, while recoverable slack has a negative to a positive curvilinear relationship with patent productivity (See Table 1). The p-value for available slack is .001, and for recoverable slack and the quadratic version of recoverable slack, the p-values are less than .001. However, there was no statistically significant relationship between the type of company and the patent productivity rate. An alpha level of .05 was used for all statistical tests.
Therefore, H1 is accepted, H1b is partially accepted, and hypothesis H1a is rejected.

3.2 Study 2: Relationship between innovation production, firm growth, and slack

Study 2 focuses on understanding the moderating effect of slack between the rate of innovation and firm growth, with:

- H2: Increases in the rate of innovation productivity within a firm is positively correlated with changes in revenue.
  - H2a: Being a technology company increases this correlation
- H3: Available slack positively moderates the relationship between innovation rate changes and revenue changes.
  - H3a: Being a technology company increases this correlation

In this model, the dependent variable is the firm revenue growth rate, and the independent variable is the growth rate in the number of patents per $1B in revenue. The moderating variable is the available slack growth rate, and the control variable is the status as a technology company or not. Two statistical tests were conducted to assess this relationship. The process macro in SPPS was used to test the regression impact from the addition of the moderating variable. However, as this model is quite simplistic and its use is limited to testing the relationship between the three variables, the regression model would not produce a high $R^2$. Therefore, the Pearson correlation coefficient was calculated with and without the addition of slack as an interaction.

The results indicate a weak but statistically significant positive correlation between patent growth and revenue growth (See tables 2 and 3). The Pearson $r$ was calculated as $0.132$ with a $p$-value of $0.005$. The addition of available slack as a moderator increased the correlation to $0.185$ with a $p$-value of $<0.001$. The same calculations were run within the data sets comprised of only technology and only non-technology firms. The increase in correlation associated with the moderation effect was more significant in the technology firm sample. The Pearson $r$ was calculated as $0.147$ with a $p$-value of $0.013$. The addition of available slack as a moderator increased the correlation to $0.295$ with a $p$-value of $<0.001$.

However, in non-technology firms, the relationship between patent growth and revenue growth was not statistically significant.
The positive effect of slack between innovation and firm growth rate in technology firms was examined in a two-step regression using the PROCESS macros within SPSS. Patent growth rate and revenue growth rate were entered in the first step of the regression analysis. In the second step of the regression analysis, the interaction term between available slack growth rate and patent growth rate was entered, and it explained a significant increase in variance in revenue growth rate, $\Delta R^2 = .1167$, $F(3, 279) = 38.34$, $p < .001$. Thus, available slack was a significant moderator of the relationship between patent growth and revenue growth. Therefore, hypotheses H2, H2a, H3, and H3a are accepted.

### 4. Conclusions & Future Research

The research conducted reaffirmed the role of slack on innovation productivity. However, contrary to previous research, a positive to negative curvilinear relationship was not found between slack and innovation. Available slack demonstrated a positive relationship, and recoverable slack showed a negative to positive relationship. Further research is needed to understand this phenomenon better; as it may be that initial expenses in G&A crowd out innovation activity until the organization reaches a tipping point, at which point the increases in recoverable slack produce increases in innovation. The research also did not indicate any increased effect of slack on innovation for technology firms. The implication is that the innovation process is not as different as anticipated in technology firms with respect to the ability to deploy slack more efficiently.

The research identified a positive relationship between the rate of innovation and the rate of revenue growth. Slack significantly and positively moderates the relationship between the changes in the growth rate of innovation and revenue. This moderating effect is substantially higher in technology firms;
where the nature of the product(s) made by technology firms may be more receptive to immediate deployment through changes in slack rates.

There are several implications of this research for firm executives. They should understand the positive impact of slack on innovation and the commercialization of innovation in their firms. Their organizations must create capacity in their teams that allow them to easily set aside tasks that are not critically time-dependent and of lesser value. This does not mean that firms must have resources on the bench that are not deployed. The firm needs to avoid optimizing resources to 100% utilization that are tied to critical projects and operational tasks, which render it too difficult for the resources to adjust and reprioritize on opportunities that will drive innovation or deploy innovation.

5. Limitations and Future Research

There are a couple of limitations to the research conducted. First, the sample was limited to publicly traded U.S.-based firms awarded more than 40 patents. The nature of smaller, start-up organizations with a heavy emphasis on rapidly scalable innovation may not reflect the same dimensions. Second, the definition of slack utilizes financial ratios as proxies to estimate its rates. Efficiency differences between firms that may produce more slack in one of them over another would not be represented. Finally, the regression model for understanding the impact of slack on the relationship between innovation rate and revenue growth is limited, as it does not capture all factors that impact revenue growth.

This research aimed to understand the relationship of slack as a moderator first. Therefore, future research would expand to include non-U.S.-based firms and private firms while building a more complete regression model to understand the relationship between innovation rate and firm growth. A more thorough examination into understanding the negative to positive curvilinear relationship between recoverable slack and innovation productivity is also needed.

6. Author Names and Affiliations

Mr. John Hill is the Chief Information Officer and Senior Vice President, Business Planning for Carhartt. He has more than 20 years of executive experience in technology across several firms and industries. He is a DBA candidate at the Nathan M. Bisk College of Business at Florida Institute of Technology, and his dissertation research is focused on digitalization inefficiencies in firms.

Dr. Walton is the Director of the Center for Innovation Management and Business Analytics and Professor of Management and Innovation at Florida Institute of Technology. He is a U.S. Delegate and Working Group Chair on ISO's Technical Advisory Committee on Innovation Management Standards (ISO 56000) and is the Co-Founder and Former Deputy Editor-in-Chief of the International Journal of Innovation Science and the International Association of Innovation Professionals.

7. References


