개방형 혁신이 산업에 미치는 효과: 슘페터 경쟁 하의 전략적 제휴를 중심으로

The Effect of Open Innovation on Industry: Strategic Alliances under Schumpeterian Competition

윤 지 영	한국투자공사	(yunji507@gmail.com)
민 진 영†	Fox Business School, Temple University	(saharamin@business.kaist.edu)
한 세 희	KAIST 경영대학	(sayhan@business.kaist.ac.kr)
이 희 석	KAIST 경영대학	(hsl@business.kasit.ac.kr)

ABSTRACT

With the increasing importance of ecosystem in a business environment, the value of open innovation is receiving great attention. Under open innovation, companies open their knowledge, capital, and other resources to cooperating companies; on the other hand, under closed innovation companies depend solely on their own resources. In this paper, we compare closed and open innovation using the simulation method, and confirm that in terms of total capital and production of the industry, open innovation provides greater opportunities to the entire ecosystem. Moreover, Schumpeterian competition, which is a dynamic of closed innovation, functions even under open innovation. Our findings highlight that not only small but also large companies can receive the benefit of an enlarged industry under open innovation

Keywords : Closed Innovation, Open Innovation, Schumpeterian Competition

Ⅰ. Introduction

Innovation has received extensive attention in both industry and academics. Companies invest a large amount of their resources for innovation because an organization that innovates successfully can bring about greater improvement in capacity than other organizations (Cyert and March, 1963; Simon, 1959), thereby obtaining competitive advantage; on the other hand, an organization that fails to innovate loses the opportunity to become an industry leader. For example, Samsung Electronics has allocated a huge amount of resources to R&D in order to innovate more aggressively than its competitors. As a result, utilizing its large investment, this company has been able to retain its leading position in the semiconductor and LCD industries for

† 교신저자

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approximately two decades.

Innovation has been an important subject in academic fields such as strategy, organization, IT, and knowledge management. Among the researchers who devoted their effort to the subject of innovation, Schumpeter, the traditional strategy researcher, is famous for his contribution to the relationship between competition and innovation. Schumpeter (1934) suggested that the organizational performance that results from innovation is affected by company size and industry concentration. Large companies are able to spend a relatively large amount of resources on innovation, thereby making successful innovation more probable as compared to its competitors. Such companies can obtain fruitful results from successful innovation such as high productivity and new product development. On the contrary, small companies cannot afford large investment for the purpose of innovation. In order to survive in the competitive environment, they attempt to imitate the leading company. Such a structure of competition is known as "Schumpeterian competition" (Nelson and Winter, 1978; Schumpeter, 1934; Simon, 1959).

In the past, under Schumpeterian competition, a company undertook the innovation process independently. Each company attempted to innovate internally and most companies hesitated to share their knowledge. Internal R&D was viewed as a strategic asset and even a barrier to entry in numerous industries (Chesbrough, 2003b, c). However, this innovation process of the past has transformed due to radical and frequent environmental changes. Most companies, which formerly undertook innovation independently, confront certain paradoxes (Chesbrough, 2003c). They struggle to find and finance growth opportunities internally, while ideas and capital are abundantly available outside the company. This causes internal R&D to become less effective. Therefore, in such an environment, attempting to innovate using external resources rather than isolated internal innovation can be more effective. Chesbrough (2003a) termed such innovation "open innovation," while traditional internal and isolated innovation was termed "closed innovation." Open innovation implies that valuable ideas may originate inside or outside the company, and may also go to the industry from inside or outside the company. The concept of open innovation places external ideas and external paths to industry on the same level of importance as internal ideas and paths to industry of the closed innovation era (Chesbrough, 2003c).

Schumpeterian competition does not seem to be applicable in circumstances in which environmental change is so severe that traditional companies cannot cope with various dynamic factors. Even small companies that conduct R&D only through partnership with large companies seem to be able to succeed at innovation and be competitive. However, internal R&D that builds a basic and foundational knowledge for innovation is still necessary for all innovative companies. Companies with more capital will benefit at some level even under open

innovation. Therefore, the application of the concept of Schumpeterian competition, which indicates that companies with more capital emerge as industry leaders, is worth investigation. Thus, we pose the following research questions in this paper: 1) Is open innovation better than closed innovation? 2) How is Schumpeterian competition applied to open innovation?

In order to answer the abovementioned research questions, in this paper we explore and compare closed and open innovation in terms of the capital and production of the industry, and describe how the concept of Schumpeterian competition functions under open innovation using the simulation method. The results obtained highlight how a leading position may be sustained in such a rapidly changing environment.

The remainder of this paper is structured in the following manner. The second section reviews Schumpeterian competition and the concept of open innovation. The third and fourth sections explain the research model and research method, respectively. The fifth and sixth sections report and discuss the research result. The seventh, eighth, and ninth sections present the implications, limitations and direction for future study, and conclusions, respectively.

Ⅱ. Background: Schumpeterian Competition and Open Innovation

1 Innovation under Schumpeterian Competition

The attempts of classical economists to analyze economical phenomena based on static efficiency do not explain numerous recent phenomena that have occurred as a result of the more complex and uncertain business environment. Therefore, certain economists adopted different perspectives in order to explain new phenomena. An example of such attempts is the evolutionary theory (Alchian, 1950; Nelson and Winter, 1982; Winter, 1971). Based on the evolutionary theory in biology, economists were able to develop evolutionary economics, which explains the behavior of companies and industry in terms of dynamic changes in innovation, imitation, and positive profit.

Adopting the evolutionary theory under Schumpeterian competition, the basic innovation process is described in the following manner. At the outset, it is assumed that there are identical companies in the industry (Nelson and Winter, 1978). Every company has an equal amount of capital for innovation and an equal level of productivity for production. These companies attempt to innovate; however, the success of this innovation is random. The company that has successful innovation results is able to improve its productivity. The other companies that failed to innovate, attempt to imitate a leading company. However, the success of imitation is also random.

Nelson and Winter (1978) attempt to explain this process using the simulation technique derived from Gibrat's law, which is presented in Mansfield (1962). This model focuses on positive feedback from the supply side of

innovation. When a company innovates successfully and obtains superior technology, there is an increase in its revenue and profits. With this surplus profit, the company increases R&D investment and attempts to undertake another innovation. An increase in R&D investment leads to an increase in the probability of successful innovation. As a result of more successful innovation, the company is able to earn more revenue than before and increases R&D investment again. This virtuous circle established by such positive feedback enables the company to maintain a sustainable competitive advantage.

In contrast to the virtuous circle, there is also a vicious circle that exists in the context of Schumpeterian competition. The lower the revenue of a company, the lower the capital invested in R&D, and, as a result, the lower the probability of successful innovation. There are studies that indicate that the size of a company improves innovation performance (Henderson and Cockburn, 1996; Lee, 2003). Therefore, in order to achieve successful innovation and generate greater revenue, companies that are not leaders have to imitate the innovation style of leading companies.

Recently, the introduction of the concept of the benefit of dynamic efficiency has changed the perception that competition is always beneficial. In classical economics, maximization of social welfare is the best in terms of static efficiency. On the other hand, in the real world, if an industry becomes more competitive, certain companies do not have the ability to innovate successfully; as a result, such companies are forced to shutdown, thereby decreasing industry size. However, in terms of dynamic efficiency, innovation can enable the expansion of industry size and improvement in technology. Therefore, in the long run, dynamic efficiency is more profitable than static efficiency.

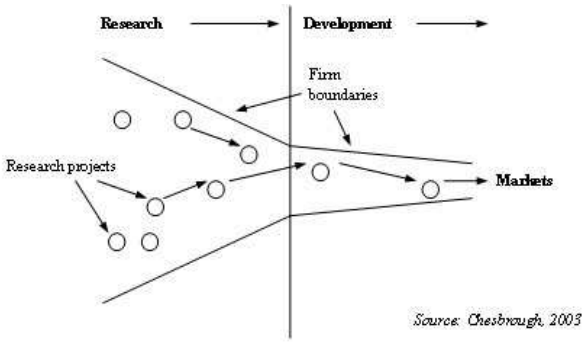
2. The Paradigm Shift from Closed to Open Innovation

Currently, we are witnessing the era in which companies with remarkable internal R&D capacities, such as Lucent, IBM, and XEROX, are struggling to survive. Chesbrough (2003c) claimed that the paradigm of innovation has undergone a radical transformation from closed to open. Like Schumpeterian competition, the logic of closed innovation also created a virtuous circle. However, radical changes and increased uncertainty of the business environment, which have made new entries easier and long term investment in research useless, have eroded the underpinnings of closed innovation. The concept of closed innovation is no longer sustainable. Instead, the concept of open innovation has been developed to replace closed innovation.

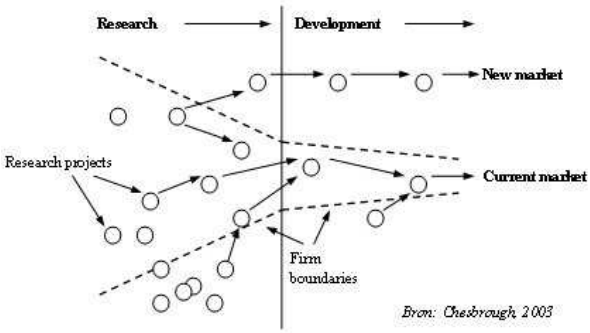
Under closed innovation, which was the paradigm of the past, most companies were highly secretive regarding their discoveries and made no attempt to assimilate information from beyond their own R&D labs. However, in recent years, the world has witnessed major advances in technology and society that have facilitated the diffusion of information through electronic communication

systems, including the Internet. This phenomenon, which has made information transfer rather easy, encourages open innovation.

Open innovation implies that valuable ideas may come from inside or outside the company, and may also go to the industry from inside or outside the company (Chesbrough, 2003c). The business model of the company determines what external information must be brought inside and what internal information must be taken outside. The central concept of open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research; instead, they should buy or license processes or inventions from other companies. In addition, internal inventions of a company that are not being used for its own business should be taken outside the company through licensing, joint ventures, or spin-offs. Figures 1 and 2 illustrate the difference between these two concepts.



〔Figure 1〕 Flow of Ideas in Closed Innovation (Chesbrough, 2003c)



〔Figure 2〕 Flow of Ideas in Open Innovation (Chesbrough, 2003c)

3. Research Models

In this paper, two models are developed and compared in order to explain the two types of innovation. The first model is developed in order to describe closed innovation under Schumpeterian competition. From this basic and initial innovation model, the second model is created in order to assimilate the interactions among companies for incorporating the phenomenon of open innovation.

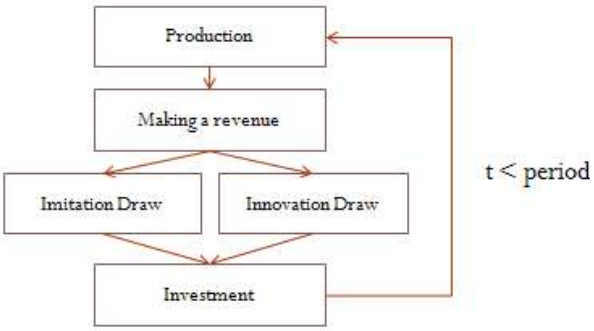
1 Model I: The Closed Innovation Model

This model, which is the basic model in this paper, is created in order to describe a closed innovation process in which there is no interaction among companies with regard to innovation. The innovation processes of companies in this model are assumed to be conducted under the virtuous circle of Schumpeterian competition based on Nelson and Winter's (1978) model. This cycle comprises four steps (Nelson and Winter,

1978). The first step is production—each company produces in proportion to its productivity. A company with high productivity produces more than a company with low productivity. The second step is generating revenue—after the production stage, companies sell their products and generate revenues. At this stage, the net incomes of companies are calculated in the following manner.

$$Net_{jt} = Price_{jt} \times A_{jt} \times K_{jt} - Cost_{jt}.$$

In the above equation, A represents the productivity of company j at period t, and K represents the capital of company j at period t. Price is given at period t. Cost includes variable costs, depreciation costs, and an interest cost. The third step is innovation and imitation—each company innovates and imitates in this step. The probability of success in innovation and imitation is proportional to the company's capital K in period t. If a company succeeds in innovation, its productivity increases according to normal distribution N. If a company succeeds in imitation, its productivity increases to the maximum productivity in the respective industry. The fourth step is investment—each company attempts to invest its profit, thereby leading to a change in its capital level. The capital of the company that made no profit at t - 1 does not change in period t. These steps simulate the virtuous circle that enables large companies to expand their size over time. These four steps are illustrated in Figure 3.



〔Figure 3〕 Basic Steps of Simulation

2. Model II: The Open Innovation Model

Model II incorporates the current phenomenon of open innovation through the four steps of the innovation process. Model II is designed on the basis of the Schumpeterian framework, the model of strategic alliance, and Schumpeterian dynamics given by Lee (2003). The simulation model given by Nelson and Winter (1978) enables a description of the functioning of Schumpeterian dynamics in the industry. Lee (2003)'s work focuses on costs and benefits of strategic alliances under Schumpeterian dynamics. However, Lee (2003) assumed that companies could innovate either from an internal or external source, and only one partnership could be formed at any given time. Our research model extends their work to adopt the concept of open innovation.

In our research model, companies can simultaneously conduct innovation internally and externally, and may form partnerships with more than one company at any given time.

The essence of open innovation is that companies seek external sources of innovation

that are more valuable than internal ones (Chesbrough, 2003c; Sakkab, 2002). Therefore, external search is used to interpret the openness of the company (Katila and Ahuja, 2002; Laursen and Salter, 2006). According to Laursen (2006), openness can be defined by two concepts—external search breadth and external search depth. External search breadth is defined as the number of external sources or search channels that companies rely upon in their innovative activities. Further, external search depth is defined as the extent to which companies draw deeply from different external sources or search channels in their innovative activities.

In order to assimilate the external search breadth and depth of networked innovation, we modify Model I by using the concept of the network given by Watts and Strogatz (1998) and the exposed rate of a company's capital given by Muller and Penin (2005). The concept of external search breadth can be represented as a degree of node in the model given by Watts and Strogatz (1998). The k degree of node implies that the number of other companies that one company decides to interact with through partnership during the innovation process is k. In the study of R&D partnership by Muller and Penin (2005), the exposed rate of a company's capital represents the ratio of open capital for networked innovation to total capital, and this is consistent with the concept of external search depth (Katila, 2002; Laursen and Salter, 2006).

In this manner, the capital of a company may be categorized into two types: open capital and closed capital. Open capital is the capital that is used in networked R&D, while closed capital is the capital that is used for internal R&D. Under open innovation, every company divides its available capital on the basis of exposed rate. Since the success rate of innovation depends on the amount of capital invested in the innovation process, the probabilities of success in closed and open innovation in company i are given below.

The probability of success in closed innovation: $\propto (1-e)\times K_{it}$.

The probability of success in open innovation: $\propto e\times\frac{K_{it}}{k_i}+e\times\frac{K_{jt}}{k_j}$.

In the above equations, e: exposed rate with a range of 0 to 1;

K_{it} : capital of company i at time t;

k_i : the number of other companies in partnership with company i.

As compared with closed innovation, the amount of innovation in a company increases under open innovation. Open innovation enables a company to save cost and time (Chesbrough, 2003b). For example, Procter & Gamble save cost and time for internal R&D by utilizing external knowledge (Sakkab, 2002). Therefore, in our model, the cost of open innovation must be lower than that of closed innovation, thereby suggesting different weights assigned to each type of innovation. The cost structure of company I is expressed in the following manner.

Cost of closed innovation = (cost rate $\times(1-e)\times K_{it}$).

Cost of open innovation = (cost rate $\times 0.5 \times e \times K_{it}$).

In the above equations, e: exposed rate with a range of 0 to 1;

K_{it} :capital of company i at time t.

The total cost of the company is given by the sum of closed and open innovation cost. The weight of open innovation is 0.5 while the weight of closed innovation is 1. This weight structure is influenced by the assumption that a company can reduce half of its internal R&D cost by utilizing partner's knowledge under open innovation.

Ⅳ. Simulation Design

We simulate 100 time periods, which implies that there were 100 iterations. Each period comprises four steps of the innovation process: production, generating revenue, imitation or innovation, and investment. One period ends with the investment step, and this moves to the production step in the next period. In order to obtain an accurate result, the process of simulating 100 time periods is repeated 1,000 times, and the results of each period generated from the 1,000 repetitions are averaged. Table 1 presents the details of the simulation setting of the models such as the number of companies, initial capital, productivity, and price of each company, probability of success of innovation and imitation, return for successful innovation, variable cost, depreciation cost, and interest rate, which are adopted from Nelson and Winter (1978).

〈Table 1〉 Parameters used in the Simulation

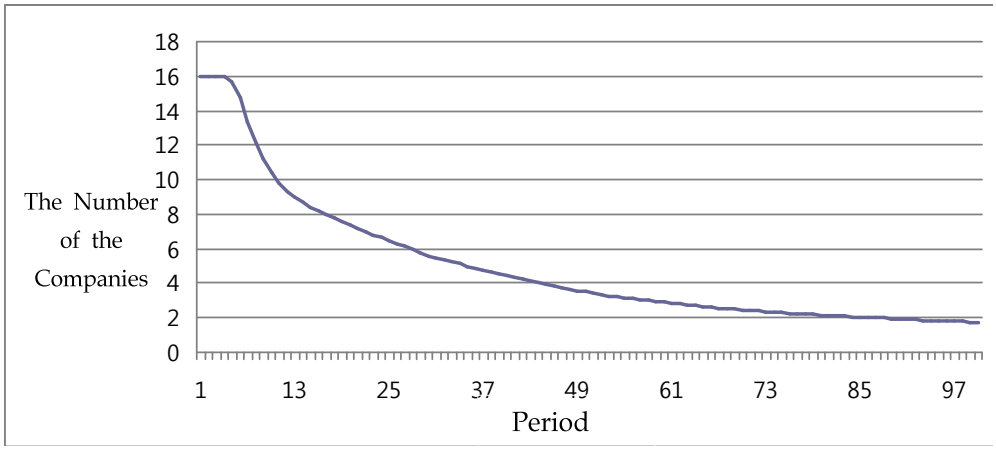
Parameters for R&D Investment	Initial Number of Companies in the Industry	16
	Initial Capital	25
	Initial Productivity	0.16
	Initial Price	512
	Probability of Successful Innovation	0.0025
	Probability of Successful Imitation	0.0025
	Return for Successful Innovation	0.03
Parameters for Costs	Variable Cost	0.1
	Depreciation Cost	0.03
	Interest Rate	0.03

In order to estimate the effect of Schumpeterian competition by incorporating various circumstances of open innovation, Model II controls expose rate, number of partnerships, and randomness of the network from Model I.

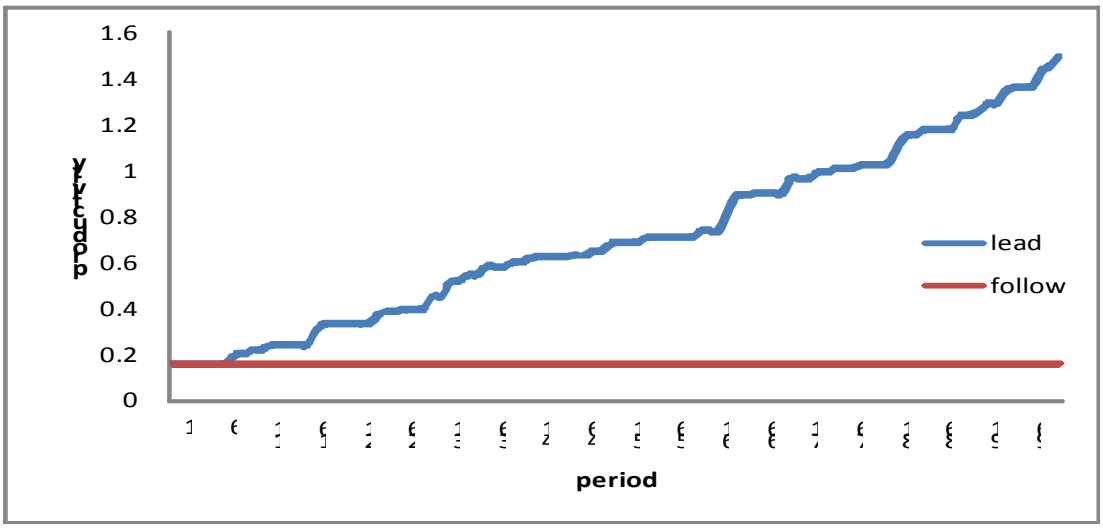
Ⅴ. Results

5.1 Result of Model I (The Basic Innovation Model)

Traditional research on innovation suggests that a winner must emerge from competitive struggle (Nelson and Winter, 1982; Schumpeter, 1934). The average number of survivors over 100 periods presented in Figure 4 indicates that fewer than two companies survived under closed innovation.



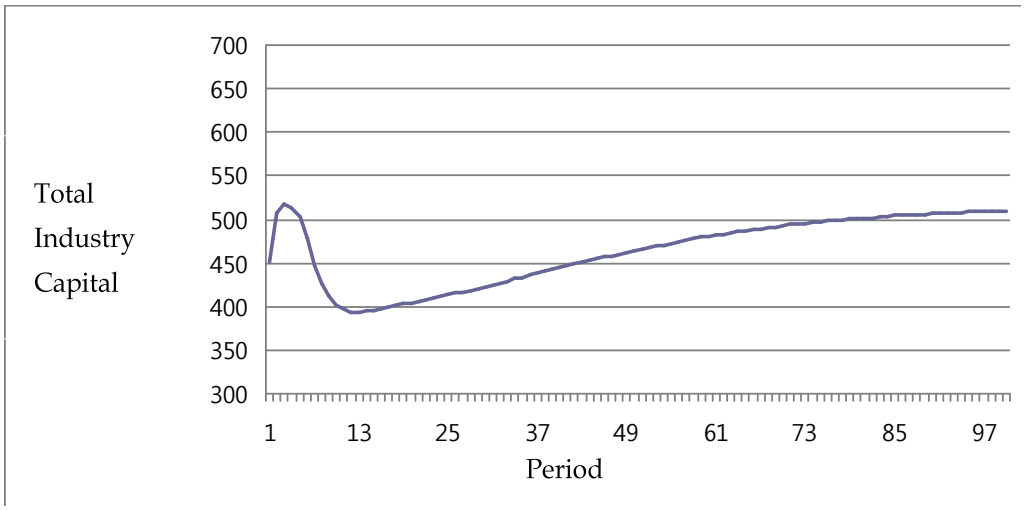
〔Figure 4〕 The Number of Survivor Companies



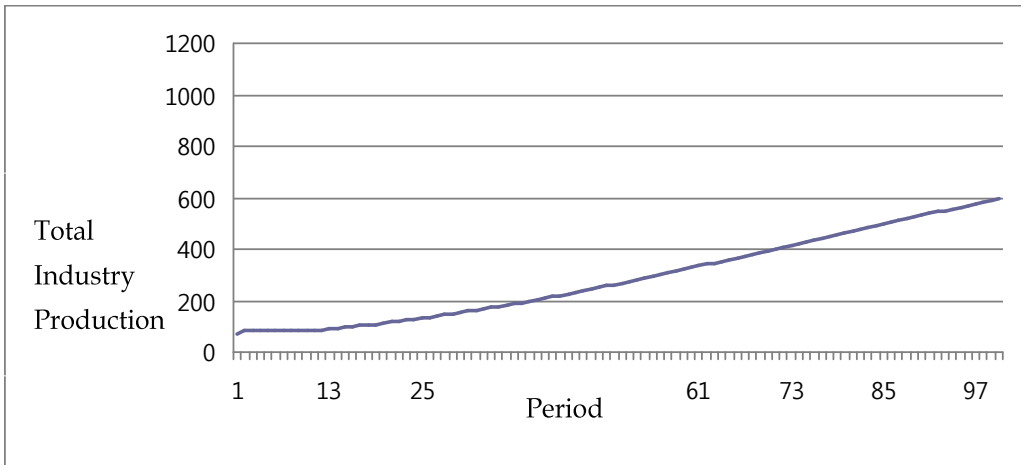
〔Figure 5〕 The Difference in Productivity between a Leader and Follower

This represents a typical industry evolution where winners emerge over time with a high degree of concentration. Figure 5 traces the productivity between the leader and follower represented as the largest company and smallest company, respectively; this reveals a large gap between the two companies, thereby implying the existence of Schumpeterian competition. The leader increases productivity through increased capital and investment for innovation, thereby representing the virtuous circle, while followers struggle under competition in the vicious circle; this is consistent with Schumpeterian competition.

Figures 6 and 7 illustrate that the total capital and production in the industry have increased slightly. With a decrease in the number of companies in the industry, the degree of competition becomes lower. As a result, the leader in the market receives the advantage of the virtuous circle—an increase in its capital and production.



〔Figure 6〕 Total Capital of the Industry under Closed Innovation

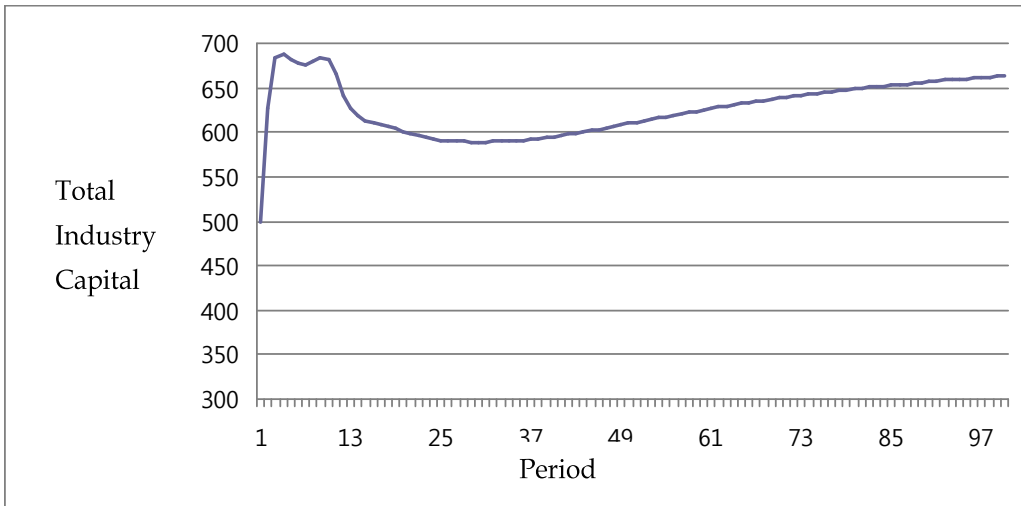


〔Figure 7〕 Total Production of the Industry under Closed Innovation

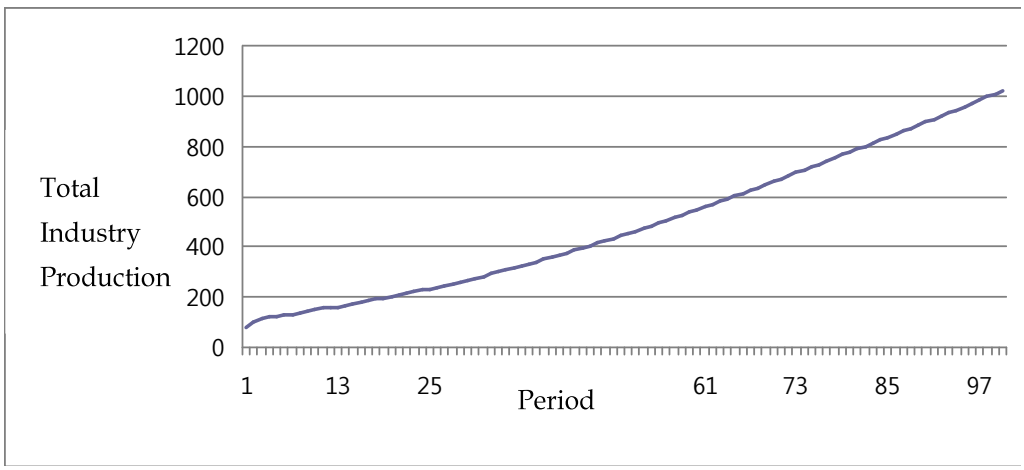
Thus, the simulation of Model I confirms the existence of Schumpeterian competition and supports traditional innovation theories under closed innovation.

2 Result of Model II (The Open Innovation Model)

In the open innovation model, we first examined the total capital and production of the industry in order to ascertain if open innovation has a more positive effect on the ecosystem over time as compared with closed innovation. The expose rate and number of alliances are fixed as 0.5 and 8 respectively, which are the medians of each range. As illustrated in Figures 8 and 9, there was a significant increase in the total capital and production of the industry. Although the total capital and production also increased over time under closed innovation, the degree of increase is much higher under open



〔Figure 8〕 Total Capital of the Industry under Open Innovation



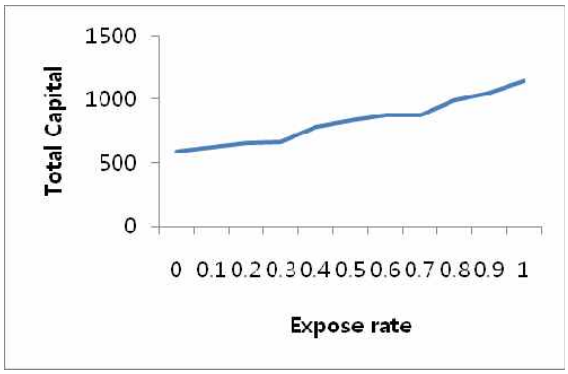
〔Figure 9〕 Total Production of the Industry under Open Innovation

innovation. As suggested by Chesbrough (2003a), this result confirms that the capability of the entire industry is stronger under open innovation than closed innovation and has a positive effect on the entire ecosystem.

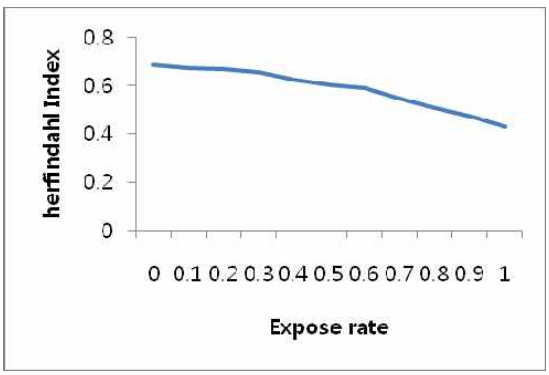
Second, we varied the expose rate and number of alliances, assuming that there are 16 initial companies in the industry, in order to ascertain the effect of external search depth and breadth on the industry. Industry concentration and competition level was estimated using the Herfindahl index.[2] A

2) The Herfindahl index is a measure of the size of companies in relation to the industry and an indicator of the amount of competition among them [11] Hirschman, A. O. (1964), The Paternity of an Index, The American Economic Review, 5(54). The index is defined as the sum of the squares of the industry shares of each individual company, when the industry shares are expressed as percentages; the result is proportional to the average

high capital concentration of the industry implies that there is a huge gap between the large and small companies; therefore, the effect of Schumpeterian competition on the industry is significant. On the contrary, alow capital concentration in the industry implies as mall gap between large and small companies; therefore, the effect of Schumpeterian competition in the industry is small.

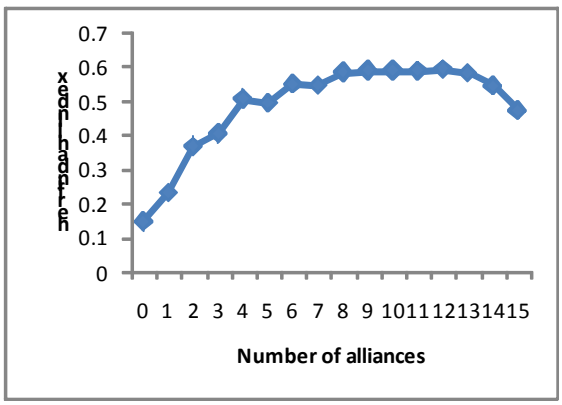


〔Figure 10〕 The Relationship between Total Industry Capital and External Search Depth



〔Figure 11〕 The Relationship between Herfindahl Index and External Search Depth

Figure 11 illustrates the relationship between expose rate and the Herfindahl index. When a company exposes a larger amount of capital for open innovation, the Herfindahl index strictly decreases, thereby implying a decrease in competition. This implies that if companies in the industry expose a larger amount of capital or make greater effort to conduct open innovation, the benefit accruing to small companies is greater than that to large companies at a certain point.



〔Figure 12〕 The Relationship between the Herfindahl Index and the Number of Alliances

In order to determine the effect of external breadth, the relationship between the Herfindahl index and number of alliances was examined, as illustrated in Figure 12. The figure presents an inverted U-shaped curve depending on the number of partners, which ranges from 0 to 15 (total number of companies - 1). This implies that when companies in the industry increase the number of partners, which implies broadening their external search, the industry concentration increases, thereby suggesting that the industry power of large companies is

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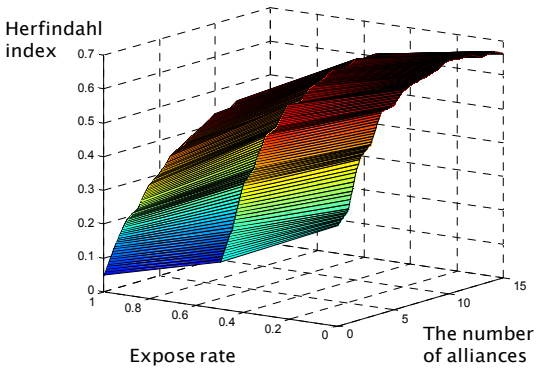
industry share, weighted by industry share— $H = \sum_i \left(\frac{K_i}{K} \cdot \frac{K_i}{K} \right) = \sum_i \left(\frac{K_i}{K} \right)^2$, where K_i is the capital of company i and K is the total capital of the industry.

strengthened. However, if the external search breadth exceeds a certain point, this benefit reduces.

The combined effect of expose rate and the number of alliances is presented in Figure 13.

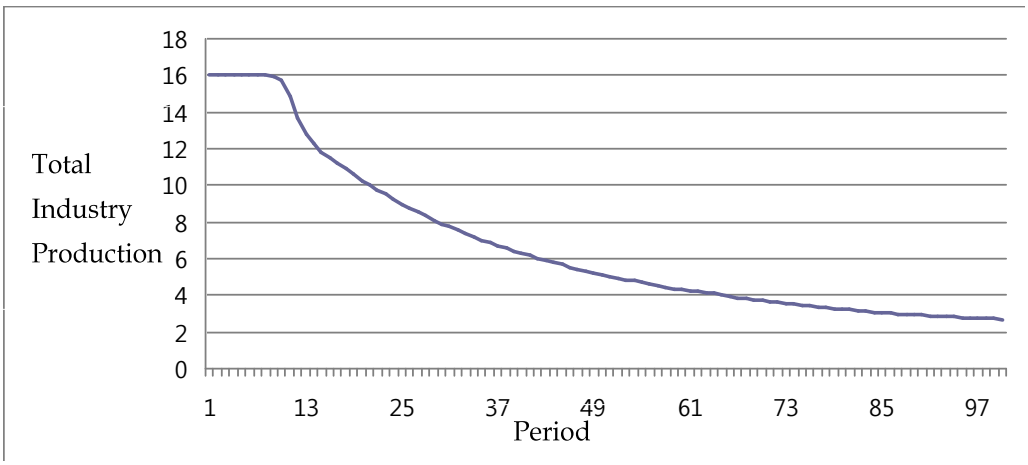


〔Figure 13〕 Combined Effect of Search Depth and Breadth

Third, we examined the number of companies that survived competition over time in order to ascertain the existence of the dynamics of Schumpeterian competition.

Figure 14 indicates that a few leading companies emerge from the competition over time. Although the number of survivors is higher under open innovation than that under closed innovation and a greater number of companies survive for a longer time, it is evident from the shape of the curve in Figure 14 that Schumpeterian competition functions even under open innovation.

Therefore, open innovation is better than closed innovation in terms of total industry capital and production, which benefit the entire ecosystem. When the number of companies remains the same, the benefit for small companies under open innovation, such as a decreased level of competition, is evident. Moreover, as the number of companies changes over time, a greater number of companies survive under open innovation than under closed innovation, thereby providing small companies with greater opportunities for survival in the competition. However, the result obtained in this paper indicates that there is an emergence of a few leading companies, thereby implying that Schumpeterian competition functions even under open innovation. Under open innovation, small companies have greater opportunities to



〔Figure 14〕 The Number of Survivor Companies

survive, and large companies have greater opportunities to enjoy increased benefit from innovation.

Ⅵ. Discussion

In this paper, we confirmed that open innovation increases the total capital production of the industry, thereby expanding the entire ecosystem. For example, Apple's iTunes and iPod strategy is a well-known example of ecosystem. Our result indicates that open innovation can positively influence the entire ecosystem.

As companies expose their knowledge beyond their boundaries, the Herfindahl index strictly decreases and total industry capital strictly increases. As companies broaden their external search breadth, the Herfindahl index curve has an inverted U shape. It is interesting to note that when the total number of companies in the industry remains unchanged, the concentration level of the industry decreases as external search depth increases, the concentration level of the industry decreases with an increase in external search breadth up to a certain point. This implies that more investment of their capital for open innovation provides small companies with better opportunities for competition, while a large number of partners will benefit large companies under open innovation. For leading companies, this implies that they have room to sustain their leadership if they can manage their openness even under open innovation.

Certain studies report that a company can improve its performance with a broader external search breadth (Katila and Ahuja, 2002; Laursen and Salter, 2006); however, excessive breadth may have negative effects (Katila, 2002; Koput, 1997). The result of Model II supports their arguments.

Moreover, the result of Model II also supports the functioning of Schumpeterian competition under certain conditions. For example, IBM successfully transformed its innovation method from closed to open (Chesbrough, 2003c). Although IBM was one of the leading companies under closed innovation, there has been a transformation in the IT environment over a period of time. The technology lifecycle has shortened, cost of innovation has dramatically increased, and consumers chose to outsource their IT resources. Due to these reasons, IBM experienced a near-death status. This made IBM realize that it must change its innovation method. It began by unbundling each individual value chain to make a profit through partnerships in the OEM industry. Moreover, the company attempted to leverage external technologies into its own and sell its own technology and intellectual property to other companies. All these activities required interaction with other companies. This example reveals that even under open innovation, leading companies can sustain their positions if they appropriately manage interaction with other companies.

This result is consistent with those of existing researches on innovation. Garman (2003) contends that "Open innovation has become a way for many big high-tech

companies to achieve a higher return on the billions of dollars they spend annually on researching and developing new products." For example, the IP Venture program of Microsoft is "the indicative of the trend toward open innovation" (Garman, 2006). Thus, in this manner, large companies are already using open innovation as a tool for sustaining competitive advantage. Further, recent research indicates that large companies tend to have a hybrid of centralized (internal) and decentralized (external) R&D (Tirpak et al., 2006). Our results support this phenomenon by indicating that industry concentration is higher at a certain level of openness, and that large companies can strengthen their leadership by using an appropriate combination of internal and external innovation. In order to utilize the effect of open innovation to sustain competitive advantage, companies must seek external sources for associated technology, foster champions to bring in outside technology, and avoid over- and under-funding (Chesbrough and Crowther, 2006).

Ⅷ. Implementation

1. Theoretical Implementation

First, in this paper, we investigated and proved the effect of open innovation through simulation. Although numerous previous researches discuss the effect of open innovation, very few researches attempt to simulate the phenomenon and obtain a definite result. Further, we focused on the effect of open innovation on the entire industry and not just on an individual organizational level.

Second, we used the simulation method in order to describe a complicated real-world phenomenon. Since the simulation method enables the study of a complex system such as open network of innovation, its application for understanding different types of networked systems will enrich our knowledge.

Third, through Model II, internal and external R&D is employed simultaneously in order to create a more real-world simulation. Most prior researches adopted one type of R&D and focused only one aspect of R&D. Simultaneous accommodation of two different types of R&D can provide an indication of the manner in which real companies function with regard to a division of their R&D resources.

2. Practical Implementation

This study suggests that managers of companies must consider opening-up their capital in order to receive greater profit. In particular, large companies that have a large number of R&D assets and are afraid of exposing their resources to outside companies may obtain an insight that if openness is appropriately controlled, profits can be increased while maintaining their leading position. Yet, this does not necessarily imply that companies should provide their resources or intellectual properties for free for greater good. Opening-up capital without much

consideration may lead to the weakening of a company's current position. Companies must be cautious in terms of how much and to whom they open. Copyrights for the intellectual property with significant competitiveness should be kept. There are other proper ways of opening their resources without taking a risk of exposing its precious resources to rival companies. For instances, licensing or co-investment under a contract can be legitimate ways to open their resources under the legal umbrella. Unethical or illegal opportunistic behavior in the relationship between partners, whether it is a large firm or a small firm, will harm future relationship, worsening the whole industry growth and harming the search for valuable outside knowledge. These shortsighted behaviors will lead to negative effects on the long run.

Furthermore, the managers of small companies must be aware that while open innovation provides them with greater opportunities for survival and enables them to gain more profits, large companies may have better opportunities over time. Therefore, small companies must be wise in selecting partners in order to become leading companies in the industry.

Ⅷ. Limitations and Future Study

First, our model concentrates on process innovation by adopting the model given by Nelson and Winter (1978). Future studies on different types of innovation can enrich existing knowledge of open innovation. Second, in addition to the simulation method, empirical tests using real-world data will strengthen our findings; for example, an event study of alliances (Chan et al., 1997) may help to strengthen our results.

Ⅸ. Conclusion

In order to explore the effect of open innovation, we simulated two different models featuring closed and open innovation, and compared the result and structure of the industry. We found that under open innovation, total capital and production of the industry is higher than under closed innovation, which implies that not only large but also small companies can obtain greater profits. Moreover, Schumpeterian competition was found to function even under open innovation. This suggests that large companies can maintain their leadership, prospering along with small companies.

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저 자 소 개

윤 지 영 (Ji-Yeong Yun)

KAIST 경영대학에서 석사학위를 취득하고 현재 한국투자공사 정보시스템팀 대리로 재직 중이다. 관심분야는 지식경영, 복잡계이론, 금융정보시스템이다.

민 진 영 (Jin-Yeong Min)

KAIST 경영대학에서 박사학위를 취득하였으며 현재 미국 Temple University에서 Post-Doc. 연구원으로 있다. 주요 관심분야는 Social Media, Human and Computer Interaction, Technology and Virtual Environment, Digital Ecosystem 이다. 경영학연구, 경영과학회지 등의 국내 학술지에 논문을 게재한 바 있다

한 세 희 (Se-Hee Han)

현재 KAIST 경영대학에서 박사학위 과정 중이다. 주요 관심 분야는 모바일 및 소셜 미디어에서의 소비자 행동 등이다

이 희 석 (Hee-Seok Lee)

현재 카이스트 경영대학 교수로 재직 중이다. 카이스트 지식경영연구센터 센터장으로 40여 회원사 기업의 지식 경영을 진단하고 있다. 현재 한국지식경영학회 학회장이기도 하다. 아리조나대학 경영학 박사 취득 후 네브라스카대학 교수를 역임하였다. 주요 관심분야는 Strategy와 IT이다. MIS Quarterly, Journal of Management Information Systems, Information and Management, International Journal of Electronic Commerce등 주요저널에 논문을 발표하였다