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The licensing of eco-technology under emission taxation: Fixed fee vs. auction☆

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ABSTRACT

This paper investigates the effect of emission taxation on outside innovator's licensing strategies for eco-technology and its welfare consequences when duopolistic polluting firms have different production costs and purchase licenses for pollution abatement goods. In the presence of an emission tax, we compare the two types of licensing contract, fixed fee and auction, and show that the preference on licensing strategy depends not only upon the level of the emission tax but also on the production cost gap. Specifically, non-exclusive licensing is preferred to exclusive licensing when the emission tax or cost gap is small, while exclusive auction (fixed fee) licensing is preferred when the cost gap is intermediate (large). We also analyze some important welfare issues and discuss public policies on emission taxation and licensing regulation.

1. Introduction

Because of the current global policy concerns on climate change and the subsequent tighter environmental regulations that have contributed to the recent expansion of green abatement technologies, the eco-industry is developing rapidly.[1] The importance of this industry, which offers eco-technology, has been recognized by numerous reports from national and international institutions; for example, see OECD (1996); Berg, Ferrier, and Paugh (1998); Ecotech Research and Consulting Ltd. (2002), and Kennett and Steenblik (2005). Moreover, most eco-technologies are likely to be patented by innovators who have market power.[2]

In the environmental economics literature, an interesting analytic framework for the eco-industry is introduced by David and Sinclair-Desgagne (2005). Later, Canton, Soubeyran, and Stahn (2008); David, Nimubona, and Sinclair-Desgagne (2011); Lee and Park (2011); Nimubona and Sinclair-Desgagne (2011), and Nimubona (2012) extend the analysis in order to examine the effect of emission taxation on the imperfectly competitive market for abatement goods and services. In this regard, it is important to

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[1] According to Environmental Business International (2012), the global market size of the eco-industry was approximately US$838 billion in 2010 and is expected to reach US$992 billion by 2017.

[2] For more detailed descriptions on the status of international patents, see Kim and Lee (2014).

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investigate how the licensing strategy of eco-technology will affect polluters' incentives and the welfare consequences for society. These are the primary objectives of our study.

In the literature of industrial economics with regard to R&D innovation activity, many prior works have studied the patent licensing of cost-reducing innovation and analyzed the welfare consequences. Most research has focused on the external innovator and analyzed the relationship between market structure and licensing strategies such as royalty, fixed-fee, and auction.[3] Early work shows that regardless of industry size and/or innovation magnitude, fixed-fee and auction licensing are superior to royalty licensing under perfect competition (Kamien & Tauman, 1984), a homogeneous oligopoly (Kamien & Tauman, 1986; Katz & Shapiro, 1986), a leadership structure (Kabiraj, 2004), and a Cournot duopoly with network externality (Wang, Liang, & Lin, 2012). However, royalty licensing is preferred to fixed-fee licensing for Bertrand competition (Muto, 1993) and the product differentiation model (Poddar & Sinha, 2004; Bagchi & Mukherjee, 2010). Regarding fixed-fee and auction licensing contracts, auction licensing yields higher revenue than fixed-fee licensing in a symmetric oligopoly market (Katz & Shapiro, 1985; Kamien, Oren, & Tauman, 1992; Liao & Sen, 2005; Sen & Tauman, 2007), while fixed-fee licensing is preferred to auction licensing in an asymmetric duopoly (Stamatopoulos & Tauman, 2009) and the sublicensing model (Miao, 2013).

Some recent research also shows that the strategic choice of patentee depends upon government policies. Kabiraj and Marjit (2003) and Mukherjee and Pennings (2006) examine the role of government in technology licensing under an open economy. In such an economy, import taxes or tariffs are imposed on foreign licensees in order to protect domestic consumers. Mukherjee and Tsai (2013) consider the effect of an output tax on technology licensing in a Cournot oligopoly market, while Kim and Lee (2014) examine the welfare consequences of an emission tax on eco-technology licensing in a Cournot oligopoly market with pollution. Such studies of government policies and their implications for technology licensing can enhance our understanding of optimal licensing strategies.

This paper investigates the effect of emission taxation on outside innovators' licensing strategies for eco-technology when duopolistic polluting firms have different production costs and purchase licenses for pollution abatement goods. When an emission tax is imposed on polluting firms, we compare fixed-fee and auction licensing contracts, and examine the optimal licensing choice and its welfare consequences. As a matter of fact, the economic situation considered in this paper is similar to Kim and Lee (2014), who analyzed symmetric oligopolistic firms where the government imposes an emission tax on the homogeneous polluting firms and compare the licensing strategies of eco-technology between royalty and fixed-fee licensing contracts. However, we incorporate the production cost gap between two firms and compare fixed-fee, auctioning, and royalty licensing contracts from the viewpoint of various policy perspectives. In this sense, we take a generalized approach on the licensing strategy for eco-technology under emission taxation.

We show that an outside innovator may exclude an inefficient licensee when two firms compete in purchasing licenses. This results in welfare loss. We also show that the preference for either a fixed-fee or auction licensing strategy depends not only upon the level of the emission tax but the production cost gap. Specifically, non-exclusive licensing is preferred to exclusive licensing when the cost gap is small or the emission tax is small, while exclusive auction (fixed-fee) licensing is preferred when the cost gap is intermediate (large). We also extend the analysis in order to provide policy implications with regard to welfare consequences. First, we examine discriminatory fixed-fee licensing, which increases an innovator's profit, and show that the innovator still has an incentive to restrict the number of licensees, which will cause welfare loss. Second, in the context of foreign innovator, we point out that imposing a tariff on imported abatement goods should accompany the emission tax in order to improve welfare. Finally, we examine an internal innovator and show that licensing a technology to an efficient firm through an inefficient patentee can improve welfare when cost gap is high.

The organization of this paper is as follows. We construct a basic duopoly model of eco-technology licensing contracts in Section 2. We then analyze and compare fixed-fee and auction licensing contracts in Section 3. We then discuss policy considerations with regard to welfare analysis in Section 4. The final section provides a conclusion. In the Appendix, we analyze royalty licensing contract and compare it with fixed-fee licensing contract.

2. Basic model

Consider a duopoly situation where two firms compete in homogeneous products that emit pollutants in the production process. The inverse demand function for the final goods is given by $P(Q)=A-Q$, where $Q=q_1+q_2$ is the market output level and q_i is firm i's output level. We assume that the production cost is constant, $c_i \geq 0$. Specifically, we consider asymmetric duopoly model with different production costs where firm 1 is more efficient than firm 2, in which the production cost of firm 1 is assumed and normalized at zero; $A/2 > c_2 \geq c_1 = 0$.[4]

There is an outside innovator who licenses eco-technology to either one or two polluting firms and establishes a contract by using either auction or fixed-fee licensing.[5] When the innovator licenses its technology to k $(=1, 2)$ firms, the licensed firms can

[3] Others have also focused on patent licensing with regard to internal innovation. They show that royalty licensing is preferred to fixed-fee licensing in a Cournot duopoly with a homogeneous good (Wang, 1998), a differentiated Bertrand duopoly (Wang & Yang, 1999), incumbent innovators in a homogeneous Cournot oligopoly (Kamien & Tauman, 2002), and a leadership structure (Kabiraj, 2005). However, Wang (2002) shows that fixed-fee licensing is preferred to royalty licensing for an internal patentee with a heterogeneous duopoly if the product differentiation is sufficiently large.

[4] Without loss of generality, this assumption assures interior solutions for abatement goods and outputs at equilibrium under the two different types of licensing strategy. Note also that it satisfies non-negative outputs at equilibrium under no emission taxation.

[5] We consider the case that the external innovator is a monopolistic provider of an eco-technology and it produces abatement goods to sell them to polluting duopoly firms. Alternatively, it can be regarded that the polluting firm has its own manufacturing company and this manufacturer gets a license from the innovator to produce abatement goods. In Section 4.4, we also examined the internal innovation case in which one of two manufacturers has a patent on eco-technology.