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Simulating the Impact of Intellectual Property Rights on the Innovation Process*

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Abstract: Whether Intellectual Property rights ("IPRs") can promote innovation and social welfare is frequently a focal point of debate among businesses, lawyers, economists and governments. It has been observed that businesses often acquire and enforce IPRs, while at the same time making their innovation available to competitors through standardization, patent pooling, cross license arrangements, open source license and other means. These behaviors of business players suggest that IPRs can promote innovation under certain conditions, or can even be an obstacle to innovation under other conditions. The author proposes designing a simple model that can simulate certain aspects of the innovation process affected by the enforcement of IPRs. The result of the simulation suggests the advantages and disadvantages of IPRs in promoting innovations.
Key words: Intellectual property rights, Industrial policy, Open innovation

1 Introduction

Whether IP rights ("IPRs") can promote innovation and social welfare is frequently a focal point of debate among businesses, lawyers, economists and governments[1, 2]. This debate is rooted in the conflict between the goal and the means of intellectual property laws ("IP Laws"). Nobody doubts that one of the major goals of IP Laws is to promote innovation and social welfare[3], and that social welfare is promoted by the generation of more innovations, and the diffusion of products and services embodying such innovations. However, in order to promote the activities of innovators, IP Laws give them an exclusive right (that is, IPRs) that can obstruct others from making innovations and/or diffusing products or services embodying them[4].

For example, the free software movement began as a protest against proprietary software licenses[5]. However, nowadays, open source or free software is often discussed in the context of how to design business models[6]. Free, or intentionally avoiding the enforcement of exclusive rights of patents, copyrights or any other IPRs, are now considered as one of the practical means to attain business purposes. Linux and Android are typical examples of successful open source software. However, still, not a few software businesses are employing the conventional business models using IPRs. Among all, Microsoft's Windows and Office, Oracle and SAP are typical examples of proprietary software, that are still successful.

Businesses are acquiring and enforcing IPRs[7], while they often make their innovation open to competitors through standardization, patent pool, cross license arrangements and other means.

At first glance, the behavior of business players enjoying openness and the behavior of players emphasizing acquisition and enforcement of IPRs appear to be incompatible with each other[8]. However,

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1 *See e.g., Landes & Posner (1989)*, *Scotchmer (2004), Bessen & Meurer (2008)*.

2 Another prong of the debates concerning IPRs is whether IPRs promote the wider and quicker dissemination of new works of authorship or inventions embodied in products or services. *See, e.g., Gurry (2013)* and the court cases quoted therein. The author discusses this issue by applying the concepts of *centrality* in Social Network Analysis in another article (*Teramoto (2015 Forthcoming)*).

3 *Jaffe & Lerner (2004)* at p. 7.

4 *Landes & Posner (1989)* warn of the disadvantage of unnecessarily strong IP rights protection. *Stiglitz (2000)* at pp. 344-347 also points out the negative aspects of IP rights. *See* also *Jaffe and Learner (2004)*.

5 *See e.g.,* "What is free software?" by Free Software Foundation (http://www.fsf.org/about/what-is-free-software).

6 *See e.g. Anderson (2009)*.

7 For example, Apple and Samsung continue to file patent suits against each other in various jurisdictions including the U.S. and Japan.

8 *See Jaffe Lerner & Stern (2001)*, *Shapiro (2001)*.

the businesses often employ both strategies simultaneously. These behaviors of business players suggest that IPRs can promote innovation under certain conditions, or can even be an obstacle to innovation under other conditions. Presumably, simple debates on whether IPRs can promote innovation would be too naive and not practical.

From the perspective of lawyers who draft laws or interpret and apply them to various cases, it is essential and productive to discover under what conditions IPRs can promote innovation, and under what conditions IPRs don't promote innovation or can even be an obstacle to innovation. However, unfortunately, it is almost impossible to compare the innovation process under conditions where IPRs are vigorously acquired and enforced with that under conditions where players employ an open strategy, while equalizing other conditions than "proprietary or open." Also, when we try to compare the innovation process in a state giving strong IP protection with that in another state giving only weak IP protection, it would give us little meaningful results, because other conditions including the degree of industrial development and education are likely to greatly differ between those two states.

In consideration of the difficulties in observing and analyzing realities, it would be helpful for lawyers in learning the pros and cons of a specific legal system or rights, if we could prepare one or more simple models by carving out certain aspects of real society, and simulate the impact of IPRs on the dynamic development of such models. Lawyers understand the advantage of "Law & Economics" because it has given them the tools to make such simulation, and this trend has had much impact on practitioners, academics and governments since the 1970s.

Admittedly, only limited aspects of reality can be implemented into a model. Moreover, if we add too many aspects of reality in a model, the model will become too complex and, we would be able to gain little meaningful ideas by conducting such a simulation through the model. Presumably, a simple model would be better than a complex model, although we might have to use multiple simple models to explain the realities. Here, the author proposes to design one of such simple models that can simulate certain aspects of the innovation process affected by the enforcement of IPRs.

2 The Model

2.1 The background for designing a model for simulation

A considerable number of authors have tried to discuss the roles of IPRs. Discussions from the perspective of philosophy scrutinize various kind of possible justification for IPRs from a Lockean perspective to instrumental theory and finally find that it is difficult to find a flaw-free justification for IPRs. Assuming that the justification for IPRs is not so strong, it would be meaningful for both practical and theoretical purposes to consider under what conditions IPRs can achieve their goal, and under what conditions they cannot.

Taking a philosophical perspective does not answer such questions. Rather, simulation of the activities of players in society by using a model would be helpful. The most often quoted study in such context is *Scotchmer (2004)*, which is mainly based on the perspective of "Law and Economics." A study from such perspective focuses on the market mechanism rather than the social network, which underlies the diffusion of knowledge and information. Naturally, it emphasizes striking a balance between the incentive to the earlier innovator by means of IPRs and the incentive to a following innovator who generates innovation utilizing the innovation of its predecessor.

Recent studies concerning industrial clusters[1] and knowledge networks and governmental efforts to build industrial clusters (for example, the efforts of the Ministry of Economy, Trade and Industry of Japan is outlined at http://www.meti.go.jp/policy/local_economy/tiikiinnovation/industrial_cluster.html) assume that innovation diffuses and cumulates on a dense social network. However, a study from the perspective of "Law and Economics" talks little about a social network. In consideration of this, designing a model on which we can simulate the diffusion and accumulation of innovation in a social network would be helpful for us to assess the impact of IPRs to promote or obstruct innovation. Because a social network is comprised of actors and their relationships, such a model has to contain, at least, vertices denoting actors, as well as some means that can denote their relationship (in the context hereof, the impact of past innovation to the generation of new innovation). The author tries to design a basic model that can supplement the discussion from the perspective of "Law and Economics" by introducing the effect of a social network.

2.2 Assumptions for designing a model

[1] *See*, e.g., *Martin (2011)*, *Valkokari & Rantala (2012)*, *Casanueva, Castro & Galán (2013)*, *Nieves & Osorio* (2013)

There are numerous phenomenon that we often face during the process of innovation. However, from among these phenomenon, the author employs only two for designing a model for simulation.

The first one is that no innovation springs from nothing ("If I have seen further it is by standing on ye shoulders of Giants." Isaac Newton's letter to Robert Hooke (1676))[1]. For the purpose of simplicity, the author assumed that a new innovation is generated when the effect of one past innovation intersects with the effect of another past innovation. This is assumed to implement the effect of a social network which underlies any generation of innovation. Also, any new intersection denotes an actor in the social network.

The second one is that the impact of one innovation increases according to the passage of time, and gradually hits a ceiling[2]. This is assumed to implement the understanding that all information is conveyed and diffused through a social network. It is also generally understood that a shorter distance between the transmitter and the receiver of information is likely to assure a better quality of communication[3]. As more time passes from the generation of a piece of information, information is conveyed to the actors who are increasingly distant from the generator of the information. Accordingly, it will become increasingly difficult for the information to have an impact on the recipients.

2.3 Designing a model

2.3.1 One innovation is denoted by a vertex

In the model proposed herein (the "Model"), one innovation is denoted by one vertex. Because one person (an innovator) may generate two or more innovations, one vertex denotes one innovation (but not one innovator).

2.3.2 Setting the first innovation(s)

Admittedly, all innovations are made upon past innovations. No person makes an innovation occur without the effect of past innovations. That is, there is never a beginning or end of an innovation process. However, a simulation using a model must have a beginning, where at least one innovation has already occurred.

Moreover, the Model assumes that a new innovation is generated when the effect of one past innovation intersects with the effect of another past innovation. Accordingly, in order to cause any successive innovation, the Model must assume that at least two or more past innovations exist at its beginning. Therefore, the Model must have two or more vertices, each of which denotes a past innovation. The simulation (the "Simulation"), shown in 2.3 below, begins from the conditions that there are three nodes (Figure 1).

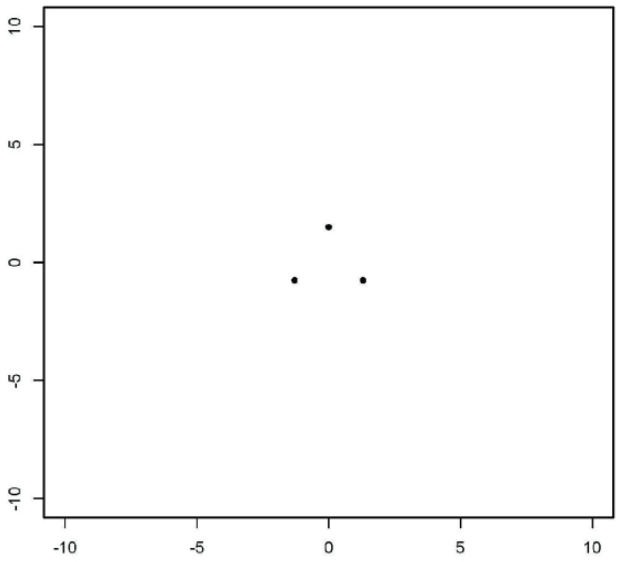


Figure 1 The Beginning Conditions of the Simulation

2.3.3 The impact of an innovation

[1] *See* also *Scotchmer (2004)* at pp.127-159.
[2] *See e,g, Rogers (2003)*.
[3] *See, e.g., Bavelas (1950), Borgatti (2005)*.

The impact of the innovation represented by one vertex is denoted by a circle having such vertex as its center. The longer the radius of such circle denotes the greater impact of the innovation, and the shorter radius denotes the smaller impact of the innovation.

For the purpose of simplicity, in the Simulation, the radius of the circle for any node is *0* at first, and it gradually increases from and after the following trial.

2.3.4 The growth of the impact of an innovation

It is convenient to use a logarithm to roughly denote the growth of a variable that gradually increases and finally hits its ceiling. In the Model, the growth of the radius ("*r*") of the circle having a certain vertex corresponding to one innovation as its center is set as follows:

$r = max\ (log\ ((t - g)/\tau) + 1,\ 0)$

t : the number of the relevant trial

g : the number of the trial when the relevant vertex was generated

τ , $\tau > 0$ *: a constant that regulates the growth of r*

By employing smaller τ , the growth of τ is accelerated, while by employing greater τ, the growth of *r* is decelerated (Figure 2). For the purpose of simplicity, the Simulation sets $\tau = 1$ at default.

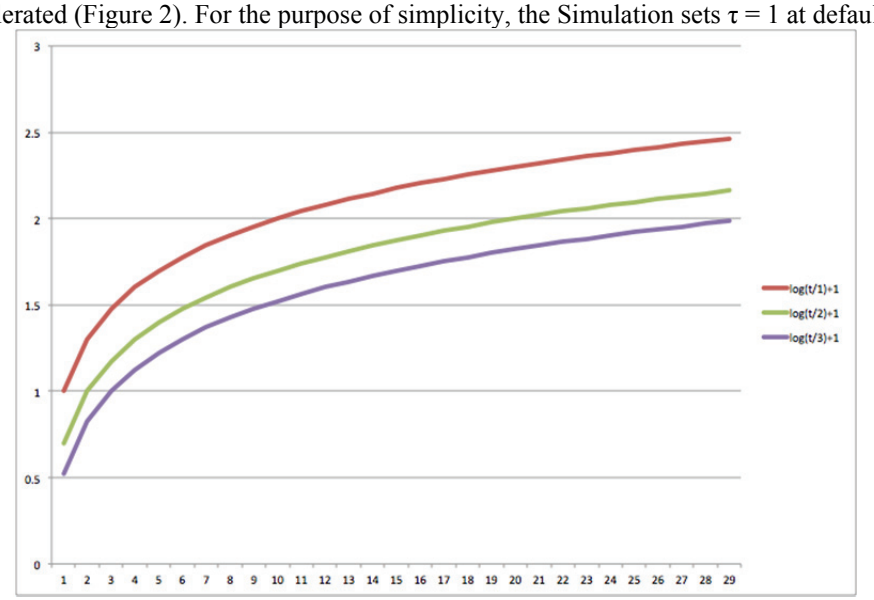


Figure 2 The Growth of *r*.

2.3.5 New innovations

The Model assumes that a new innovation is generated when the effect of one past innovation intersects with the effect of another past innovation. Therefore, the Model denotes such new innovations by the intersections of two circles, one of which denotes the effect of one past innovation, while another of which denotes the effect of another past innovation.

In the model, just for the purpose of simplicity, only the last extended circles of existing vertices generate intersections.

2.3.6 The geodesic positions of the vertices

The coordinates (or, the geodesic positions) of the vertices existing at the beginning of the Simulation can be determined arbitrarily. The greater distance between these vertices may denote the remoteness (geographical, social, industrial sector, technological sector, or otherwise) between the past innovations denoted by these vertices, while the shorter distance may denote the closeness. However, the Simulation does not implement such issues in the Model

In the Model, the coordinates of the three vertices that exist from the beginning of the Simulation are (0, 1.5), ($1.5 \times cos\ (\pi/6)$, $-\ 1.5 \times sin\ (\pi/6)$) and ($-\ 1.5 \times cos\ (\pi/6)$, $-\ 1.5 \times sin\ (\pi/6)$) respectively. This setting is only for the purpose of simplicity.

2.3.7 Intellectual property rights ("IPRs")

IPRs such as patents or copyrights give the inventor or author of inventions or creative works (or, their assignees including their employers or contractors) the power to prevent others from disseminating products or services that fall within the scope of the legal protection afforded to such inventions or works. A stronger IPR has a wider scope of legal protection, while a weaker IPR has a narrower scope.

Presumably, the growth of the effect of an innovation is likely to be obstructed, if the dissemination of products or services embodying such innovation is prevented by the exercise of intellectual property rights that protect a past innovation.

Assume that the innovation denoted by $vertex_i$ is protected by IPR_i. The scope of protection provided by IPR_i can be denoted by the area of the circle having $vertex_i$ as its center, with a certain radius. If another vertex ("$vertex_j$") denoting another innovation is located within the said circle, the said IPR_i can suspend the dissemination of the products and services embodying the innovation denoted by $vertex_j$. Thereby, the increase of the effect of such innovation is obstructed. This phenomenon can be denoted by the deceleration of the increase in the radius of the circle having $vertex_j$ as its center.

In the Simulation, for the purpose of simplicity, only the vertex (0, 1.5) is given IPR. The scope of protection provided by such IPR is denoted by the area of the circle having the said vertex as its center and having a certain length of radius. If any newly generated vertex falls within such area, the growth of the radius of the circle denoting the effect of the innovation corresponding to the vertex is decelerated by assigning greater τ to the vertex (in the Simulation, for the purpose of simplicity, greater $\tau = 2$).

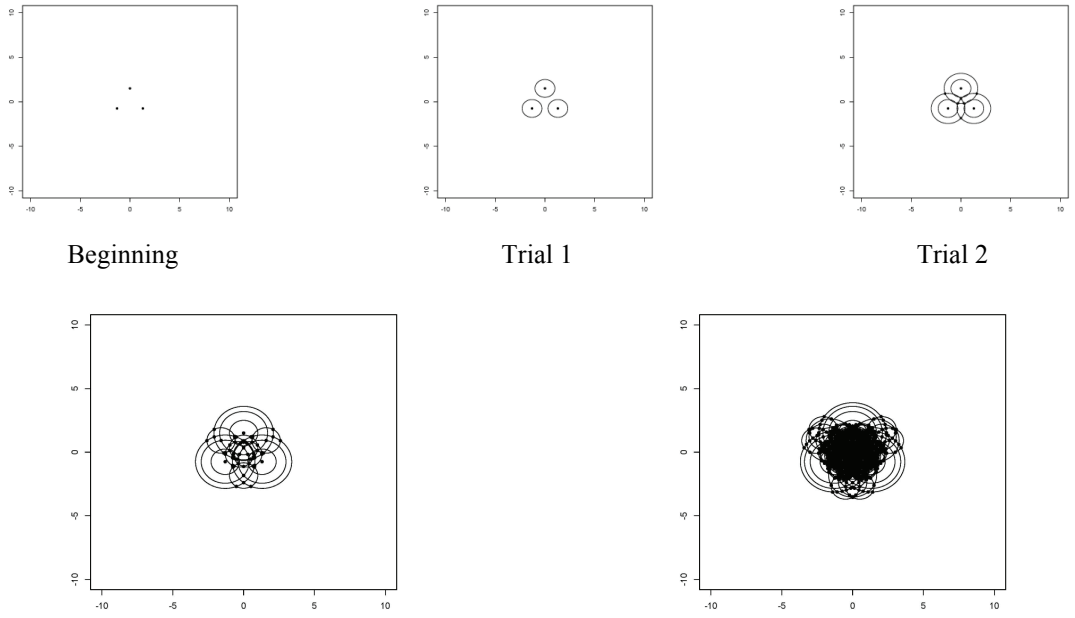
3 Simulation

The Simulation begins with the existence of the three vertices as set forth in Figure 1, above, and continues through the end the 4th trial. So, the radius of the circle surrounding each of these three vertices is extended four times.

Each of the new vertices, generated at a certain trial by the intersection of the two circles surroundings each of the two existing circles, also generates a circle having such new vertex as its center at each successive trial, while extending its radius at each trial.

Each of the simulations assumes that an IPR is given only to the vertex (0, 1.5) existing from the beginning of the simulation. The strength of such IPR is denoted by the radius 0 (no IPR protection), 1 (weaker IPR protection), 1.5, 2, and 3 (stronger IPR protection) of the circle surrounding (0, 1.5) that denotes the scope of IPR protection.

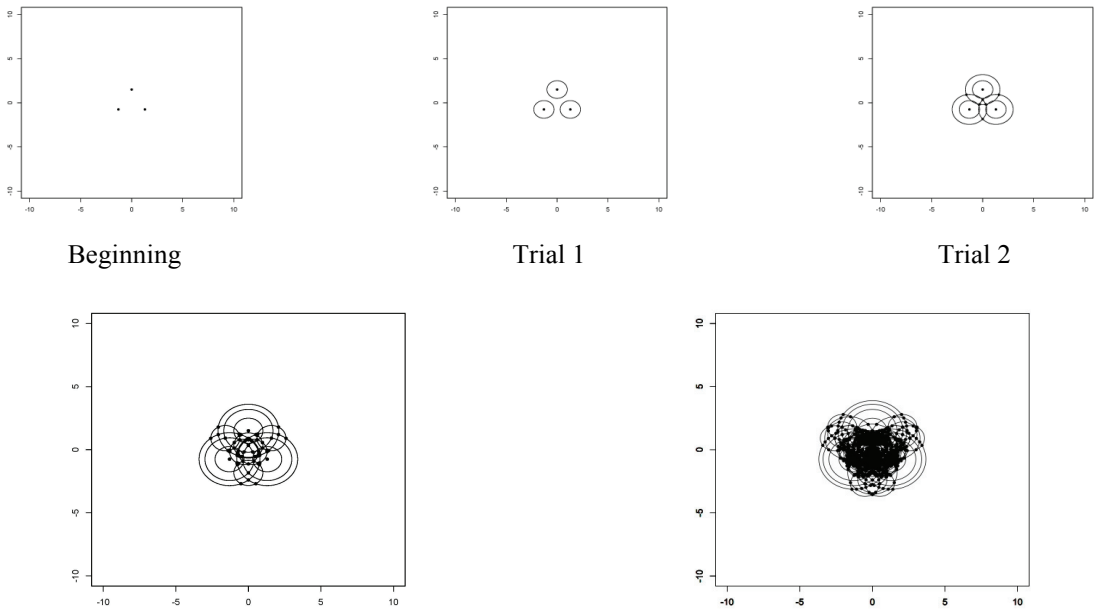
Figures 3 through 6 show the growth of the network graph by the increase of vertices through trials when the said radius is 0, 1, 1.5, 2, and 3, respectively. Likewise, Figure 7 shows the increase in the number of vertices through trials.



Beginning Trial 1 Trial 2

Trial 3 Trial 4

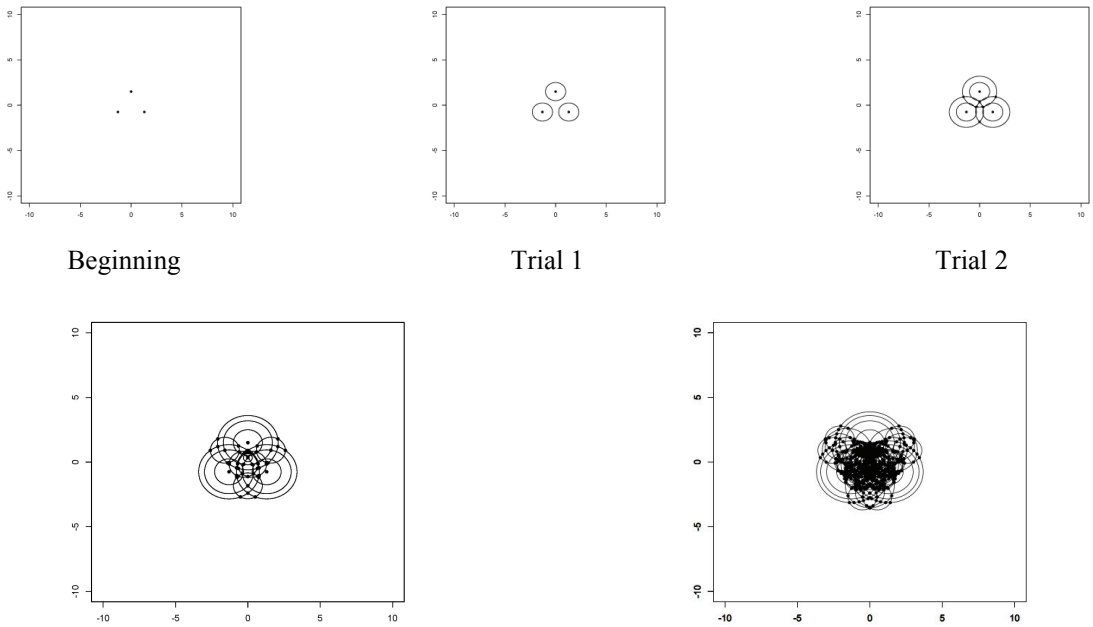
Figure 3 The Growth of the Network in the Case of No IPR (radius = 0)



Beginning Trial 1 Trial 2

Trial 3 Trial 4

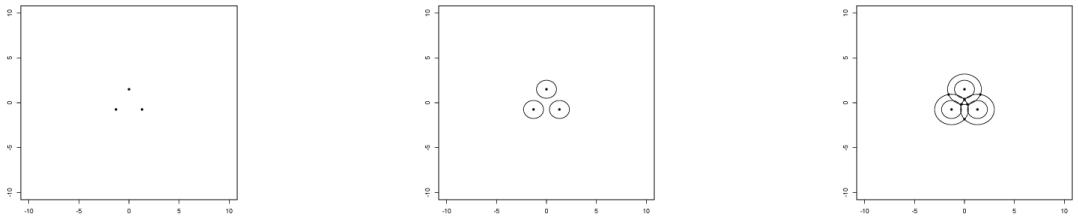
Figure 4 The Growth of the Network in the Case of Weaker IPR (radius = 1)



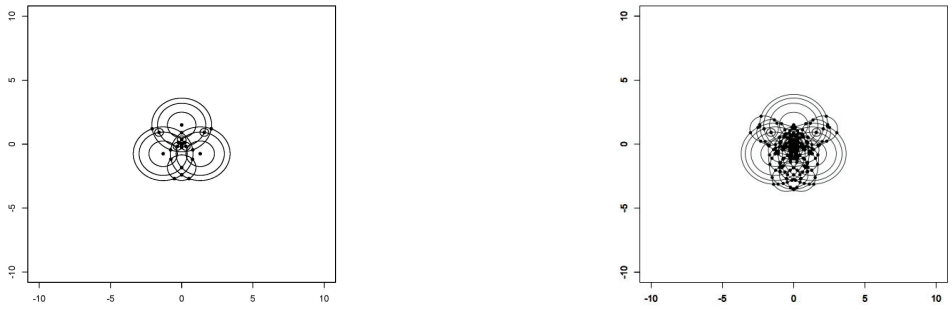
Beginning Trial 1 Trial 2

Trial 3 Trial 4

Figure 5 The Growth of the Network in the Case where the Radius (denoting the strength of IPR) = 1.5

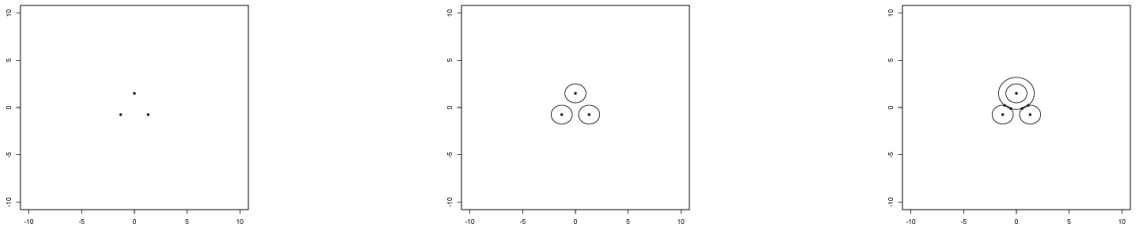


Beginning Trial 1 Trial 2

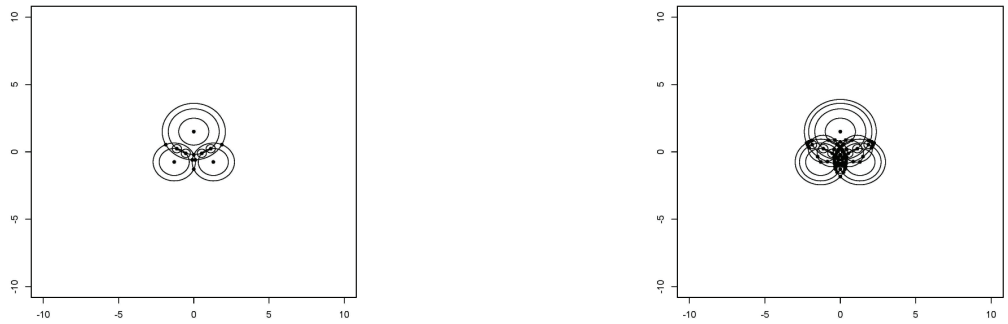


Trial 3 Trial 4

Figure 6 The Growth of the Network in the Case where the Radius (denoting the strength of IPR) = 2



Beginning Trial 1 Trial 2



Trial 3 Trial 4

Figure 7 The Growth of the Network in the Case of Stronger IPR (radius = 3)

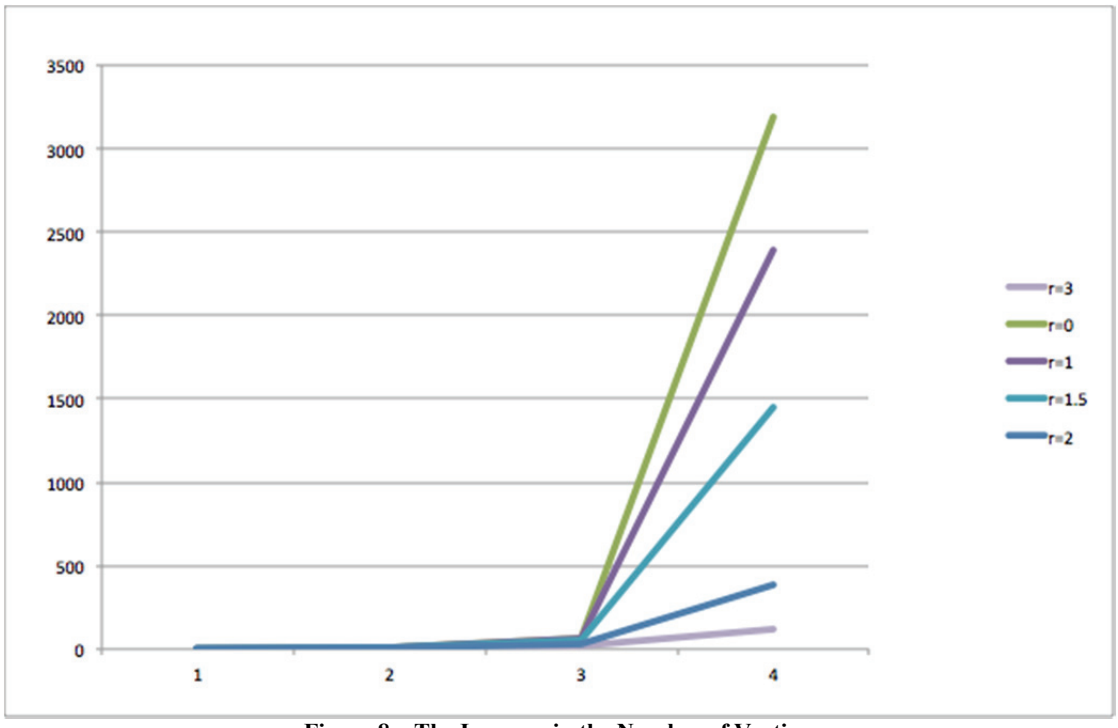


Figure 8 The Increase in the Number of Vertices

The Simulation shows that a greater scope of IPR protection is likely to be an obstacle to an increase in the number of vertices generated by intersections in the Model.

4 Discussion

The Simulation suggests at least two things, even though the model can reflect only limited aspects of the reality of the innovation process.

The first suggestion would be concerning the perspective of industrial policy. Under the conditions that can be denoted by the Model, the exercise of strong IPRs by one or more actors can be an obstacle to the generation of successive innovations arising out of intersections of the effect of the past innovations. This suggestion can partly justify the industrial policy often employed by governments that promote open and cooperative research and development by academics and businesses at the infant stage of certain sectors of industry.

The second suggestion is from the perspective of individual enterprises. Under the conditions that can be denoted by the Model, the exercise of strong IPRs by one enterprise can effectively block the generation of successive innovations that might become a threat to the existing products and services of such enterprise embodying past innovation. This suggestion can partly justify the activities of enterprises to acquire and accumulate groups of IPRs and seek the chance to exercise them.

Generally, these results coincide with the mainstream of academic discussions, as well as empirical knowledge of practitioners, that IPRs have both advantages and disadvantages in promoting innovations[1]. This would demonstrate the possibility that the Model has a certain degree of potential to be usable as a basic model on which we can simulate the impact of various forms and the strength of IPRs by manipulating the model in various ways.

5 Conclusion and Future Developments

The debates over the utility and/or the adverse effects of IPRs in the innovation process tend to become a *dialogue des sourds*. Conducting a simulation using a model representing limited aspects of the realities will help lawyers to assess the effect of a specific legal strategy, legal interpretation, and industrial policy, by looking at the similarities of the specific conditions they face through one or more models.

[1] *See, e.g., Landes & Posner (1989)*, *Drahos (1996)*, *Scotchmer (2004)*.

However, it must be admitted that even the simple simulation on a model, as shown above, shows the difficulties in our choice of whether we should advocate for stronger IPRs or for weaker IPRs (or, even a perfectly open license). The said simulation suggests the merit of openness to society as a whole, while it suggests the merit of strong IPRs to specific enterprises under certain circumstances. Moreover, if individual enterprises cannot protect their innovations against their competitors by means of their IPRs, they may hesitate to invest in R&D, and this would be an obstacle to innovations. The Simulation highlights the difficulties entrepreneurs face in choosing a strategy.

In order to obtain more detailed and practical suggestions from simulations, the Model should be manipulated in various ways. For example, in order to assess the viability of open source licenses, patent pools, SSOs or other means to alleviate the problems caused by IPRs, we have to give IPRs to multiple (or, every) vertex of the Model, and also we have to implement a trigger that makes IPRs exercisable. In light of the simplicity of the Model proposed herein, the Model would be viable to accept various manipulations and would permit its variations.

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