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Technology licensing contracts with network effects

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ABSTRACT

We study the optimal technology licensing contracts with network effects and investigate the welfare implications when the product innovator is an insider that acts as a Stackelberg leader. We show that (i) the market is fully covered when relatively small network intensity matches quality differentiations that are sufficiently large; (ii) with regard to profit maximization, the optimal licensing strategy varies from one of royalty licensing to two-part tariff licensing as network effects increase (not including fixed-fee licensing); (iii) consumer surplus is optimal under non-licensing conditions in comparison to other licensing strategies, due to the covered market; (iv) depending on network effects, the preferred strategies to achieve social welfare maximization change from no-licensing or fixed-fee licensing to two-part tariff licensing, and royalty licensing is not preferred in this instance; (v) conflict does not always or necessarily occur between the goals of enterprise profit maximization and social welfare optimization. Two-part tariff licensing is preferred both by the licensor and by society when the network effect is large.

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1. Introduction

A network effect, which is generally referred to as a network externality, is a kind of economy of scale economy relating to demand (Katz and Shapiro, 1985, 1994). In markets characterized by networks such as Mobile OS, Videogame and Social commerce, the evaluations made by consumers can be improved as the installed base of the suppliers' products or complementary products increases. Since a network effect can have a significant impact on the willingness of consumers to pay, the conclusions about markets which are subject to network effects may be strikingly different than those of traditional markets.

In product markets with network externalities, both incumbents and potential entrants have two choices regarding their choice of technology. They can either attempt to establish their own standards via self-developed products, or they can decide to accept other firms' standards through technology licensing. According to Bloomberg news, after making a one-time payment of in excess of $1 billion to Nokia, Microsoft was able to require Nokia to abandon its own MeeGo system, being developed in cooperation with Intel, in favor of the development of a mobile system based on the Windows phone. As part of the agreement, every sale of a mobile phone made by Nokia requires the payment of patent royalties to Microsoft. This agreement poses two questions. Why was Microsoft willing to license its own technology to Nokia in this way? In addition, why did Nokia abandon the development of its own system and accept the license offer?

One feature of technology licensing is that it does not transfer ownership of the licensed technology. The licensor merely transfers the right to use the technology to the licensee. This feature of retaining ownership leads to strategic behaviors on the part of licensors which in turn generate impacts on licensees in terms of their output and profits. Closely associated with rapid technological changes and increasing degrees of product complexity, technology licensing has gradually come to be viewed by most enterprises (especially high-tech enterprises) as a quick and effective means of enhancing the licensee's technical capabilities. From the perspective of society as a whole, technology licensing is seen as being conducive to the diffusion of advanced technology. Licensing contributes to improvements in technology and innovation in industry as a whole. In highly efficient innovation enterprises, licensing not only helps the company reap early R&D investment and increase profits, but licensing also enables the company to choose "good" competitors and deter potentially aggressive entrants to the market. The licensee can then maintain and enhance their position in the market (Rockett, 1990). For enterprises with lesser innovative and technological capabilities, licensing can be a useful means to shorten a product's or service's development period, reduce R&D risks, learn through the digestion and absorption of new technologies and increase the enterprise's competitive advantage, and finally for the company to form

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their own core competitiveness (Cohen and Levinthal, 1989; Chatterji, 1996; Henderson and Cockburn, 1996; Han and Bae, 2014). Therefore, a detailed and in-depth study of technology licensing has important theoretical and practical significance.

In reality, establishing a technology standard and negotiating with other parties are highly complex practices, involving not only economic but also technological, legal and public policy issues. In this paper, we do not attempt to capture all the nuances of standard competition. Instead, we focus on the economic issue and, in particular, address the following questions: (i) Should an innovator as an insider develop a proprietary standard, or should the innovator allow others to adopt its technology? (ii) If the innovator licenses technology to others, what pricing strategy should be implemented with network effects? (iii) What are the attitudes on technology licensing with network effects from the viewpoints of enterprise, consumer, and society? (iv) Is there a conflict between profit maximization and social welfare optimization?

Without network effects, many theoretical works on the question of optimal licensing strategies exist. Some scholars examine the issue under different market structures (such as Arrow, 1962; Katz and Shapiro, 1985, 1986), proceeding from the competition mode (Kabiraj, 2004, 2005; Erkal, 2005; Filippini, 2005; Mukherjee and Pennings, 2006; Chou et al., 2010), as well as from the information structure point of view (Gallini and Wright, 1990; Macho-Stadler et al., 1996; Beggs, 1992; Choi, 2001; Poddar and Sinha, 2004; Sen, 2005; Van Triest and Vis, 2007; Crama et al., 2008; Lo Nigro et al., 2014). Optimal licensing contracts also depend on the following factors: product differentiation (Kamien and Tauman, 1984, 1986, 2002; Muto, 1993; Wang, 1998, 2002; Stamatopoulos and Tauman, 2008; Li and Wang, 2010; Ye and Mukhopadhyay, 2013), imitation costs (Rockett, 1990; Mukherjee and Balasubramanian, 2001; Kogan et al., 2013), the number of participants (Tombak, 2003; Arora and Fosfuri, 2003) and so on.

However, very few published studies exist which deal with the optimal technology licensing contract with network effects. It was only recently that Lin and Kulatilaka (2006) first studied the choice of optimal technology licensing in a homogenous product market from the viewpoint of the incumbent. They find that network intensity can play a crucial role in the optimal choice of licensing strategies. They also find that the incumbent licensor generally changes their choice of optimal licensing from one of royalty per unit to one of a fixed fee as network intensity increases. However, are the conclusions and results of that 2006 study robust? Rostoker (1984) finds that 46 percent of licensing cases use two-part tariff, 39 percent are based on royalties alone, and 13 percent are fixed fees alone. In fact, three deficiencis exist in their study. Firstly, they assume that all consumers or users have the same preferences and that all the products on offer are of equal quality. In the real world, people have different preferences, and products differ in quality. Meanwhile, theoretical studies (e.g. Fudenberg and Tirole, 2000; Gabszewicz and Garcia, 2007; Stamatopoulos and Tauman, 2008; Li and Wang, 2010; Nabin et al., 2012) also find that consumer preferences and product differentiation have significant impacts on market equilibrium. In our paper, we consider and apply the assumptions that more closely match the likelty realities in the marketplace. Secondly, they assume that enterprises compete in a Cournot Quantity Model. In the real world, firms which compete in the market place are asymmetrical in nature, with some firms being dominant and some others being weak (Filippini, 2001, 2005; Kabiraj, 2005). For instance, Nokia and Samsung always price their Smart Phone products using WP or Android systems, following the example of the pricing of IPhones using iOS systems used by Apple, the price leader, in spite of the fact that Samsung has higher global sales than Apple. In the Stackelberg Leadership Structure, we capture partner asymmetry by means of the asymmetry of moves. Thirdly, the researchers cannot consider the impacts of the optimal licensing strategy used by an enterprise on consumers and society, and they cannot investigate whether or not a conflict between profit maximization and social welfare optimization exists.

In our paper, we refine and consider the above-mentioned assumptions. Our contributions and conclusions are that (1) Compared to the existing licensing studies that have not taken into account network effects, we find that network effects play a crucial role in deciding upon the optimal technology licensing contracts to be used in network markets: (1a) When the network effect is relatively small (e.g. $\beta < 0.37$) or large (e.g. $\beta \geq 0.37$), pure royalty and two part tariff licensing, respectively, are optimal for licensors. This situation is different from selecting optimal licensing without network effects, which will always be pure royalty licensing under the same settings. (1b) The licensing contract preferred by the licensor does not coincide with society preferences in markets without network effects. However, in markets with network effects, there is an interval relating to network effects (e.g. $0.38 \leq \beta < 0.5$) so that a two-part tariff licensing contract is preferred by both the licensor and by society. This finding means that network effects can, to a large extent, internalize or offset the externality inevitably caused by the dissemination of technology in technology licensing. (2) In contrast to the existing licensing studies which do consider network effects, our findings are more convincing and more in line with reality. We consider the impacts of such factors as consumer preferences, differences in quality and leadership structure. (2a) We find that the licensing contracts preferred by licensors are pure licensing or two-part tariff licensing. This finding is opposite to the results published by Wang et al. (2012), who concluded that fixed-fee licensing is always optimal for the licensor when the network effect is large. At the same time, the participation constraint of the licensee is always binding. Again, this is contrary to the findings of Lin and Kulatilaka (2006). (2b) We comprehensively examine the role of network effects and their impact on optimal technology licensing contracts from the views of the licensor, consumers and society. See the details contained from Proposition 1 to Proposition 7.

The remainder of our paper is organized as follows. In Section 2, we present the model and derive the benchmark status quo for non-licensing in the covered market. In Sections 3–5, we examine the effects on profitability of fixed-fee licensing, royalty licensing and two-part tariff licensing. In Section 6, we discuss the implications of the availability of different licensing contracts in terms of the licensor's profit, consumer surplus and social welfare. Hence, we also examine whether or not there exists a contradiction between profit maximization and social welfare optimization. Finally, we make a number of conclusions in Section 7.

2. Model descriptions and no-licensing for the covered market

2.1. Model descriptions

Consider an industry which consists of two firms in which the goods have network effects. Firm 1 produces a product of high quality s_1, Firm 2 produces a product of low quality s_2, and $s_1 > s_2$. Let $s_1 = 1$, and $s_2 = ts_1 = t$, where $t \in (0,1)$. The parameter t captures the degree of product quality differentiation. A larger t implies closer substitutability between the two products and that they are more homogeneous. A smaller t indicates a larger quality difference between the products and that they are more heterogeneous.

For consumers with different preferences, when they buy nothing, the utilities are zero. If they buy a product with quality s_i at most, the utility function is $U_i = \theta s_i + v(q^e) - p_i$, $i = 1, 2$. Here, θ is a marginal utility regarding quality, and it reflects consumer

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