

# **COMPETITIVE DYNAMICS OF INNOVATION: WHAT DETERMINE FIRMS' SPEED IN SEARCHING TECHNOLOGY BREAKTHROUGHS?**

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## **Abstract**

This paper examines technology search speed of firms when they develop potentially competing products. Technology search speed is the time it takes for a firm to incorporate a new technology developed by others into its own innovations. Recent research shows that when exploring a valuable technology area, the faster a firm searches it, the more innovative its product can be (Katila & Chen, 2009). Consequently, the firm can benefit from its leading position in the market created by these innovations (Lieberman & Montgomery, 1987). In contrast, the longer it takes for a firm to search this technology field for the technological breakthrough that is necessary for the development of a new product, the less chances it will have to develop truly innovative product, resulting in a disadvantageous position in the market (Katila & Chen, 2009).

Despite the importance of firms' search speed, there is surprisingly little research that examines the factors that determine firms' technology search speed. The majority of prior literature on technology search suggests that search speed may be determined by organization's internal factors, and particularly firm's absorptive capacity, which results from firms' investment in R&D activities. Prior research contends that absorptive capacity enables a firm to be alert to and react fast to external technology changes (Cohen & Levinthal, 1990). This contention reflects a view that technology search speed is determined by organization's own characteristics.

In contrast, research on competitive dynamics and inter-organizational learning suggests that competitors may also have impacts on a firm's search speed. It is likely that competitors' search may spill over some knowledge about using the new technology that helps the focal firm to incorporate it faster (Zander and Kogut, 1995). It is also possible that competitors' faster exploitation of the breakthrough technology depletes technological opportunities that the technology being searched can offer, or it imposes constraints on the features of innovation that the focal firm can develop (Ingram & Baum, 1997). This may prolong the focal firm's innovation process as it must find new ways to use the technology. These alternative views suggest two distinct theoretical possibilities, which, however, have not been developed and empirically examined. We investigate these possibilities in a framework which considers a breakthrough technology that is necessary to develop a class of competing products. Each competing firm is looking for

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the technological breakthrough to develop its proprietary competitive products. We asked three questions:

- (1) What is the effect of firms' absorptive capacity on their speed of search?
- (2) What is the effect of competitors' search on the focal firm's search speed?
- (3) What is the interactive effect of competitors' search and the focal firm's absorptive capacity on its search speed?

To answer these questions, we chose the U.S. pharmaceutical industry as our empirical setting, because it is a highly innovative sector (Mansfield, 1986). We collected a unique dataset by linking three data sources, i.e., FDA's brand-name-drug database, US Patent and Trademark Office's patent citation data, and COMPUSTAT's database of public firms. Our dataset includes all the brand name drugs produced in the industry, which were approved by FDA and were still protected by patents as of September 2008.

Overall, 241 competing cases were identified, which involve 130 firms competing on 230 key technologies. All the key technologies were developed between 1985 and 1998. Specifically, this dataset includes time-series information about these competing firms' characteristics (e.g., R&D, size, and performance), their competing products (brand name drugs), innovations upon which the competing products are based, critical technologies that were searched by these firms to develop these innovations, and the time they spent on searching.

This dataset has two unique features that contribute to the research fields of innovation and competition. First, it contains a complete list of all competing new products between these firms. Identifying competing products has been recognized as a key and one of the most challenging tasks in empirical studies of competition. We did so by classifying all drug products in our dataset based on their indications (Lichtenberg & Philipson, 2002). The classification was cross-validated by two legitimate drug classification systems. If two drugs are in the same class, they are regarded as competing with each other (Lichtenberg & Philipson, 2002). The second unique and probably more important feature is that we clearly linked every drug product to its associated innovations (i.e., patents), and then tracked the key technologies (i.e., patents) being searched to develop the innovations. Due to practical challenges, such important links between products and technologies have been rarely identified in prior research.

This research makes three contributions. First, it adds insights to the technology search literature by identifying factors that determine firms' technology search speed and their relative importance in doing so, which have been overlooked in prior research. Second, it adds the idea of competition to the study of technology search. Competition has not been taken into consideration in current studies, which maintain that technology search is firm-centric and firms search in isolation (cf: Katila & Chen, 2009). In contrast, our research shows that competition can significantly impact firms' technology search speed. Third, it also contributes to the competitive dynamics literature. While current literature has mainly focused on the competitive actions and responses between on-the-market products, this paper opens a new line of research by examining competition between firms in their innovation stage. It thus enriches our understanding of competition

by looking into the “under-the-ground” processes that lead to “on-the-surface” competition.