Proceedings of Conference on Business Venturing and Entrepreneurship, Spring 2022
April. 16, 2022. pp.25-30

Too Costly to Convince: how do startups deliver radical innovation via partnership?

김유진*
서강대학교, 조교수
송재용**
서울대학교, 교수

Abstract

Despite the importance of partnership for commercialization of innovations in startups, it is not easy for startups to persuade an established firm to collaborate on a completely novel idea. If information transfer about the innovations is too costly, startups may avoid pursuing radically new projects. Our paper examines the impact of policy signals on the novelty of the innovations pursued by startups. In the context of the Orphan Drug Act(ODA), we find that startups develop more radical therapies when policy signals help them to convince potential partners of the value of prospective therapies. While the likelihood of partnership increases, the timing of partnership is delayed in ODA-affected fields.

Keywords: radical innovation, high-tech startups, inter-firm partnership, technology commercialization, information asymmetry, signaling, Orphan Drug Act, biopharmaceutical industry

Ⅰ. Introduction

High-tech startups are important sources of radical innovation, or novel and unique technological advances in which new scientific knowledge is applied to meet unfulfilled needs of customers and create new markets(Henderson 1993; Christensen 2013). Since most startups lack the resources and knowledge necessary to deliver innovations to market independently, they often partner with large firms that possess well-established commercialization assets(Teece 1986; Gans & Stern 2003; Arora et al., 2004; Katila, Rosenberger and Eisenhardt 2008). However, it is costly to accomplish radical innovation through inter-firm partnership; if one partner lacks verifiable information, such as scientific references, or experience with market performance of similar technologies, the partnership may be susceptible to information asymmetry(Spence 1978). An issue is that, without tapping into the commercialization assets owned by large partners, it costs far beyond what a single startup can afford to develop innovations enough to convince a partner. This presents a dilemma: the startup needs a large partner to prove the concept of a new technology, but it is unlikely to attract a partner without proving the concept. If it is disproportionately costly to market their products through an inter-firm partnership, startups may change their focus from promoting radical innovation to incremental development, which is easier to convince a partner to support. We examine the role of policy-backed quality signals in motivating startups to pursue radical innovation and to deliver radical innovation to market.

Ⅱ. Theory

* yseongkim@sogang.ac.kr
** jsong@snu.ac.kr

2.1. The impact of information asymmetry on the commercialization of radical innovation

High-tech startups play an important role in bridging the gap between science and business, seeking to transform radical innovations into commercial applications; due to the high uncertainty involved in this process, it is often considered too risky by established firms(Ettlie, Bridges and O'keefe 1984; Sorescu, Chandy and Prabhu 2003; Jansen, Van Den Bosch and Volberda 2006; Krieger, Li and Papanikolaou 2018).

Because most high-tech startups lack the resources necessary for independent commercialization, they often depend on partnerships with established firms to deliver their products to market. Commercializing a technology requires a comprehensive set of resources other than the technology itself, including, but not limited to, mass production capabilities, sales and distribution channels, management of regulatory requirements, and fundraising(Teece 1986; Tripsas 1997; Sosa 2009). While some assets can be sourced from specialized providers such as venture capitals(VCs) that provide early-stage funding, others, such as mass production capability or quality control know-how, are neither accessible in a market nor easily and quickly accumulated by startups. Where complementary resources are critical for technology commercialization, as in the case of the pharmaceutical industry, high-tech startups must collaborate with existing firms to tap into their partners' assets(Gans and Stern 2003; Arora, Fosfuri and Gambardella 2004; Marx, Gans and Hsu 2014).

That said, cooperation between two or more firms to bring an early-stage innovation to market is difficult due to information asymmetry. In the process of technology commercialization, the developing party may have better information about the innovation than its partner, but may find it impossible to transfer the information to the partner credibly(Akerlof 1970). Radical innovation, by definition, lacks verifiable and standardized valuation methods compared to incremental innovation.This ambiguity regarding radical innovation may make a would-be partner wary. Thus, inter-firm partnerships for the purposes of radical innovation are more costly than those for incremental innovation.

Facing this extra burden of validation, startups seeking partners must develop radical innovations enough to demonstrate their scientific and commercial feasibility. Yet, in high-tech sectors, advanced development such as late-stage R&D and initial marketing often requires complex capabilities far beyond what a single startup can afford. This catch-22 situation results: a startup needs access to resources owned by an established partner to generate credible evidence of radical innovation, but the necessary resources are unavailable until the startup provides a proof-of-concept to the potential partner.

The difficulty of valuation due to information asymmetry disproportionately burdens inter-firm communication about the prospects of radical innovations compared to incremental innovations. If it is too costly for a high-tech startup to convince a potential partner of the value of radical innovation, the startup may move away from pursuing radical innovation.

2.2. The impact of policy signals on the incentives of startups for radical innovation

To overcome the barriers caused by information asymmetry, startups use a variety of signaling measures including patents granted, reputation of existing investors, receipt of public grants and contest prizes, and designations from regulatory agencies to demonstrate their quality to partners or potential investors(Stuart, Hoang, and Hybels 1999; Lerner 2000; Gans, Hsu and Stern 2008; Hsu and Ziedonis 2008; Gorry and Useche 2018). Likewise, where the extra costs associated with inter-firm partnership make radical innovation difficult, effective signaling can help firms better communicate the genuine value of their products by turning tacit and unverifiable information into objective and verifiable information(Spence 1978).

We claim that policy-backed quality signals encourage startups to pursue radical innovation. While these signals could benefit both types of innovation, we posit that the extent to which they facilitate effective inter-firm communication is greater for radical innovation than for incremental innovation, given that alternative sources of

verifiable information are relatively scarce for radical innovation. An effective signal designated by public agencies can moderate the risk of misjudgment, encouraging large firms to form inter-firm partnerships. The increased possibility to convince a partner to aid in commercialization can incentivize startups to pursue radical innovation and develop products that they would have avoided otherwise.

We predict that an effective signaling measure increases the propensity of inter-firm partnership for radical innovation, by incentivizing both established firms and promising startups to engage in the collaborative commercialization of radical innovation.

To an established incumbent firm, inter-firm partnership is a costly option if the level of information asymmetry is high. In general, information asymmetry leads to the "lemon problem," in which a would-be partner is reluctant to pay for a radical innovation beyond the average value of all radical innovations in a given pool. If an effective policy-led signal helps identify promising radical innovation, a large firm that might otherwise have shunned cooperative commercialization due to the difficulty of valuation might consider partnering on the distinguished radical innovation.

The availability of effective signaling positively affects startups' beliefs as to whether or not they can generate reasonable profits from collaboration. The possibility of signaling also encourages competent startups to seek collaborative ways to market their innovations.

2.3. The impact of policy signals on inter-firm partnerships on radical innovation

Lastly, the signaling possibility can also impact the timing of partnership between a startup and a larger firm. Once a startup decides to pursue a partnership, the next important decision to make relates to timing. There is a trade-off between forming a partnership at the early stage and doing it at the advanced stage(Luo 2014). Startups must secure a deal with their partners in a timely manner before competitors do. However, if negotiation occurs too early, proofs of concept may be lacking, putting the startup in a lopsided bargaining position where it may have to yield the lion's share of potential gains to an established partner.

This trade-off may be mitigated by the availability of a quality signal, which may allow the timing of inter-firm partnership to be delayed. In the absence of signaling, it is difficult for startups to provide convincing proofs of concept no matter how long they hold out on their radical projects. In such cases, the optimal strategy is to secure a partnership as early as possible before the opportunity is taken by competitors. With the availability of signaling measure, however, the credibility of radical innovation increases stepwise once the project obtains the quality signal. A quality signal becomes an effective milestone that helps a startup and its investors make strategic decisions on how much extra time and resources must be committed to achieve a superior bargaining position in negotiations with potential partners. If the quality signal is successful, one or a few potential partners may strongly prefer to negotiate with a startup whose product based on radical innovation is believed to demonstrate excellent potential and fewer risks. Greater bargaining power thanks to the policy-led quality signal is likely to yield a larger share of potential profits from the partnership for the startup. Thus, the presence of an effective signal can incentivize a startup to put off seeking a partnership.

Ⅲ. Research design

3.1. Hypotheses

In sum, the availability of a credible policy signal can reduce the level of information asymmetry associated with radical innovation and, therefore, incentivize high-tech startups to promote radical innovation. In addition, the opportunity to showcase the prospect of radical innovation via an objective quality signal can enable startups to take the extra time and seek the resources needed to advance the process of radical innovation to the point that they can obtain quality signals before negotiating with would-be partners. It suggests that startups strategically postpone the timing of partnership when policy-led signals become available.

We therefore hypothesize as follows.

Hypothesis 1: If a policy-led signal that helps firms objectively demonstrate the prospect of

radical innovation becomes available, startups are more likely to pursue radical innovation.

Hypothesis 2: If a policy-led signal that helps firms objectively demonstrate the prospect of radical innovation becomes available, startups are more likely to pursue inter-firm partnership to commercialize radical innovations.

Hypothesis 3: If a policy-led signal that helps firms objectively demonstrate the prospect of radical innovation becomes available, startups are more likely to delay the timing of inter-firm partnership on radical innovation.

3.2. Empirical Context

We test our hypotheses in the context of the Orphan Drug Act(ODA) enacted by the European Union(EU) in 2000. Since rare diseases only affect a small number of patients, drug developers are reluctant to develop therapies for them; the market size is too small to justify the costly investment in drug development. The ODA was originally designed to incentivize the development of drugs for rare diseases. Contrary to the original intention of the act, however, small biotech firms have found that the orphan designation helps them signal the quality of novel drugs to large pharmaceutical firms interested in extending these therapies to treat common diseases in larger markets.

The ODA was first enacted by the US in 1983 to provide developers of rare disease treatments a variety of incentives, including market exclusivity for a designated period, accelerated approval, regular guidance, protocol assistance by regulatory agencies, and reduced fees. To take advantage of these ODA-induced incentives, a drug developer must file an application to the regulatory agency, specifying 1) which disease to target, 2) why the disease meets the rare disease criteria according to the guidelines provided by the regulatory agency, and 3) why its therapy is the best treatment for the rare disease(Grabowski 2005). The regulatory agency carefully examines applications, granting an orphan designation to drug candidates that demonstrate strong scientific efficacy.

Interestingly, some small biotech firms have carved out a new drug development strategy around the ODA. Since many rare diseases are caused by gene mutation, effective treatments are often biotechnology-based stratified medicines that selectively treat a group of patients with specific features, including biomarkers(Trusheim, Berndt and Douglas 2007). By definition, rare diseases afflict very few, relatively homogenous patients. This situation allows biotech firms developing novel drugs to use a sequential approach: first, they aim to develop a novel drug as an orphan disease treatment to attract the attention of potential investors and business partners; later, they contract with established partners to expand the use of the drug to treat common diseases that are caused by similar mechanisms. Increasingly, established pharmaceutical firms have moved towards biotech-driven personalized medicines and away from the traditional approach of developing small, chemical-based, untargeted drugs. Thus, the opportunity to showcase the scientific feasibility of new biotechnology becomes more important to small biotech firms that seek to develop pioneering technologies to treat a few diseases with significant market size.

To test the hypotheses on the impact of EUODA on the delivery and collaborative commercialization of radical innovations, we use a difference-in-difference(DiD) approach. Specifically, we compare the originality of innovation undertaken by biotech startups, the propensity and the timing of inter-firm partnership between biotech startups and commercialization partners in the pre-ODA period to that in the post-ODA period, to examine whether a group of startups disproportionately affected by EUODA exhibits the greater magnitude of change, compared to the control group.

References

Adams, C. P., & Brantner V. V.(2010). Spending on new drug development 1. *Health economics,* 19(2), 130-141.

Akerlof, G. A.(1970). The market for "lemons": Quality uncertainty and the market mechanism. *The quarterly journal of economics,* 488-500.

Alcacer, J., Cantwell, J., & Gittelman, M.(2009). *Are licensing markets local? An analysis of the*

geography of vertical licensing agreements in bio-pharmaceuticals. Working paper, Harvard University.

Alvarez-Garrido, E.(2015). *The value translation model: A theory of venture growth and innovation. Academy of management proceedings*. Briarcliff Manor, NY: Academy of Management.

Arora, A., Fosfuri, A., & Gambardella, A.(2004). *Markets for technology: The economics of innovation and corporate strategy* MA: MIT press.

Arrow, K. J.(1979). The property rights doctrine and demand revelation under incomplete information. *Economics and human welfare(Academic Press)*, 23-39.

Berndt, E. R., & Trusheim, M. R.(2012). The segmentation of therapeutic populations in oncology. *Health management, policy and innovation*, 1(1), 19-34.

Blume-Kohout, M. E., & Sood, N.(2013). Market size and innovation: Effects of Medicare Part D on pharmaceutical research and development. *Journal of public economics*, 97, 327-336.

Budish, E., Roin, B. N., & Williams, H.(2015). Do firms underinvest in long-term research? Evidence from cancer clinical trials. *American economic review*, 105(7), 2044-85.

Cheung, R. Y., Cohen, J. C., & Illingworth, P.(2004). Orphan drug policies: implications for the United States, Canada, and developing countries. *Health LJ*, 12, 183.

Chatterji, A. K., & Fabrizio, K. R.(2016). Does the market for ideas influence the rate and direction of innovative activity? Evidence from the medical device industry. *Strategic management journal*, 37(3), 447-465.

Christensen, C. M.(2013). *The innovator's dilemma: when new technologies cause great firms to fail,* Harvard Business Review Press.

Christensen, C. M., & Bower, J. L.(1996). Customer power, strategic investment, and the failure of leading firms. *Strategic management journal*, 17(3), 197-218.

Danzon, P. M.(2000). The pharmaceutical industry. *The encyclopedia of law and economics.* Edward Elgar, 1055-1091.

Ettlie, J. E., Bridges, W. P., & O'keefe, R. D.(1984). Organization strategy and structural differences for radical versus incremental innovation. *Management science*, 30(6), 682-695.

Gans, J. S., Hsu, D. H., & Stern, S.(2008). The impact of uncertain intellectual property rights on the market for ideas: Evidence from patent grant delays. *Management science*, 54(5), 982-997.

Gans, J. S., & Stern, S.(2003). The product market and the market for "ideas": commercialization strategies for technology entrepreneurs. *Research policy*, 32(2), 333-350.

Gompers, P., Gornall, W., Kaplan, S. N., Strebulaev, I. A.(2016). *How do venture capitalists make decisions?*. Cambridge, MA: National Bureau of Economic Research.

Grabowski, H. G.(2005). Increasing R&D incentives for neglected diseases: Lessons from the Orphan Drug Act. *International public goods and transfer of technology under a globalized intellectual property regime.* Cambridge: Cambridge University Press.

Henderson, R.(1993). Underinvestment and incompetence as responses to radical innovation: Evidence from the photolithographic alignment equipment industry. *The RAND journal of economics*: 248-270.

Higgins, M. J., & Rodriguez, D.(2006). The outsourcing of R&D through acquisitions in the pharmaceutical industry. *Journal of financial economics* 80(2), 351-383.

Hölmstrom, B.(1979). Moral hazard and observability. *The Bell journal of economics,* 74-91.

Hsu, D.(2006). Venture capitalists and cooperative start-up commercialization strategy. *Management science*, 52(2), 204-219

Hsu, D. H., & Ziedonis, R. H.(2008). Patents as quality signals for entrepreneurial ventures. *Academy of management proceedings.* 1, 1-6.

Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W.(2006). Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. *Management science*, 52(11), 1661-1674.

Johnson, D. E.(2014). Fast-tracking an orphan drug indication within a broader development project. *Expert opinion on orphan drugs* 2(2), 107-111.

Katila, R., Rosenberger, J. D., & Eisenhardt, K. M.(2008). Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships. *Administrative science quarterly,* 53(2), 295-332.

Kim, Y., Chatterjee, C., & Higgins, M. J.(2018). *Moving beyond the valley of death: regulation and venture capital investments in early-stage biopharmaceutical firms*. Cambridge, MA: National Bureau of Economic Research.

Krieger, J. L., Li, D., & Papanikolaou, D.(2018). *Developing novel drugs*. Cambridge, MA: National Bureau of Economic Research.

Lerner, J.(2000). The government as venture capitalist:

the long-run impact of the SBIR program. *The Journal of private equity*, 3(2), 55-78.

Lichtenberg, F. R., & Waldfogel, J.(2003). Does misery love company? Evidence from pharmaceutical markets before and after the Orphan Drug Act. Cambridge, MA: National Bureau of Economic Research.

Luo, H.(2014). When to sell your idea: Theory and evidence from the movie industry. *Management Science,* 60(12), 3067-3086.

Macher, J. T., & Boerner, C. S.(2006). Experience and scale and scope economies: trade-offs and performance in development. *Strategic management journal*, 27(9), 845-865.

Marx, M., Gans, J. S., & Hsu, D. H.(2014). Dynamic commercialization strategies for disruptive technologies: Evidence from the speech recognition industry. *Management science*, 60(12), 3103-3123.

Megginson, W. L., & Weiss, K. A.(1991). Venture capitalist certification in initial public offerings. *The journal of finance*, 46(3), 879-903.

Pisano, G. P.(1991). The governance of innovation: vertical integration and collaborative arrangements in the biotechnology industry. *Research policy*, 20(3), 237-249.

Rothaermel, F. T.(2001). Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic management journal*, 22(6-7), 687-699.

Schumpeter, J.(1942). Creative destruction. *Capitalism, socialism and democracy, Harper and Brothers,* 825, 82-85

Sorescu, A. B., Chandy, R. K., & Prabhu, J. C.(2003). Sources and financial consequences of radical innovation: Insights from pharmaceuticals. *Journal of marketing*, 67(4), 82-102.

Sorescu, A. B., Chandy, R. K., & Prabhu, J. C.(2007). Why some acquisitions do better than others: product capital as a driver of long-term stock returns. *Journal of marketing research*, 44(1), 57-72.

Sosa, M. L.(2009). Application-specific R&D capabilities and the advantage of incumbents: Evidence from the anticancer drug market. *Management science* 55(8), 1409-1422.

Spence, M.(1978). Job market signaling. *Uncertainty in economics (Academic Press)*, 281-306.

Stuart, Toby E., Ha Hoang, and Ralph C. Hybels(1999). Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative science quarterly* 44(2), 315-349.

Teece, D. J.(1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research policy* 15(6), 285-305.

Toh, P. K., & Polidoro F.(2013). A competition-based explanation of collaborative invention within the firm. *Strategic management journal,* 34(10), 1186-1208.

Tripsas, M., & Gavetti G.(2000). Capabilities, cognition, and inertia: Evidence from digital imaging. *Strategic management journal* 21(10-11), 1147-1161.

Trusheim, M. R., Berndt, E. R., & Douglas, F. L.(2007). Stratified medicine: strategic and economic implications of combining drugs and clinical biomarkers. *Nature reviews drug discovery*, 6(4),287-293.

Wellman-Labadie, O., & Zhou, Y.(2010). The US Orphan Drug Act: rare disease research stimulator or commercial opportunity?. *Health policy,* 95(2-3), 216-228.

Yin, W.(2008). Market incentives and pharmaceutical innovation. *Journal of health economics* 27(4), 1060-1077.