

**THE EFFECTS OF NETWORK STRUCTURE ON SLACK AND R&D INTENSITY**

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**ABSTRACT**

*We propose an inverse U-shaped relationship between firm slack resources and research and development (R&D) intensity and consider two alliance network contingencies that can influence this relationship: firm centrality and structural holes. We show that the amount of slack available to firms has an inverted U-shape relationship to the high volume of experimentation necessary to pursue bold but risky projects in the biotechnology industry. When slack is low there are not enough resources to experiment, and when it is a high firms can behave in a wasteful way. Furthermore, this relationship varies based on the firms' position within their alliance network, with more central firms needing to invest less, and structural hole brokers investing more of their slack in the R&D process. Our analysis of the U.S. biotechnology industry between 1992 and 2011 provides support for our hypotheses. Overall, our findings show how variations in alliance network structure provide an explanation for how slack resources affect R&D intensity.*

**Keywords:** Slack, R&D intensity, centrality, structural holes.

**1. INTRODUCTION**

As an important measure of firms' research and development (R&D) efforts, R&D intensity is typically defined as the firms' total R&D expenses divided by total sales (Chen and Miller, 2007; Cohen and Levinthal, 1989). How does a firm's position within its alliance network impact the allocation of slack resources towards innovative activities? Are centrally located firms in a better position to use their slack resources? Does bridging a structural hole allow firms to rely more on their network alliances to better direct their research efforts? We will examine the effect of alliance network position on the relationship between slack, or excess resources that may be used discretionarily by firms, and research and development (R&D) investments, showing how the relationship changes depending on the firms' degree of network centrality, and whether they bridge a structural hole. In doing so we will highlight how a firm's position within its alliance network influences the level of experimentation and new product innovation they must undertake.

Slack refers to the reserve of resources that an organization may use either to solve organizational problems or to engage in the pursuit of goals that are outside of its main organizational strategy (Bourgeois, 1981; Stan *et al.*, 2014). A different perspective is offered by Nohria and Gulati (1996), who proposes that slack is the organizational pool of resources that exceed the minimum required to maintain a certain level of output. Some examples of slack are unused capacity, redundant employees, as well as opportunities to raise output, which firms choose not to exploit (Simsek *et al.*, 2007). Firms can use slack to engage in experimentation, to respond to disruptions in performance, or to survive downturns in the markets (Meyer, 1982; Iyer and Miller, 2008; Kuusela *et al.*, 2017). Given the nature of our focus on the biotech industry, where firms must undergo a high degree of experimentation, the availability and use of slack resources to spur the R&D process is crucial.

We propose that slack has an inverted U-shaped relationship with R&D intensity, with low levels of R&D at both low and high levels of slack, and high R&D at moderate slack levels. R&D intensity has been used in prior literature as a measure of risk-taking behavior, as it represents an allocation of resources to projects with uncertain future outcomes (Kim *et al.*, 2008; Su and Lee, 2013). To address contingencies that may affect this relationship we draw on the social network perspective, which assumes that firms are embedded