Technovation 43-44 (2015) 49–63

Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

Effects of intellectual property rights and patented knowledge in innovation and industry value added: A multinational empirical analysis of different industries

Seokkyun Woo [a], Pilseong Jang [b], Yeonbae Kim [b,*]

[a] Korea Institute for Industrial Economics and Trade, 370, Sicheong-daero, Sejong-si, Korea 339-007, Republic of Korea
[b] Technology Management, Economics and Policy Program, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea

ARTICLE INFO

Available online 8 April 2015

Keywords:
Intellectual property rights
Patent
R&D
Sequential innovation

ABSTRACT

Technological innovation drives long-term economic growth, so most countries attempt to provide an innovation-friendly environment that includes tightening protection of intellectual property rights (IPR). However, debate continues on whether strengthened IPR lead to technological development and economic growth: patents promote innovation by protecting appropriation from invention and disclosing knowledge to the public, but they also create excessive monopoly power that may impede further innovation.

Using simultaneous equations with cross-country panel data from 12 countries and 3 industries (chemical, electronic, machinery), we estimated the direct effect of IPR on industry value added and the indirect effect of it through enhanced research and development (R&D). The bilateral role of IPR, as measured by patented knowledge, was used to distinguish different characteristics of industries as well as the positive and negative effects of IPR on innovation.

Results suggest that IPR generally enhance industry value added, but the positive effect is mitigated with increased enforcement of IPR. Also, IPR enhanced R&D but showed a negative relationship with patented knowledge, suggesting that excessive propertization of knowledge may hinder sequential innovation. The positive role of IPR on R&D predominated in the chemical (discrete) industry and exerted negative effects in the electronic and machinery (complex) industries.

1. Introduction

Present technological change is the most essential driver for long-term economic growth, and endogenous technological changes have been a key force for economic growth in advanced countries (Romer, 1990). Therefore, provision of innovation-friendly environments, including increased enforcement of intellectual property rights (IPR), emerged as an important policy agenda during the 1980s in developed countries. With the emergence of the free trade doctrine and the World Trade Organization's Trade-Related Aspects of Intellectual Property Rights (TRIPs) of 1994, developing countries were forced into involuntary tightening of IPR (Hall, 2007). However, debates abound on whether such enforcement of universal IPR standards leads to technological development and economic growth. Specifically, is the world becoming more innovative after the efforts of global strengthening and standardization of IPR? Part of the answer may be revealed by the sharp rise of an innovator-friendly patent systems concurrently emerging with the information and communication technology revolution that resulted in enormous increases in patent filings at the turn of the 21st century (Kortum and Lerner, 1999). However, patent numbers alone are not good measures of innovation, because not all patented inventions represent successful innovations and many innovations are never patented (Pakes and Griliches, 1980).

Of course, many previous paper shows, both in theory and as empirically measured, that strong IPR stimulates technological innovation by incentivizing the inventors who drive economic growth (Kanwar and Evenson, 2003; Park and Ginarte, 1997). However, some also acknowledged (potential) negative impacts of strong IPR. First, some articles discuss the negative effect of strong IPR on technology transfer, diffusion, and commercialization due to the excess monopoly power given to inventors as well as incentives for strategic patenting (e.g., blocking the competitors entering the market) (Neuhäusler, 2012; Allred and Park, 2007; Encaoua et al., 2006; Gallini, 2002; Hall and Ziedonis, 2001).

* Corresponding author.
E-mail addresses: wsk618@hotmail.com (S. Woo), eznl2000@snu.ac.kr (P. Jang), kim1234@snu.ac.kr (Y. Kim).

http://dx.doi.org/10.1016/j.technovation.2015.03.003
0166-4972/

Second, the IPR impact may differ by the economic development level of countries (Sweet and Eterovic Maggio, 2015; Kim et al., 2012; Falvey et al., 2006; Gould and Gruben, 1996; Park and Ginarte, 1997; Schneider, 2005). Researchers generally found that developed countries tend to benefit more than developing nations from strong enforcement of IPR.

Third, numerous scholars have addressed the limitations of IPR in terms of patentable technology of a sequential nature (Bessen and Maskin, 2009; Encaoua et al., 2006; Gallini, 2002; Murray and Stern, 2007). They argued that when an invention directly follows from previous ones, the exclusive rights may impede access to the knowledge embedded in the development of previous inventions and thus slow down technological progress. While the current patent holder attempts to hold up the future innovation of a rival through a strong IPR regime, the inventor will also be delayed by previous patent holders. Therefore, in this setting, the link between patent strength and innovation incentives remains ambiguous (Gallini, 2002).

In this paper, we empirically estimated the effects of IPR on innovation and economic growth (value added) using international panel data of three main industries. We set up an innovation (Spence, 1984) and a value added (production function) (Jones, 1995) equation. We then combined and estimated them simultaneously to identify direct and indirect effects of IPR on economic growth. IPR may create two different influential paths: a direct effect on the value added (commercialization of technology) and an indirect effect via innovation (research and development [R&D]) (Park and Ginarte, 1997; Schneider, 2005). Additionally, we introduce a patented knowledge variable in the R&D investment equation to distinguish the specific IPR effects on the sequential innovation from the general IPR effects on the innovation (R&D investment).

We also focus on the relationship between the characteristics of knowledge and IPR. Because IPR comprise a system in which property rights are enforced on intangible and non-rival goods rather than tangible and rival goods, we focus on the characteristic of knowledge, or in an industrial context, of technology, to observe the potential varying effects of IPR on different industries. To do this, we assume that industry characteristics are largely distinguished by their specific technological compositions.

Inspired by ideas from the previous literature regarding the varying characteristics of technology (industries), such as discrete versus complex industries (Cohen et al., 2000), complementary innovation versus isolated innovation (Bessen and Maskin, 2009), and tacit versus codified technology (Brusoni et al., 2005; Winter, 1998), we apply theoretical framework that explains the ways those characteristics work in an innovation system. By using industry level data, we empirically examine varying effects of IPR on commercialization, sector-specific innovations, and sequential innovations.

To our knowledge, this paper is the first that empirically identifies the impact of IPR by the nature of technology (industry) and specifically on sequential innovation across main industries (Murray and Stern (2007) conducted similar research by only on bio-technology sectors). We examine how the compositions of technologies in different industries are affected due to IPR enforcement.

The paper is organized as follows: in Section 2, we review an important literature on IPR, innovations, and the characteristics of technologies influenced by industry strategies. In Section 3, the research framework and methodology are presented, including the development of a variable as a proxy for the characteristics of each industry. Section 4 shows the empirical results, Section 5 discusses our interpretation of the outcomes, and Section 6 features our conclusions.

2. Theoretical frameworks

2.1. Intellectual property rights and technology

A description of the fundamental nature of technology, or *knowledge*, and the strategic behavior of the firms when utilizing these technologies, which are protected by property rights, explain the importance of our industry-level analysis. The difference in the technological composition of specific industries leads to different incentives for protecting intellectual assets through patents, and many scholars have drawn attention to the different patenting activities and motives across industries.

2.2. Discrete versus complex industry and sequential innovation

The discrete and complex nature of knowledge, an aspect of technology that tailors the innovation-incentive mechanism of the industry, means that one or many patents can apply to new inventions (products), which are subsequently characterized as discrete and complex, respectively (Cohen et al., 2000; Kash and Kingston, 2001; Kusunoki et al., 1998; Merges and Nelson, 1990; Reitzig, 2004). Examples of discrete products include new drugs and chemical products, and examples of complex products include those of electronics industry.

In case of a complex industry, numerous complementary technologies are developed via different and diverse R&D lines, which increase the overall probability of creating a successful innovation (Bessen and Maskin, 2009). Complex industries feature complementary technologies, which then relate to *sequential innovation* (Encaoua et al., 2006), described as the complementarity of technologies in dynamic perspective. Innovations are intrinsically cumulative (sequential) in that advances build on and interact with many other features of existing technology (Merges and Nelson, 1990).

2.3. Codified versus tacit knowledge

The following researchers distinguished knowledge between codified and tacit characteristics: Balconi (2002), Brusoni et al. (2005), Grimaldi and Torrisi (2001) and Johnson et al. (2002). Codified knowledge, sometimes called “explicit knowledge,” can be described as messages and generic algorithms that can be transmitted at relatively low costs and deployed in a context other than that in which they were originated (Brusoni et al., 2005).

In a philosophical context, Johnson et al. (2002) categorized these types of knowledge as “know-what” when referring to knowledge about the facts and “know-why” when referring to knowledge about principles and laws. These types differ from tacit knowledge, which is described by “know-how” and “know-who” characteristics. The transfer of codified knowledge tends to less require absorptive capacity in terms of necessary institutional support. In other words, codified knowledge, representing explicit content, is much less painfully transferred to and digested by rival entities.

Brusoni et al. (2005) defined tacit knowledge as an “inarticulable contextual framework that provides individuals' cognitive processes in the background within which to focus and to attribute meaning to conditional statements.” Tacit knowledge embedded in skills is difficult to articulate but can be transferred through personal, informal contact and training (Winter, 1998). Examples of tacit knowledge include skills and know-how that are difficult to imitate.