Information Economics and Policy 22 (2010) 391–397

Contents lists available at ScienceDirect

Information Economics and Policy

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

The impact of piracy on innovation in the presence of technological and market uncertainty

Dyuti Banerjee [a,*], Ishita Chatterjee [b]

[a] Department of Economics, Monash University, Clayton, VIC 3800, Australia
[b] Economics, The University of Western Australia (M251), 35 Stirling Highway, Crawley, WA 6009, Australia

ARTICLE INFO

Article history:
Available online 20 October 2010

JEL classification:
D21
D43
L13
L21
L26
O3

Keywords:
Innovation
Market uncertainty
R&D race
Technological uncertainty

ABSTRACT

With a single innovating firm facing only technological uncertainty, piracy unambiguously retards innovation. However, with R&D competition where firms face both market and technological uncertainties, we show that if the two firms differ "significantly" with respect to the efficiency in R&D investment, then piracy increases the R&D investment of the less efficient firm and reduces that of the more efficient firm. In this case piracy enhances the overall probability of a successful innovation.

1. Introduction

This paper studies the validity of the claim that piracy retards innovation when the probability of success in developing a new product depends on the level of R&D investment. We analyse this claim when there is a single innovating firm facing technological uncertainty and also when there are multiple firms involved in R&D competition, thus facing both technological and market uncertainties.[1] Technological uncertainty in innovation implies that the R&D investment resulting in a new product is stochastic and depends on the level of investment. Market uncertainty arises when multiple firms are involved in R&D competition; thus a firm's success in developing a new product does not necessarily imply its success in obtaining a patent. The literature on piracy and innovation, which is discussed in the next section, only considers a single innovating firm, but not R&D competition. In this paper we attempt to bridge this gap and bring together the literature on piracy and innovation with that on patent race.

We show that if there is a single innovating firm facing only technological uncertainty, piracy unambiguously retards the incentive to innovate and adversely affects profit. However, in the case of R&D competition, the innovating firms compete in R&D investment in the first stage and the firm that is successful in receiving the patent then competes in prices with the pirating firm. In the competitive case we show that if the firms differ significantly with respect to efficiency in R&D, then an increase in piracy *increases* the R&D investment of the *less* efficient firm and *decreases* that of the *more* efficient firm. In this case, the overall probability of a successful innovation increases.

The intuition of our results is as follows. Piracy reduces the second stage realised profit of a firm that is successful

* Corresponding author.
E-mail addresses: dyuti.banerjee@buseco.monash.edu.au (D. Banerjee), ishita.chatterjee@uwa.edu.au (I. Chatterjee).

[1] The terms technological uncertainty and market uncertainty have been introduced by Shy (2000).

0167-6245/$ - see front matter © 2010 Published by Elsevier B.V.
doi:10.1016/j.infoecopol.2010.09.005

in receiving the patent. Thus in the first stage the firms have to decide whether to increase or decrease their R&D investment. A reduction in R&D investment has two opposing effects on a firm's first stage expected profit. The investment reduction increases the firm's expected profit due to lower cost. However, lower R&D investment reduces the probability of success, thereby reducing expected profit. If the R&D efficiencies of the two firms differ significantly, then for the less efficient firm an increase in profit due to an increased R&D investment (via the increase in the probability of success) dominates the reduction in profit due to the higher cost of R&D The opposite is true for the more efficient firm.[2]

This paper is organized as follows. In Section 2 we discuss the literature. In Section 3 we present the model with a single innovating firm and discuss the results. In Section 4 we present the case where there is R&D competition between two innovating firms. Section 5 contains the concluding remarks.

2. Overview of the literature

Piracy has generally been perceived as having a damaging influence on software and media industry sectors that have high information and digital content since such products can be copied at a low cost (Marshall, 1999; Straub and Nance, 1990). This issue assumes importance because of the high magnitude of loss in retail sale and possible detrimental effects on the incentive to innovate.[3] In empirical studies, Ding and Liu (2009) and Park and Ginarte (1998) show that under weak Intellectual Property Rights (IPR) regimes piracy dissuades the innovating firms from continuing research on the development of new technologies.

The literature addressing the impact of piracy on innovation focuses on a single innovating firm and shows that piracy can have both adverse and beneficial impacts on innovation. The adverse effect of piracy can be that the innovating firms will be producing less and spending more on copyright protection (Novos and Waldman, 1984). Qiu (2006) shows that a weak copyright protection regime results in the development of customized rather than general software products. According to Jaisingh (2009) piracy generally harms innovation. Only strict regulatory enforcement policies can improve product quality.

However, piracy can be beneficial by playing the role of a medium of advertisement for legal products and for providing market insights (Conner and Rumelt, 1991; Duchene and Waelbroeck, 2006; Peitz and Waelbroeck, 2006). The beneficial aspect also includes the generation of a positive feedback effect on innovation (Easley et al., 2003; El Harbi and Grolleau, 2008).[4] This effect provides direction to innovating firms for further R&D.[5] There can also be tacit reciprocity (Kolm, 2006) in knowledge exchange between the innovating and pirating firms in which case the innovating firm accepts piracy (Barnett, 2005; Raustiala and Sprigman, 2006; Barnett et al., 2010). In this paper, we ignore such positive feedback effects and reciprocity, and investigate whether piracy can enhance R&D investment.

The literature on the impact of piracy on innovation has not yet addressed the issue by considering R&D competition between innovating firms. Also, piracy has not been explored in the literature on innovation and patent races. This literature shows that patents and innovations can have a two-way relationship. Kultti et al. (2006) shows that excessive patent competition can reduce a firm's incentive to innovate. Lower patent standards or lower patenting cost may increase a firm's incentive to innovate. [6] However, lower patent costs may result in low R&D investment if the information content of such product is low.[7] Shapiro (2006) models two firms successfully inventing a product, simultaneously and independently, but only one being able to file for the patent. However, he does not examine the impact of piracy on innovation.

3. The model with technological uncertainty

Let us consider the market for a product, like software, that faces piracy. We first consider the case where there is only one firm investing in R&D technology in order to increase its profit over and above a reservation level, $\bar{\pi}$. For simplicity we assume $\bar{\pi} = 0$. Let R be the R&D investment of the firm and the probability that it is successful in developing the product is $k\alpha(R)$ such that $0 \leqslant k\alpha(R) \leqslant 1$ with the properties $\alpha'(R) > 0$ and $\alpha''(R) < 0$.[8] Thus, technological uncertainty in our model is captured by $k\alpha(R)$; k can be viewed as the R&D efficiency parameter. We further assume that $-\frac{\alpha''(R)}{\alpha'(R)}$ is decreasing in, meaning that the curvature of $\alpha(R)$ is decreasing in R.

There is a pirating firm who competes with the innovating firm in the product market by selling unauthorised

[2] For more on the relationship between efficiency and R&D investment see Rosen (1991), Cohen (1995), Patel et al. (1995) and Poyago-Theotoky (1996).

[3] Business Software Alliance (BSA) believes that "local software industries (are) crippled from competition with high-quality pirated software" and International Federation of the Phonographic Industry (IFPI) in its 2005 Commercial Piracy Reports argues that "the illegal music trade is destroying creativity and innovation". IDC and BSA (2007) claim that around US$48 billion were lost worldwide to piracy. BSA further projects that by 2010 almost US$200 billion worth of software will be pirated globally.

[4] When hackers used Valve Software's Half Life game engine to develop a game called Counter Strike, Valve, a gaming company, took the illegal game software and marketed it themselves, selling over 1.5 million copies (Barnes, 2005). Apple Computer, in a strategic reaction to P2P file sharing technologies, launched the iTunes online music library that was easy to navigate and explore, with free music previews, and allowed flexible download and copying for personal use. See Choi and Perez (2007) for anecdotal evidences on legal firms adopting technologies used by illegal P2P file sharers.

[5] This is especially true for design-based industries where being pirated is a signal of the high quality of the legal product, and products which 'are not faked are considered too weak to generate consumer demand and are consequently not produced' (Whitehall, 2006). Ritson (2007) says that pirated goods are indicative of heralding a brand's renaissance and a brand dies if no copies appear in the market.

[6] Bessen and Hunt (2003) and Maurer and Scotchmer (2003) offer a detailed review.

[7] This 'counter-intuitive' phenomenon can be observed in industries that are highly technology-intensive such as, semiconductors, electronics and computers (Hunt, 2004, 2006).

[8] These properties ensure that the second order condition for profit maximization holds.