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What Motivates Start-up Firms When Innovations are Sequential?

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순차적인 혁신하에서 창업기업에 어떤 동기부여가 가능한가?

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* This paper presents a dynamic analysis of the interaction between incumbent firms and successful new entrepreneurs, that can provide R&D incentives when innovations are cumulative/ sequential. It is argued that insights of the basic model extend to varying market structures and regulatory environments.

• Key Word: Sequential Innovation(순차적인 혁신), Patent(특허권), Venture Capital(위험부담자본)
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ABSTRACT

This paper presents a dynamic analysis of the interaction between incumbent firms and successful new entrepreneurs, that can provide R&D incentives when innovations are cumulative/sequential. It is argued that the insights of the basic model extend to varying market structures and regulatory environments.

본 논문은 기업의 혁신이 순차(누증)적으로 일어날 때, R&D 인센티브를 제공할 수 있는 현존 기업들과 성공적인 신임 기업가들의 관계를 동태적으로 분석한 것이다. 본고에서는 기본 모델이 다양한 시장구조와 규제환경으로 확대(적용)될 수 있다고 주장한다.

Ⅰ. Introduction

A distinguishing feature of modern high-tech industries, such as software and biotech, is that the technological progresses are made through sequential innovations that build upon previous innovations. Due to such sequential nature of innovations, the conventional approach and results on R&D that treat innovations as isolated events, are inadequate for modern high-tech industries.

The conventional wisdom is that strong protection of invention/innovation (e.g., by patents) promotes the incentives of R&D, thereby economic growth, by rewarding the successful entrepreneurs through monopoly rent for the duration of patents. On the other hand, more protection means larger dead-weight loss of monopoly. The optimal patent policy, therefore, would be to balance the positive effect of providing incentives for worthy R&D activities, and the negative effect of allowing the monopoly dead-weight loss.

When innovations are sequential (i.e., they build on previous innovations), strong patent protection has an extra, negative effect of discouraging R&D efforts of further innovation by anyone other than the patent-holder of the previous innovation,[1] because the sequential nature of further innovation means that it will infringe on the previous patent. Bessen and Maskin (2004) show that this negative effect can be so large between major rival innovators of the industry, such that stronger patent protection reduces (rather then promotes) their R&D activities. Scotchmer (1991) argues that, unlike the conventional R&D literature, "breadth" of patent protection is an important policy dimension in sequential/cumulative innovation, and that the role of patent protection is more on determining the bargaining positions in ex ante joint venture agreement between the current patent firm and the potential next-generation innovator.

The patent's effect of discouraging further innovation is particularly important in industries in which many valuable discoveries are made by enthusiastic new entrepreneurs, such as internet and software industries. For such environments, the findings of Bessen and Maskin (2004) are not particularly useful because they analyze established rival firms in an industry, nor those of Scotchmer (1991) because it would be practically hard to identify the right joint venture partner from many unknown entrepreneurs. In this paper we present a dynamic mechanism between incumbent firms and successful new entrepreneurs, that may provide R&D incentives of the latter, hence sustain innovation process in the industry. This is mainly done in Section 3, preceded by preliminary discussions on a single-innovation case in Section 2. Then, in Section 4 we extend the findings of the basic model and explore the roles of startup firms in innovation processes in varying market structures and regulatory environments. A brief overview of these sections follows below.

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[1] In high-tech industries there also exists a competition in a separate dimension, namely, in establishing your own technology as the industry platform/standard, which will expand your market base. The current analysis concerns successive product improvements through sequential innovations in industries with already established platforms. An interesting future research would be to analyze a dynamic model that combines both aspects of the high-tech industries.

Successful amateur entrepreneurs (e.g., in Silicon Valley) will form small startup firms with a marketable product, however, they would be much less positioned to market their products than an established major player of the industry (e.g., Microsoft). Moreover, chances are that the new product is infringing on some patents in a large patent portfolio of the major firm. Instead of taking legal action that is costly and uncertain in practice (empirically patent litigations have about 50% chance of winning in the US), the major firm can reach a buyout deal with the startup firm.[2] The degree of patent protection affects the bargaining positions in this deal in two ways: stronger protection shifts the bargaining power to the current patent-holder (major firm); at the same time, the major firm finds the current deal more valuable because its enlarged patent portfolio strengthens its future bargaining position to a larger extent. The latter increases the size of pie that they bargain over, thereby improves the bargaining outcome for the startup firm. The expected value of such buyout deal provides incentives for the entrepreneurs.

In this dynamic context of sequential innovations, an optimal degree of patent protection is one that motivates the major firm for longest periods in buyout deals for future benefit, which in turn generates a share of the startup in the buyout deal that is sufficient to attract the entrepreneur at the beginning. As this outline of the analysis indicates, in industries where a pool of creative and open-minded entrepreneurs is important in successful innovations (relative to the in-house R&D of established firms), the successful small startup firms are at the centre of the engine of technological innovation. Accordingly, it is important to have entrepreneurial culture and financial systems that are favorable to small startups. This finding accords well with the observation that the software industry prospered much more in the US where venture capital for startups are developed, than in the EU where patent protection is much lower (which would be favorable for innovation in the context of Bessen and Masking).

Note that in our setting the R&D incentives of the startups are essentially determined by the Nash bargaining outcome and the stronger future bargaining position rendered by enlarged patent portfolio. These essential forces are not affected by some realistic changes of the model, such as when multiple entrepreneurs engage in R&D race, when the firms negotiate licensing agreements rather than buyout deals, and when more than one major firms compete as rivals in the industry. Because some market power of the major firm is necessary for adequate surplus to sustain the R&D of startups (transmitted via Nash bargaining), one obvious concern is the reconciliation of limiting the market power without killing the R&D incentives. Competition by major firms may reduce the market power without dampening R&D incentives excessively, because the startup firm would have a stronger bargaining position with multiple potential partners. Existence of a rival firm, even of a medium-size, may ease this concern beyond the direct competition in current markets, especially if reputations of major firms matter for future demand.

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[2] Westbrock (2004), for example, reports that mergers in the semiconductor and computer industry during 1990-2000 are concentrated on the technology leaders like Intel, 3Com, and Apple Computers, ATI Technologies and Broadcom.

Ⅱ. Preliminary: A Single-Innovation Model

Consider an industry consisting of two asymmetric firms: Firm 1 is an incumbent (dominant) firm (e.g., Microsoft) and firm 2 is a startup. Firm 2 can engage in R&D at a cost $C > 0$, which will result in a successful innovation with probability $\pi > 0$. The value of successful innovation from the perspective of supplier is V if firm 2 commercializes it, whereas it is worth more, say $V^* > V$, if firm 1 does. The value of unsuccessful R&D is 0.

Due to the sequential nature, the new innovation builds on previous technology owned/patented by firm 1. If firm 1 litigates, therefore, firm 2 loses the case with probability p: In this case the new technology is freely available to anyone, lowering its actual value to firm 1 down to bV^*, $0 \le b \le 1$. Its value to firm 2 in this case would be much smaller, which we assume to be 0 for convenience. On the other hand, if firm 2 wins the case (which happens with probability $1-p$), firm 2 gets a patented ownership of the innovation and captures the full value V. A stronger IP protection is captured by higher p. A litigation incurs costs of $c_i \ge 0$ to firm i, $i = 1, 2$, although we assume $c_1 = c_2 = 0$ here for expositional ease.

Instead of litigation, firm 1 can negotiate a buyout deal with firm 2. We model this process as a Nash bargaining as follows. Should they fail to reach a deal, they will end up in a court. Hence, the disagreement/threat points of the firms are the respective expected surpluses from litigation, i.e.,

$$d_1 := pbV^* \quad \text{and} \quad d_2 := (1-p)V.$$

Since V^* is the maximum value of the technology for the suppliers, the two firms would bargain over how to split V^* between them, i.e., the Nash bargaining set is defined as

$$B := \{(u_1, u_2) \in \Re_+^2 \mid u_1 + u_2 \le V^*\}.$$

Since B is compact and convex, there is a unique Nash bargaining solution (s_1, s_2) that solves

$$\max_{(s,s')\in B} (s - d_1)(s' - d_2)$$

and the solution values are,[3] as functions of p,

$$s_1(p) = \frac{V^* + d_1 - d_2}{2} = \frac{1 + p(b+r) - r}{2} V^* \quad \text{and}$$
$$s_2(p) = \frac{V^* - d_1 + d_2}{2} = \frac{1 - p(b+r) + r}{2} V*$$

where $r := V/V^* \in (0,1)$. These will be the equilibrium outcome of the

[3] See, e.g., Myerson (1997).

single-innovation model. Hence, we have

PROPOSITION 1: *In the single-innovation model the firms would reach an equilibrium buyout deal that splits* V^* *into* $s_1(p)$ *and* $s_2(p)$ *above, hence firm 2 will invest in R&D if and only if* $\pi s_2(p) \geq C$ *. Stronger IP protection decreases (increases) the share of firm 2 (firm 1) via weakening (strengthening) its bargaining position and thereby, reduces the innovation incentives of the startup firm.*

Ⅲ. A Sequential Model

We follow Bessen and Maskin (2004) closely in enriching the model to accommodate sequential innovation. There are infinite periods indexed by $t = 1, 2, \cdots$, in each period of which firm 2, if invested in R&D, succeeds in an innovation with probability π, that has commercial values of V^* and V to firms 1 and 2, respectively. Here, firm 2 is a new firm that arrives in each period[4] while firm 1 is long-lived.[5] To avoid the so-called *replacement effect,* as in Bessen and Maskin (2004), we suppose that these values are incremental values.

If there is no IP protection (i.e., $p = 0$), what can happen to firm 1 in the future is independent of what happens in the current period and, therefore, the two firms bargain over V^* in every period. With a positive level of IP protection, the value of owning the innovation to firm 1 is V^* (direct value) plus the increment in future bargaining share due to a strengthened bargaining position via an enlarged patent portfolio (which pushes up future p). Since the increased value of owning the new technology for firm 1 increases what the firms bargain over, it can improve the bargaining outcome of the firm 2. Hence, some positive level of IP protection may give more R&D incentive to startup firms than no protection. To capture this effect, we need to define p as a function of both the degree of IP protection and the size of firm 1's patent portfolio $L = 0, 1, 2, \cdots$.

We model the level of IP protection by a parameter $z \in [0, 1/2]$ in the following manner. Since $L = 0$ means no IP to protect, $p_z(0) = 0$ for all z, where the argument of p_z is L. Then, the k-th patent added to firm 1's portfolio increases p by z^k : that is, $p_z(1) = z$, $p_z(2) = z + z^2$, and

$$p_z(L) = \sum_{k=1}^{L} z^k .$$

REMARKS: (1) Not having a patent on an innovation would reduce p in reality but not modelled. This would only reinforce our message because firm 1 would have less bargaining power when it reduces p. (2) The impact of the k-th patent of firm

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[4] In reality, many potential innovators may engage in R&D race. This is not likely to change our main results as discussed in Section 4.1.

[5] In reality, firm 1 may also engage in R&D. In this case firm 2 needs to succeed in innovation before firm 1 to get the benefits, hence has less incentive to invest in R&D. This does not change the qualitative results of the paper, although it dampens the effect of patent protection on promoting R&D by start-up firms.

1 would differ depending on how many previous inventions are not in L, which we also abstract from. This should not matter for the qualitative results.

If $z = 0$, every period is separate as explained earlier, and the buyout deal would be the same as in Section 2 with $p = 0$. In particular, each period the surplus of the startup firm that undertook R&D is $\pi s_2(0) := \pi(1+r)V^*/2$. Depending on the size of R&D cost C relative to $\pi s_2(0)$, either there will be R&D by startup (hence, innovation with probability π) in every period, or there will be no R&D at all. For each of these two cases, we examine the effects of positive levels of IP protection, i.e., $z > 0$.

1. The Case of R&D When $z = 0$

If $\pi s_2(0) > C$ there will be R&D every period when there is no IP protection, i.e., $z = 0$. Hence, IP protection ($z > 0$) does not induce any innovation that would not have been possible without it. Nonetheless, we examine the innovation incentives in this case, for it would help understand the analysis in the other case.

Let $\hat{z}$ be such that $\pi s_2(p_{\hat{z}}(\infty)) = C$. Then,

[A] for any $z < \hat{z}$, firm 2 invests in R&D in every period.

To see this, observe that in each period i) firms 1 and 2 bargain over a total surplus exceeding V^* if there is an innovation, ii) $p < p_{\hat{z}}(\infty)$, and iii) the disagreement points are the same as when there was no future (because once they go to the court, the firm 1 does not own the new innovation even if it wins the case as described in Section 2, hence the incremental value due to an enlarged patent portfolio is foregone). Since i) means that the surplus they bargain over is larger than that of the single-innovation case, and ii) and iii) imply that the bargaining position of firm 2 is better than that in the single-innovation case for $p_{\hat{z}}(\infty)$, it follows that the expected value of Nash bargaining outcome for firm 2 is larger than $\pi s_2(p_{\hat{z}}(\infty)) = C$.

If $z > \hat{z}$, on the other hand, for large enough L firm 2 would not find it profitable to invest in R&D, because the total surplus to bargain over becomes arbitrarily close to V^* and so do the disagreement points to those in the absence of future, while p exceeds $p_{\hat{z}}(\infty)$, hence the expected value of Nash bargaining outcome for firm 2 goes below $\pi s_2(p_{\hat{z}}(\infty))$, i.e., it would not recover the R&D cost. Let L^* denote the largest portfolio size for which R&D takes place. For any $L < L^*$, R&D takes place as well because, relative to L^*, the total surplus to bargain over is larger and p is lower (and the disagreement points are the same as when there was no future). That is,

[B] if $z > \hat{z}$, firm 2 invests in R&D until firm 1's portfolio reaches a certain size, then no more R&D takes place.

2. The Case of No R&D When $z=0$

In this case it seems plausible to anticipate that IP protection can promote innovation in early stages of technology development, i.e., for low L, by enlarging the total surplus to bargain over. The innovation process, though, would inevitably stop eventually, because the total surplus to bargain over will converge back to V^* as the value of an additional patent dwindles to nil. However, this reasoning is self-contradictory: in the last period that R&D is supposed to take place, firm 2 would not have an incentive to invest in R&D because it would bargain with firm 1 over no more than V^* and have a worse bargaining position than when $z=0$ due to positive p. This appears to suggest a disturbing conclusion that, unlike the anticipation above, innovation would never take place in equilibrium.

This result, however, is an artifact of the simplifying assumption that all startups have the same cost of carrying out their R&D. Hence, we relax this assumption minimally as follows:

(α) In each period there is some chance, a probability $\eta>0$, that the R&D cost of the startup (firm 2) in that period is small, normalized to 0, instead of C. The realized R&D cost is private information of the firm 2 in each period.

Note that firm 2 will engage in R&D in any period if the cost is 0, hence an innovation will come forth with at least probability $\eta\pi$ in every future period. Recall that we are currently considering the case in which firm 2 will not invest in R&D if cost is C when there is no IP protection ($z=0$). Now, return to check the presumed equilibrium described above in this section. Again, the innovation process would inevitably stop eventually by the same reason. Consider the last period L^* that firm 2 would invest in R&D regardless of its cost. Since innovations will come forth with probability $\eta\pi$ in each future period, firm 1 would extract more surplus in the future if it had patent on the current innovation. Therefore, the total surplus to bargain over is larger than V^* by at least a certain amount, and firm 2 may still have an incentive to invest C in R&D even if its bargaining position is worse than when $z=0$ (i.e., even if $p>0$). This last period is one such that adding the current innovation to firm 1's patent portfolio will render firm 1's bargaining position strong enough that firm 2's share of the next pie to bargain over (which will be smaller than the current pie) does not recover C. Indeed such last period can exist in equilibrium. Furthermore, R&D takes place in any previous period because the pie is larger and firm 2 has a better bargaining position due to a smaller portfolio of firm 1.

For illustration, fix $V=10$, $b=0.5$, $r=0.1$, $C=5.5$, $\pi=1$ and $\delta=0.9$. Then, it is straightforward calculation to verify that, for all $0<z<0.5$, the startup firm will invest in R&D regardless of its cost if $L=0$, but not if $L\geq 1$ unless when the R&D cost is zero. Furthermore, for higher values of η and/or δ the future value of having a larger portfolio is greater for firm 1, enlarging the size of pie to bargain over. Hence, the startup may invest in R&D when $L=1$ as well, and possibly for larger L: For instance, this is so for large $z(<0.5)$ when $\eta>0.6$ or δ is near 1. The calculations for these illustrations are done by *Mathematica* and are available from the author upon request.

One obvious question of interest is the level of IP protection (z) that maximizes L^*, i.e., that induces R&D investments from high-cost startups as long as possible. It is straightforward to see that higher z is not always better, because p will get high very quickly, which is detrimental for firm 2's bargaining outcome. Hence, the optimal IP protection would be an intermediate level such that the value of the first patent is large enough (i.e., the pie in the first period to bargain is large enough) to drive up the innovation process via motivating the early-arriving high cost startups, but not too large to give excessive bargaining power to firm 1 prematurely that will discourage R&D investment.[6] However, it will be technically complex to give a full characterization or a general calculation formula of the optimal level of z. We summarize the discussions so far as below, which is a version of the findings in Panagopoulos and Park (2005).

PROPOSITION 2: *Consider the sequential model described above with the cost uncertainty as in (*α*). If* $s_2(0) > C$*, high-cost startup firms will always invest in R&D when IP protection is sufficiently low, including* $z = 0$*. If* $s_2(0) < C$*, high-cost startup firms will never invest in R&D for sufficiently low* z*. In this case, it is possible to induce R&D from high-cost startups by increasing IP protection, until firm 1's patent portfolio reaches a certain size: The optimal* z *that maximizes this critical portfolio size is an intermediate level such that early patents in the portfolio are valued sufficiently highly by firm 1 for their impact in strengthening firm 1' future bargaining position, but not too quickly to discourage startup firm's R&D incentives too soon.*

Ⅳ. The R&D Motives of Startup Firms

The analysis in the previous section suggests certain ways that may enhance and sustain the R&D motives of startup firms even when the innovations are sequential. Although the analysis is carried out on a simplified model in the previous section, the basic insights can be extended to varied market structures and regulation regimes.

1. Multiple Startups in R&D Race

In the base model we postulated that there is a single startup in each period. More generally, however, there may be multiple startup firms competing in R&D activities to be the first in succeeding in innovation. In the standard case that the startup firms are ex ante symmetric, each firm's incentive is lower than when there is a single firm because the probability of winning the R&D race is smaller when there are competitors. In equilibrium, the number of firms who engage in the race is the maximum number such that each firm's prospect of winning justifies the R&D cost, because any additional firm in the race would reduce the expected value of R&D

[6] Put differently, higher z means that the size of pie to bargain over is larger because the current deal would improve firm 1's future bargaining position, i.e., firm 1 "borrows" some part of its future bargaining shares. This borrowing should be large enough (i.e., z not too low) so that the early-arrived firm 2's shares are large enough to justify R&D investment, but not too large (i.e., z not too large) to deplete future pies too quickly and thereby, destroy firm 2's R&D incentives.

investment below its cost. This does not affect the fundamental roles of startup firms in industries with sequential innovations, but entails some changes in details as noted below.

Since the number of startup firms engaging in R&D is (weakly) larger than the case of a single startup,[7] the probability of innovation is higher in each period. This would speed up the innovation process for a given IP protection level.

When multiple startup firms invest in R&D, a question arises as to whether the individually rational multiple R&D decisions are inefficient from the perspectives of social welfare. It is possible, therefore, that the authority may find reducing IP protection desirable in the face of multiple potential startups, to prevent socially excessive, duplicative R&D activities.

2. Licensing Instead of Buyouts

The base model considered the case that the incumbent firm negotiates a buyout deal with the new innovator for a mutually beneficial outcome relative to the alternative of costly and uncertain legal proceedings, hence the incumbent retains the market power as long as a deal is reached. Although modelling out-of-court negotiations in this way allows cleaner analysis, such outright takeovers/mergers may not be prevalent for various reasons such as antitrust regulations. An alternative form of negotiation feasible in practice is licensing agreements: the startup firm markets its own product but pays royalties to the incumbent for the right to use the previous state of art which its own innovation is built upon. The essential findings of the previous section carry through when the firms negotiate licensing agreements instead of buyout deals, because the equilibrium terms of licensing agreement would be qualitatively the same bargaining outcome as the buyout deal, albeit over a different amount of total surplus. There are, however, the following additional considerations.

The equilibrium terms of licensing agreement would be a result of bargaining as before. The exact terms would depend on how the post-license market works, because it determines what they bargain over. If the two firms behave collusively (i.e., as if a cartel), then the analysis would be identical to the previous section. If the firms behave more competitively, the consumers would benefit but it may be harder to provide adequate R&D incentives due to reduced profit from competition. The overall effect would also depend on whether the new innovation provides a complementary product to the previous state of art or a substitute for it. We elaborate a little bit on this presuming that the incumbent firm behaves as a Stackelberg leader after the licensing agreement.

First, if the startup supplies a substitute for the previous state of art supplied by firm 1, then the two firms are in direct competition. The price of firm 1 would be lower compared with the case that the firm 1 solely supplies both products after a buyout deal. The price of firm 2, however, would be under a downward pressure from competition on the one hand, but at the same time under an upward pressure

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[7] Note that it cannot be smaller for any given IP protection: If a high cost firm were to invest in the base model and multiple firms would not engage in a race, then one firm would still find it profitable to invest.

due to the higher marginal cost of firm 2 by the amount of royalty. (This upward pressure disappears if the royalty is lump-sum rather than per unit of sale.) Unlike the price of firm 1, therefore, firm 2's price may not be lower under licensing agreement than under a buyout deal, hence the comparison of social welfare may be ambiguous between the two scenarios. In addition, competition reduces the total surplus for the firms to bargain over, thereby the startup firm's share as well. Consequently, the R&D investment by high-cost startups may not be sustained as long under license agreement, reducing the prospects of continued innovations.

A standard result for complementary products is that their prices are lower when supplied by a single firm than when supplied by separate firms, because the single supplier internalizes the positive effect of supplying one product on the demand of the other, hence produces more than two separate firms that do not benefit from such effect.[8] If the new innovation is a complementary product, therefore, both the consumer surplus and the producer surplus would be lower under licensing agreement than under buyout deal. Consequently, the R&D investment by high-cost startups would be lower under license agreement. All of these suggest that the social welfare would be lower under license agreement than under buyout deal if the innovations provide complementary products to the previous state of art.[9]

3. Oligopoly Incumbents

Modern high-tech industries typically exhibit high market concentration among a small number of major firms, nonetheless the assumption of monopoly incumbent in the base model is a special case. When there are multiple incumbent firms, the competition among them would dampen the potential surplus from an innovation. Since this dampened surplus would be reflected in the bargaining share of the startup firm, it seems at first sight that multiple incumbents would reduce R&D incentives of the startup firms. This indeed would be the case if there is one clear incumbent firm whose patent portfolio the new innovation may have infringed on, hence any deal would be between the startup and this incumbent firm but no other. On the other hand, due to the interdependent nature of technology, if there are multiple incumbent firms that the innovation may have infringed on, then there are at least two reasons why this is not necessarily the case. The first is a relatively straightforward observation that the startup firm would be in a strengthened bargaining position when multiple firms compete to become a partner in the deal.[10]

The second reason comes from the fact that the value of owning the innovation for an incumbent firm is the difference in profit between when it owns the innovation and when one of its rival firms owns it. Since this difference is larger when there are significant rival firms, striking a deal may be more valuable for an incumbent when there are rivals than when there is none, which may in turn has a favorable effect on

[8] See, for example, Shapiro, C. (1989).

[9] When there exists a competing product (substitute) for one of the products, potential antitrust issues arise from the possible practice of refusing to sell the two products separately (foreclosure).

[10] In principle, there can patent-infringement litigation by another major firm on the acquired innovation through a buyout deal. We abstract from this complication, say, by assuming that the head-to-head court confrontation between two major firms are too costly for both parties.

the bargaining share of the startup. This aspect may also have a dynamic strategic effect if an incumbent firm's good reputation shifts future demand in favor of that firm: current reputable behavior would improve a firm's position in future bargaining by reducing the potential value of innovation for rival firms, thereby their desirability as potential partners for the startup firm. Note that this reasoning would not be affected when some incumbent firms are smaller than others. Hence, existence of even a med-size firm may restrain the dominant firm’s market power beyond its direct competition, by becoming a tougher rival in buyout deals the more market power the dominant firm exercises.

Ⅴ. Summary

Reflecting the prominent features of modern high-tech industries, we consider environments in which innovations are sequential, hence further innovation efforts are discouraged due to the potential threat of patent-infringement litigation. We present a dynamic analysis of the interaction between incumbent firms and successful new entrepreneurs, that can provide R&D incentives of the latter, thereby sustain innovation process. We argue that the insights of the basic model on the degree of IP protection and the roles of startup firms in the innovation process, extend to varying market structures and regulatory environments. These discussions identify some of the main factors and their interactions that determine the R&D dynamics, which can be useful in policy considerations.

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