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Essays on Markets for Technology: the Role of Licensing as a Complementary Strategy to Internal R&D

Vincenzo Palermo

Abstract

I study the role of licensed technologies in the R&D development process, the knowledge assimilation mechanism and the patent litigation procedure. The use and adoption of licensed technologies is not a linear process and it has important strategic consequences. First, I find that, on average, internal R&D and licensing investments are neither complements nor substitutes but the ability to combine them depends on firm-level drivers. Second, the adoption of external technology may be limited by internal knowledge accumulation, but this trade-off is mitigated by absorptive capacity and decentralization. Finally, licensed patents increase the probability of winning a patent lawsuit. Under this circumstance, firms are able to reduce patent uncertainty, limit market entry, and protect future revenue streams.

Category: Strategy, Innovation Management

Keywords: Markets for technology, Licensing, Internal Knowledge, Patent litigation

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Executive summary

The conceptual framework of this dissertation lies at the intersection of strategy, innovation, markets for technology, and organizational theory research. The objective of this dissertation is to analyze two broad questions. First, are firms able to assimilate and integrate external knowledge with their existing knowledge and under what circumstances are firms more successful in this process? Second, how can firms exploit licensed technologies as a defensive strategy against market entry? In particular, I attempt to address these questions by looking at the firm-level of analysis and by trying to understand the role played by licensed patents under several circumstances: R&D development, knowledge assimilation and patent litigation. Addressing these questions requires an interdisciplinary approach; specifically, I draw insights from different streams of research including organizational theory, innovation research, and the knowledge-based view of the firm, sociology, and economics. In this introduction, I briefly describe the three main chapters of my dissertation and highlight the main contributions.

I look at technologies developed outside of the firms' boundaries and I make an effort to identify the potential benefits and threats associated with their adoption. A large body of innovation research has examined the capabilities that firms possess in order to be innovative. Existing research has primarily focused on the role and antecedents of technologies that were produced internally and licensed out. However, firms exploit

external technologies to boost their innovative performance; this in-licensing process depends on the ability to recombine, assimilate and transfer knowledge. Therefore, it is important to understand how companies can benefit from their licensing strategy. To address this gap, I examine the impact of licensing investments on both sales and innovative performance when combined with internal knowledge. I document how licensed technologies can have a positive impact only under specific circumstances. In the three chapters of my dissertation, I examine the effect of acquired knowledge on firms' innovative output, sales performance, and patent litigation outcomes. The general setting of this dissertation is the pharmaceutical industry. I use multiple databases to follow a largely representative sample of incumbent firms. I primarily rely on licensing data as a measure of external technology acquisition and patent data to analyze drug litigations.

In the first chapter, I argue that the relation between internal R&D and external technologies may be misleading. Past research has focused on the question whether these two form of innovative investment are either complement or substitute but I argue that the level of complementarity and substitutability varies conditional on the existing capabilities of the firm. I attempt to provide a deeper understanding of the firm-level drivers of complementarity between these two types of investments by looking at the production of innovative products. Results suggest that on average internal R&D and in-licensing investments are neither complements nor substitutes, thus supporting the idea that a more complex relationship exists between the two forms of investments. In fact, I find that the level of complementarity differs between different levels of scientific publications and absorptive capacity, firms with high levels of publications and large

R&D stock are better able to integrate external technologies. Companies may be able to use knowledge across therapeutic areas additively and therefore experience better levels of complementarity. Finally, complementarity increase for firms with a larger stock of prior licensing experience. In other words, experience in licensing agreements may facilitate the management and integration of the acquired technologies.

Some firms, such as Morgan Stanley, have advocated a radical shift for the management of R&D in certain industries. In particular, they argue that the pharmaceutical industry should abandon its current R&D model and fully adopt a "search and development" (S&D) model. Under an S&D framework firms would abandon all internal research and focus solely on development. Thus, 100% of a firm's drug candidates would come from external licensing and firms would adopt a vertical disintegrated structure. An opposite view is proposed by Gary Pisano, he criticizes a "market-based" organization since it has not delivered the promised innovation and reduction in R&D costs. Pharmaceutical firms should implement a more integrated structure to deal with R&D uncertainty and with the lack of results from the biotech sector. Under this view, firms should become knowledge integrators and exploit only few long-term collaborations that are very broad in scope. For example, pharmaceutical companies should not sign 40 agreements per year but they should sign four or five agreements that focus on specific therapeutic areas or target families. While full adoption of an S&D model or a vertical integrated structure is an extreme position, some pharmaceutical companies have openly acknowledged a move toward intermediate level of integration based on more frequent engagement in external licensing. For example, in 2009, GlaxoSmithKline (GSK) terminated its legendary neuroscience program in order to

free up capital to meet its stated goal of allocating 50% of its R&D budget to external projects. Ultimately, knowing whether internal development and in-licensing are complements or substitutes might help build a feasible equilibrium between these two strategies. This would allow for a more complete understanding of the proposed outsourcing move by companies such as GlaxoSmithKline. Ultimately, this knowledge also allows for a deeper understanding of the feasibility of more radical views of the innovative process, such as the search and development model proposed by Morgan Stanley or the vertical integrated structure advocated by Pisano.

In the second chapter, I combine the markets for technology framework and research on organizational boundaries to examine the impact of internal knowledge accumulation and licensing acquisitions. I argue that when firms specialize in internal knowledge and adopt an inward oriented knowledge accumulation process, they can be reluctant to adopt external technologies. While recent studies have emphasized the importance of combining technologies from different sources, there is a lack of attention on the integration of external technologies into innovative production. This chapter focuses on the potential tension between external knowledge acquisition and internal knowledge accumulation. My results show that reliance on existing knowledge reduces the marginal effect of licensed technologies on firm market capitalization. It may be possible that internal knowledge accumulation favors the development of an inward oriented process and, as a consequence, firms may suffer from the Not Invented Here syndrome and have negative biases towards external knowledge. As a consequence, this inward attitude of the firm may conflict with the exploitation of external technologies, thereby limiting the potential benefits associated with the markets for technology.

I also find that higher level of absorptive capacity and a decentralized organizational structure moderate the negative bias towards external technologies. In essence, this chapter analyzes the relationship between internal knowledge and in-licensing investments, showcasing how companies can reduce the trade-off between internal knowledge accumulation and external technologies.

The results have important managerial implications. This paper shows the importance of managing knowledge within organizational boundaries: a bias towards external technologies may limit the adoption of open innovation strategies and the exploitation of external technologies. Firms are often in favor of exploiting internal knowledge to reduce their costs and to specialize on technological trajectories; however, the same attitude may limit the ability to integrate external knowledge. Managers should be aware of the trade-off between a strong inward oriented behavior that may generate the NIH syndrome and the ability to exploit internal knowledge.

For example, Merck has historically been known as an inward oriented company that relied on internal development as its main innovative driver. Merck scientists did not consider it worth spending time on something that was not created inside Merck. While this closed innovative process was sufficient in past decades, the company has recently changed their attitude towards external knowledge to fill its pipeline. Other firms have recently begun adopting similar strategies to reduce the negative effects of internal knowledge accumulation without reducing the positive effect of internal innovative effort. When Pfizer downsized their UK establishment (known as Pfizer Sandwich) in 2011, a group of scientists created a spin-out called 'The Research Initiative'. The scope of the project is to support the integration of external research and to connect project

teams with different sources of knowledge. This strategy allows Pfizer to maintain their organizational culture and to reduce potential biases towards external technologies. This initiative creates a bridge between the employees of the internal innovative process and the environment outside the firm boundaries. Similarly, Eli Lilly has introduced the 'Phenotypic Drug Discovery' (PD2) initiative. The program is based on the submission of molecules by scientists outside the company, thus creating a competitive environment that may boost internal effort and facilitate the acceptance of outside knowledge. A similar approach has been adopted in other industries as well. Procter & Gamble implemented the 'Connect and Develop' strategy to adopt a new innovative process that included both internal and external scientists. As a result of this new strategy, 35% of Procter & Gamble's new products include elements that originated outside the company and also their R&D productivity has increased by 60%. To summarize, firms need to create fuzzier organizational boundaries to incentivize both internal knowledge accumulation and external knowledge adoption. The exploitation of internal knowledge is beneficial but it may favor the rise of an inward looking behavior that damages the performance of the company.

In the last chapter, I assume that firms are able to assimilate and adopt external patents and I examine how these technologies can be used as a defense mechanism to prevent market entry. Past research has considered when and why firms may choose to access the markets for technology. However, in the case of licensing little is known about the reliability of external patents. "Weak" external patents can expose a firm to the loss of a protected revenue stream. In some industries, such as pharmaceuticals, where development cycles are long, the loss of a revenue stream due to litigation can be a

significant event. I focus on a unique legal action called a "Paragraph IV challenge" that is peculiar to the U.S. market: under specific circumstances, generic manufacturers may enter the market five years after drug commercialization and before patent expiration. This setting offers a natural experiment to test whether external technologies are more reliable than those developed internally.

My findings suggest that external patents do not influence the decision of Paragraph IV challenges. However, they are important in reducing the possibility that generic manufacturers win the lawsuit, and in turn enter the market. In addition, the results confirm the importance of sales as a major incentive for generic entry, a conclusion in line with existing literature. I also find that the introduction of the Medicare Modernization Act in 2003 has lowered litigation costs for generic manufacturers and it has increased the risk of being challenged. The findings on the Medicare Modernization Act suggest that generic manufacturers are able to take advantage of the new legislation regarding the litigation thirty-month stay period: under the new legislation pharmaceutical companies cannot stack multiple thirty-month periods of protection. As a consequence, the incentives to apply for a Paragraph IV certification are greater than before. It then follows that the reform has increased the threat of generic entry and lowered the barriers to entry. The implication of policy changes can be reflected in a potential welfare increase for consumers. For example, in the hypertension market, consumers benefit for a total of $92 billion after Paragraph IV generic entry, while pharmaceutical producers lose approximately $14 billion. In the short run, these results suggest a potential benefit to the society, but in the long run, the prospect of limited

profitability of new drugs may reduce pharmaceutical incentives to invest in R&D and develop new and innovative drugs.

Finally, the conclusions of this paper have several implications. Most importantly, on average, external technologies are more reliable in protecting a focal drug from generic competition. First, this effect may be due to the selection processes of external technologies. Since low internal productivity and high cospecialized assets increase the demand for external technologies, pharmaceutical companies select the most valuable technologies. Second, this result may suggest that the technology selection process adopted by pharmaceutical firms is able to identify the most valuable patents.

Concluding, I have attempted to highlight the central role of licensed technologies as drivers of firm-level innovative outcomes. However, in contrast to extensive existing research that focuses on the importance of markets for technology and the antecedents of licensing, I examine the significance of in-licensing investments. It is crucial to understand when acquired technologies generate synergies with existing capabilities, as they are more reliable than patents developed internally. I rely on the markets for technology framework as the primary conceptual lens to analyze drivers of complementarity and the knowledge assimilation process. I also use litigation literature to focus on the role of external patents in intellectual property rights lawsuits. As a result, the main contribution of this dissertation is to highlight the impact of in-licensing on different firm-level performance variables: the ability of an organization to generate synergies between types of R&D investments, the capacity of an organization to assimilate and adopt new knowledge when the existing knowledge stock is high, and the

capability of an organization to effectively select and use external patents in “Paragraph IV challenges.”