International Review of Economics and Finance xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

International Review of Economics and Finance

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

Tariffs, technology licensing and adoption

Hsiu-Li Chen [a], Hong Hwang [b,c], Arijit Mukherjee [d,e,f,g], Pei-Cyuan Shih [h,*]

[a] Department of International Business, Ming Chuan University, No.250, Sec. 5, Zhongshan N. Rd., Shilin Dist., Taipei City 111, Taiwan, ROC
[b] Department of Economics, National Taiwan University, No.1, Sec. 4, Roosevelt Rd., Da'an Dist., Taipei City 106, Taiwan, ROC
[c] RCHSS, Academia Sinica, No.128, Sec. 2, Academia Rd., Nangang Dist., Taipei City 115, Taiwan, ROC
[d] Nottingham University Business School, University Park, Nottingham NG7 2RD, UK
[e] CFGE, Loughborough University, Leicestershire LE11 3TU, UK
[f] CESifo, and INFER, Poschingerstr. 5 81679 München, Germany
[g] RCIE, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong
[h] Department of International Business, Ming Chuan University, No.250, Sec. 5, Zhongshan N. Rd., Shilin Dist., Taipei City 111, Taiwan, ROC

ARTICLE INFO

Available online xxxx

JEL classification:
L13
L24
O33

Keywords:
Licensing
Technology adoption
Tariffs

ABSTRACT

This paper develops a two-country Cournot duopoly model to investigate the implications of international technology licensing. It is shown that if the tariff imposed by the domestic country is high, it is optimal for the foreign firm to adopt an inferior technology for its production when it licenses its most advanced technology to the domestic firm. Such a licensing arrangement may improve welfare of the two countries.

1. Introduction

It is commonly believed that a producer with a superior technology in hand has no incentive to adopt an inferior technology since the inferior technology decreases the firm's production efficiency and hence its profits.[1] However, this is not true if the firm can license its technology to its rivals. There are empirical evidences in support of this argument. For example, one of Samsung's high-end smart phone, the S6, is known to use Sony's newest and most superior sensor (model IMX240), which has never appeared in the latter's own products.[2] Another example is the Apple A5 (a chip using a 32 nm process, model S5L8942), which was manufactured by Samsung and used in the iPad2 in March 2012. However, it was not until August 2012 that Samsung adopted the same production process to produce its own tablet computer.[3] These cases indicate that a licensor firm might use an inferior technology for its own production, yet its theoretical underpinning has never been explored. In this paper we shall provide a theoretical model to explain why a licensor firm has an incentive to adopt an inferior technology even if a superior technology is available at no cost.

* Corresponding author. Tel.: +886 2 2882 4564; fax: +886 2 2880 9751.
E-mail addresses: hlchen@mail.mcu.edu.tw (H.-L. Chen), echong@ntu.edu.tw (H. Hwang), arijit.mukherjee@nottingham.ac.uk (A. Mukherjee), pcshih@mail.mcu.edu.tw (P.-C. Shih).

[1] Shieh and Peng (2000) is an exception. They employ a vertical product differentiation model in which firms compete in Bertrand competition and find that in order to soften price competition, a firm has an incentive to produce a low-quality product. Their setting and approach are very different from ours.

[2] Please refer to http://image-sensors-world.blogspot.tw/search?q=imx240.

[3] Please refer to http://en.wikipedia.org/wiki/Apple_A5#cite_note-23.

http://dx.doi.org/10.1016/j.iref.2016.02.012
1059-0560/

Please cite this article as: Chen, H.-L., et al., Tariffs, technology licensing and adoption, *International Review of Economics and Finance* (2016), http://dx.doi.org/10.1016/j.iref.2016.02.012

Technology licensing is a topic which has attracted much attention during the last two decades.[4] It discusses how a technologically advanced firm licenses its superior technology to a technologically backward rival (see, for example, Wang, 1998; Wang, 2002; Wang & Yang, 1999; Fauli-Oller & Sandonis, 2002, and Poddar & Sinha, 2010).[5] It is shown that the optimal licensing contract involves the use of a royalty (fixed fee) if a licensor firm and a licensee firm compete in a common market and their products exhibit high (low) substitutability. This is because if the two products exhibit high substitutability, the licensor firm can use a royalty to weaken competition from the licensee firm and is thus preferable to fixed-fee.

Furthermore, Kabiraj and Marjit (2003); Mukherjee and Pennings (2006), and Mukherjee (2007), have analyzed the policy implications of technology licensing in an international context. Kabiraj and Marjit (2003) set up a three-stage model to show that a government can use an import tax to induce a foreign high-tech firm to license its technology to a domestic firm via a fixed-fee licensing contract, thereby increasing its consumer surplus and social welfare. Mukherjee and Pennings (2006) find that a tax policy imposed by a domestic country could encourage a foreign monopolist to license its advanced technology to domestic firms and this practice can increase the social welfare of the domestic country. Mukherjee (2007) analyzes the optimal licensing contract between a foreign licensor firm and a domestic licensee firm when the foreign firm competes with the domestic firm in the domestic market. He shows that the optimal licensing contract for the foreign licensor is a royalty (fixed-fee) if the trade cost is sufficiently low (high), while the combination of fixed-fee and royalty licensing is optimal if the trade cost is moderate.

While each of these papers has enriched the literature, their results depend on the following simplified assumptions that both the licensor and the licensee use the same technology after licensing.[6] However, as mentioned above, in reality, the technology employed by a licensor firm may be inferior to the technology adopted by the licensee firm. The purpose of this paper is to provide a theoretical rationale for this behavior and to analyze the corresponding effect on welfare. Hence, we will ask the following questions in this paper: (i) Why does a foreign licensor have the incentive to adopt an inferior technology even if a superior technology is available at no cost? (ii) Does trade liberalization always increase trade volume and consumer welfare as believed usually?

The key innovation of the paper is that there are cases in which the foreign licensor firm adopts an inferior technology for its own production when it is determined to license its most advanced technology to its competitor. This inferior technology adopted by the foreign firm increases consumer surplus and welfare of the licensee firm's country.

The remainder of this paper is organized as follows. Section 2 outlines the model and shows technology adoption by the foreign firm. Section 3 compares social welfare under different technologies of the foreign firm. Section 4 concludes.

2. The model

Assume that there are two countries, called, domestic and foreign. There is a firm in each country—domestic firm (in the domestic country) and foreign firm (in the foreign country). The firms produce homogeneous goods and compete in Cournot fashion in the domestic market. The inverse demand for the good is $p=p(Q)$, with $Q=q+q^*$, $p'<0$, where q^* represents the amount of export by the foreign firm to the domestic market and q is the output of the domestic firm. We assume that the domestic firm possesses a technology corresponding to the marginal cost c and the foreign firm possesses a technology corresponding to the marginal cost $c-\theta$, where θ belongs to $[0,\bar{\theta}]$. Thus, the foreign firm's marginal cost is $c-\bar{\theta}$ if it adopts the most superior technology for its own production, but the cost remains at c if it adopts the most inferior one. The foreign firm also needs to pay a per-unit tariff, t, for its exports to the domestic country. Following the literature on technology licensing, we further assume that the foreign firm licenses, via a two-part tariff contract, i.e., a fixed fee (F) and a royalty rate (r), its *most superior* technology to the domestic firm.[7] Hence, the domestic firm's marginal cost after licensing is $c-\bar{\theta}+r$.

The game in question consists of three stages. In the first stage, the foreign firm chooses the optimal technology for its own production.[8] In the second stage, given the adopted technology, the foreign firm licenses its most superior technology to the domestic firm through a two-part tariff (a royalty rate and a fixed fee) licensing contract, followed by the domestic firm's move to accept the offer or not.[9] In the third stage, the two firms produce their outputs simultaneously for the domestic market and the profits are realized. As usual, we shall solve the game through backward induction.

The profit functions of the foreign and the domestic firms are expressed respectively as follows:

$$\pi^*\left(q^*, q; r, F, \theta\right) = p(Q)q^* - (c-\theta)q^* - tq^* + rq + F, \tag{1}$$

[4] Nadiri (1993) shows that international payments for patents, licenses and technical know-how for Japan, the U.K. France and the U.S. were growing substantially between 1979 and 1988. Moreover, Maskus (2015) provides an excellent review on the effects of IPRs on innovation, trade and technology transfer.

[5] According to Rostoker (1984), royalty licensing alone was used 39% of the time, fixed-fee licensing alone 13% of the time, and royalty and fixed-fee licensing 46% of the time, among the firms surveyed.

[6] In the literature, it is common to assume that the level of innovation is exogenous. See, for example, Kabiraj and Marjit (2003) and Mukherjee (2007); Chang and Peng (2013) and Nabin and Sgro (2013). However, some papers regard the innovation level as endogenous (Rockett, 1990; Kabiraj & Marjit, 1993; Chang, Hwang, & Peng, 2013, and Hwang, Marjit, & Peng, 2015).

[7] The result that a licensor firm licenses its most superior technology to a licensee firm is well documented in the literature. See, for example, Rockett (1990) and Kabiraj and Marjit (1993).

[8] In this game, we assume that the foreign firm can determine and commit to the adopted technology before its licensing and output decisions.

[9] Strictly speaking, there are two subgames in the second stage of the game—one with the domestic licensee firm accepting the licensing arrangement, and the other with the domestic licensee firm rejecting the offer. As the domestic licensee firm would always accept the arrangement in the equilibrium, we shall consider only the first subgame.

Please cite this article as: Chen, H.-L., et al., Tariffs, technology licensing and adoption, *International Review of Economics and Finance* (2016), http://dx.doi.org/10.1016/j.iref.2016.02.012