Lobbying for tariff protection and international technology licensing[*]

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Abstract: We consider international technology licensing when the domestic firm lobbies for import tariff. Tariff protection may increase or decrease the incentive for licensing and consumer surplus compared to free trade, depending on the way lobbying affects tariff. If lobbying determines tariff following the "tariff-function formation" approach, lobbying reduces consumer surplus by reducing the incentive for licensing. However if lobbying determines tariff following the "political contribution" approach, lobbying increases the incentive for licensing but creates an ambiguous effect on consumer surplus. Our results are strikingly different from the existing literature on international technology licensing under welfare maximising tariff protection.

Key Words: Consumer; Lobbying, Technology licensing; Tariff

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1. Introduction

It is argued that tariff protection helps to attract superior foreign technologies through international technology licensing,[1] which, in turn, benefits domestic consumers (Kabiraj and Marjit, 2003, Mukherjee, 2002, Mukherjee and Pennings, 2006 and Ghosh and Saha, 2008, 2015). We show that this conclusion may not hold true if the tariff rate is influenced by lobbying by the domestic firm.

While the literature on international technology licensing under endogenous tariff determination provides important insights, it is restrictive due to its attention on welfare maximising governments.[2] It is widely recognised that trade policies are often influenced by many special interest groups (Findlay and Wellisz, 1982, Mayer, 1984, Hillman, 1989, Magee et al., 1989, Grossman and Helpman, 1994, Long and Soubeyran, 1996, Mitra, 1999, Bhagwati, 2000, Kayalica and Lahiri, 2007, Gawande et al., 2012, Weymouth, 2012 and Cai and Li, 2014, to name a few) and domestic firms often lobby for tariff protection. Given this background, we examine how lobbying for a tariff protection by the domestic firm affects international technology licensing.

[1] Arora et al. (2001) mentioned that more than 15,000 technology licensing transactions occurred worldwide during 1985 and 1997 with an average worth of $25 billion per year. As per The Economist (2005), technology licensing worldwide was worth around $1000 billion and the US alone accounted for around $45 billion. See also Vishwasrao (2007), Ghosh and Saha (2008, 2015), Kim (2009) and Maskus and Saggi (2014) for information on international technology licensing.

[2] Dinda and Mukherjee (2011) consider a vertical technology transfer under international outsourcing in the presence of a welfare maximising tax policy of the host country. Wang et al. (2020) show how technology licensing affects the privatisation policy.

There is a vast literature on technology licensing where governments are not active agents. As a representative sample, one may look at Kamien and Tauman (1986), Kamien et al. (1988, 1992), Gallini and Winter (1985), Katz and Shapiro (1985), Gallini and Wright (1990), Marjit (1990), Rockett (1990), Muto (1993), Saggi (1996, 1999), Yang and Maskus (2001), Faulí-Oller and Sandonís (2002, 2003), Glass and Saggi (2002), Sen (2005), Mukherjee (2001), Mukherjee and Balasubramanian (2001), Poddar and Sinha (2004), Arya and Mitendorf (2006), Sen and Tauman (2007), Mukherjee et al. (2008), Stamatopoulos and Tauman (2009), Chang et al. (2013), Mukherjee and Mukherjee (2013), Bagchi and Mukherjee (2014, 2020), Avagyan et al. (2014), Duchêne et al. (2015), Sen and Stamatopoulos (2016), Sen and Bhattacharya (2017), Lu et al. (2019) and Wu (2019).

To address this question, we consider an international duopoly, where a technologically superior[3] foreign firm from a developed country and a technologically inferior domestic firm from a developing country compete in the domestic country like Cournot duopolists. The domestic firm lobbies for a tariff protection[4] and the foreign firm decides whether to license its technology to the domestic firm. Lobbying by the domestic firm only can be justified by Kayalica and Lahiri (2007) and Bandyopadhyay et al. (2012), which suggest that in many countries, it is legal for political parties to accept political contributions from the nationals of that country, but it is illegal to accept foreign contributions, and it is illegal in some countries to bribe abroad. In this framework, we consider two separate political economy models of lobbying – first, the "tariff-function formation" approach of Findlay and Wellisz (1982) and Long and Soubeyran (1996), and second, the widely used "political contribution" approach of Grossman and Helpman (1994). While the first approach does not give consideration to welfare, the second approach cares both welfare and political contribution.

We derive the following results. Whether we consider the "tariff-function formation" approach or the "political contribution" approach, the tariff rate is higher under licensing compared to no licensing. However, these models have different effects on the incentive for licensing and consumer surplus. The incentive for licensing is lower under lobbying compared to no lobbying under the "tariff-function formation" approach, while it is higher under the "political contribution" approach. While lobbying (compared to no lobbying) reduces consumer surplus under the "tariff-function formation" approach, the effect is ambiguous under the "political economy" approach. Hence, lobbying and the way it affects tariff protection may

[3] In this paper, the marginal cost of production specifies the technology of a firm and a lower marginal cost of production implies better technology.

[4] For the evidence of lobbying for protection in the developing countries, one may look at Saha (2019, 2020) for India, http://www.ft.lk/front-page/Protected-sectors-depend-on-lobbying--IMF/44-657777 for Sri Lanka and https://www.cnbc.com/2019/09/06/reuters-america-exclusive-china-sugar-industry-to-lobby-government-for-extension-of-hefty-tariffs-on-imports-sources.html for China.

play an important role in determining the incentive for licensing and the corresponding implications on the consumers.

Our results are strikingly different from the existing literature on international technology licensing under welfare maximising tariff protection, as in Kabiraj and Marjit (2003). Kabiraj and Marjit (2003), which is most closely related to our paper, show that welfare maximising tariff protection benefits consumers in the importing country by inducing technology licensing, thus suggesting that if free trade cannot attract foreign technologies, restrictive trade policies help to attract foreign technologies and benefits consumers. Unlike them, we show that tariff protection through lobbying may reduce the incentive for technology licensing and consumer surplus. Even if tariff protection through lobbying increases technology licensing, it may still reduce consumer surplus. Hence, if technology licensing does not occur under free trade, it is not necessary that tariff protection will induce international technology licensing and will improve consumer surplus. Therefore, one needs to be more cautious about the way tariff is determined when considering the effect of tariff protection on technology licensing.

When tariff protection induces technology licensing in our paper, the mechanism is different from Kabiraj and Marjit (2003). Technology licensing in their analysis reduces the tariff rate and therefore, benefits the foreign licenser by reducing its tariff inclusive cost. In contrast, tariff protection in our paper increases the incentive for licensing when it is higher under licensing. Higher tariff protection under licensing helps to increase the competitiveness of the domestic firm and the foreign firm can use the licensing fee to extract this benefit from domestic firm's competitiveness.

To the best of our knowledge, there is no empirical research analysing how lobbying for tariff protection affects product-market competition and international technology licensing.

Our results provide testable hypothesis for future empirical research on international technology licensing in the presence of lobbying for tariff protection.

The remainder of the paper is organised as follows. Section 2 describes the model and derives the results. Section 3 concludes.

2. The model and the results

Assume that there are two firms, a foreign firm (firm F) and a domestic firm (firm D). We assume that the foreign firm is from a developed country and the domestic firm is from a developing country. The foreign firm exports to the domestic country from the foreign country and the firms compete in the domestic country like Cournot duopolists with homogeneous goods. Assume that the constant marginal costs of productions for the domestic and foreign firms are c_d and c_f ($c_d > c_f$) respectively. For simplicity, consider $c_f = 0$ and $c_d = c$. Assume that there is no transportation cost of exporting.

Assume that the inverse market demand function is

$$P = a - q, \tag{1}$$

where P is price and q is the total output. We assume that $c < \frac{a}{2} \equiv c^{\max}$ to ensure that both firms always produce positive outputs under no lobbying.

2.1. Licensing under free trade

First, consider the case under free trade, implying that there is neither any lobbying nor any welfare maximizing tariff policy.

Consider the following game. At stage 1, the foreign firm decides whether to license the technology. If it decides to license the technology, like Kabiraj and Marjit (2003), it charges

an up-front fixed fee for the technology.[5] At stage 2, the firms compete like Cournot duopolists and the profits are realised. We solve the game through backward induction.

If there is no licensing, firms D and F respectively maximise the following expressions to maximise their outputs:

$$\underset{q_d}{Max}(a-q-c)q_d \tag{2}$$

$$\underset{q_f}{Max}(a-q)q_f, \tag{3}$$

where $q = q_d + q_f$. We get the equilibrium outputs of firms D and F under no licensing as $q_{d,ft} = \frac{a-2c}{3}$ and $q_{f,ft} = \frac{a+c}{3}$. The corresponding equilibrium profits are $\pi_{d,ft} = \left(\frac{a-2c}{3}\right)^2$ and $\pi_{f,ft} = \left(\frac{a+c}{3}\right)^2$.

Next, consider the situation under licensing. In case of licensing, both firms have the marginal costs of production equal to 0. Hence, we can get the equilibrium values under licensing by considering *c = 0* in the above-mentioned expressions. Hence, the equilibrium outputs of firms D and F under licensing are respectively $q_{d,ft,l} = \frac{a}{3}$ and $q_{f,ft,l} = \frac{a}{3}$. The corresponding equilibrium profits are $\pi_{d,ft,l} = \left(\frac{a}{3}\right)^2 - K$ and $\pi_{f,ft,l} = \left(\frac{a}{3}\right)^2 + K$, where *K* is the fixed-fee paid by firm D to firm F for the licensed technology.

[5] There are several other papers, such as Katz and Shapiro (1985), Marjit (1990), Kabiraj and Marjit (1993), Mukherjee (2001) and Yang and Maskus (2009), to name a few, considered fixed-fee licensing contracts in closed and open economies. Even if patent protection prevents duplication of innovation, imitation or "inventing around" with a non-infringing innovation is possible under technology licensing. Inventing around the licensed technology by the licensee or lack of information needed for a royalty provision may be the reason for charging a fixed fee licensing contract (see, e.g., Katz and Shapiro, 1985 and Rockett, 1990). The use of a fixed-fee only in the licensing contract is also empirically relevant. For example, 13% of the firms surveyed by Rostoker (1984) used fixed-fee alone. Vishwasrao (2007) collected data on all foreign technology licensing agreements by the manufacturing firms in India during 1989-1993, and found that 968 contracts, which was 45% of all licensing agreements, used fixed-fee only during 1991-1993.

Licensing is profitable if it increases the industry profit compared to no licensing. Only in this situation, the licenser can charge a price for its technology that makes neither firm worse off under licensing compared to no licensing. We get that licensing is profitable if $\Omega_l = \pi_{d,ft,l} + \pi_{f,ft,l} > \pi_{d,ft,n} + \pi_{f,ft,n} = \Omega_n$ or $c < \frac{2a}{5} \equiv c'$, which is similar to the condition provided in Marjit (1990) and Kabiraj and Marjit (2003) under free trade.

The above discussion gives the following result immediately.

Proposition 1: *If there is no lobbying, technology licensing with a fixed-fee is profitable if* $c < \frac{2a}{5} \equiv c'$.

The reason for the above result is as follows. On the one hand, licensing increases production efficiency in the industry, but on the other hand, it increases product-market competition by making the licensee more competitive. If the cost difference between the firms is very high, it creates a near monopoly of the licenser under no licensing. In this situation, licensing is not profitable since it reduces the industry profit compared to no licensing by increasing the product-market competition significantly. However, if the initial technologies of the firms are very similar, i.e., if the initial cost difference between the firms is very small, the competition-increasing effect of licensing is negligible but licensing increases production efficiency in the industry sufficiently to make licensing profitable.

3. Licensing under lobbying: tariff-formation function approach

Now consider lobbying by the domestic firm for tariff protection. In this section, we consider the tariff-formation function approach, as in Findlay and Wellisz (1982) and Long and Soubeyran (1996), where a tariff level is determined as a stable function of the resources

committed to the political process by the interest group. We will consider the political contribution approach of Grossman and Helpman (1994) in Section 4.

Assume that the foreign firm faces a tariff $t(e)$ per unit of its output where e is the domestic firm's lobbying expenditure with $t(0)=0$, $t' > 0$,and $t'' \leq 0$. However, lobbying is costly and the domestic firm has to incur a cost $R(e)$ for lobbying with $R(0) = 0$, $R' > 0$ and $R'' > 0$. This formulation is similar to Long and Soubeyran (1996), and the lobbying expenditure and the cost of lobbying can be linked respectively to the labour force used for lobbying and the loss of labour force for productive activities in Findlay and Wellisz (1982). Hence, the domestic government supports free-trade in the absence of lobbying. This tariff-formation function approach, following Findlay and Wellisz (1982) and Long and Soubeyran (1996), help to show the implications of lobbying by ignoring the welfare maximising tariff, which is considered in Kabiraj and Marjit (2003).

We consider the following game in this section. At stage 1, the foreign firm decides whether to license the technology. At stage 2, the domestic firm lobbies for tariff on the foreign firm's output. At stage 3, the firms compete like Cournot duopolists and the profits are realised. We solve the above game through backward induction.

We consider a situation where the domestic firm lobbies after the technology licensing decision. It is a reasonable sequence to consider since, after the licensing decision, the domestic firm has the incentive to increase its profit by making the foreign firm less competitive by lobbying for a tariff protection.[6]

First, consider the game under no licensing. Given the tariff rate created by the lobbying expenditure, the domestic and foreign firm maximise the following expressions to determine

[6] The sequence of moves we are considering is similar to the non-committed government policies considered in several papers in different contexts, such as Staiger and Tabellini (1987), Al-Saadon and Das (1996), Mukherjee (2000), Neary and Leahy (2000), Mukherjee and Pennings (2006), Poyago-Theotoky (2007), Golombek and Greaker (2010) and Dijkstra et al. (2011).

the respective outputs in stage 3:

$$\underset{q_d}{Max}(a-q-c)q_d \tag{4}$$

$$\underset{q_f}{Max}(a-q-t(e))q_f\,. \tag{5}$$

We get the equilibrium outputs of firms D and F under no licensing as $q_{d,lo}=\frac{a-2c+t(e)}{3}$ and $q_{f,lo}=\frac{a-2t(e)+c}{3}$. We assume that both firms produce positive outputs under lobbying.[7] The corresponding equilibrium profits are $\pi_{d,lo}=\left(\frac{a-2c+t(e)}{3}\right)^2$ and $\pi_{f,lo}=\left(\frac{a-2t(e)+c}{3}\right)^2$.

At stage 2, the domestic firm chooses the lobbying expenditure to maximize the following expression:

$$\pi_{d,lo}=\left(\frac{a-2c+t(e)}{3}\right)^2-R(e)\,. \tag{6}$$

The equilibrium lobbying expenditure is given by

$$\frac{2(a-2c+t(e))}{9}t'(e)=R'(e). \tag{7}$$

Assume that the second order condition for maximization is satisfied, i.e., $\left[\frac{2}{9}t'^2+\frac{2}{9}(a-2c+t)t''-R''\right]=Z<0$. Define the equilibrium lobbying expenditure under no licensing by e_n^*. Hence, the equilibrium tariff under no licensing is $t(e_n^*)$.

[7] It is trivial to understand that if lobbying creates domestic monopoly, the foreign firm will license the technology, implying that lobbying in this situation will increase the incentive for licensing compared to no lobbying. Further, domestic monopoly with the foreign technology can reduce consumer surplus compared to the situation with free trade and no licensing, due to the monopoly distortion created under lobbying. Since the case of domestic monopoly does not add much to our analysis, we concentrate on the situation where both firms always produce positive outputs. This is also directly comparable to Kabiraj and Marjit (2003).

Proposition 2: *If both firms produce positive outputs, the domestic firm's lobbying* expenditure *is negatively related to the marginal cost of production of the domestic firm.*

Proof: Differentiating (7) with respect to c gives $\frac{\partial e}{\partial c} = \frac{4t'}{9Z}$. Therefore, $\frac{\partial e}{\partial c} < 0$ as $t' > 0$ and $Z < 0$. ■

If the marginal cost of production of the domestic firm decreases, it gives the domestic firm a higher market share and, therefore, higher profit for any given lobbying expenditure, which, in turn, induces the domestic firm to increase the lobbying expenditure.

The equilibrium profits of the domestic and foreign firms under no licensing are respectively $\pi_{d,lo,n} = \frac{(a+t(e_n^*)-2c)^2}{9} - R(e_n^*)$ and $\pi_{f,lo,n} = \frac{(a-2t(e_n^*)+c)^2}{9}$, and the corresponding industry profit is

$$\Omega_{lo,n} = \frac{(a+t(e_n^*)-2c)^2}{9} + \frac{(a-2t(e_n^*)+c)^2}{9} - R(e_n^*). \quad (8)$$

Next, consider the situation under licensing. If both firms produce positive outputs under licensing, the equilibrium outputs and profits under licensing can be found by setting $c = 0$ in the equilibrium values under no licensing. The equilibrium outputs of the domestic and foreign firms are $q_{d,lo,l} = \frac{a+t(e_l^*)}{3}$ and $q_{f,lo,l} = \frac{a-2t(e_l^*)}{3}$ respectively, where e_l^* shows the equilibrium lobbying expenditure under licensing and $t(e_l^*)$ is the corresponding tariff rate. The corresponding equilibrium profits are $\pi_{d,lo,l} = \frac{(a+t(e_l^*))^2}{9} - R(e_l^*) - K$ and $\pi_{f,lo,l} = \frac{(a-2t(e_l^*))^2}{9} + K$. The equilibrium industry profit under licensing is:

$$\Omega_{lo,l} = \frac{(a+t(e_l^*))^2}{9} + \frac{(a-2t(e_l^*))^2}{9} - R(e_l^*). \quad (9)$$

It follows from Proposition 2 that the lobbying expenditure and the tariff rate are higher under licensing compared to no licensing.

For a clear exposition with the closed form solutions, we take the lobbying function and the cost of lobbying as

$$t(e) = e \qquad \text{and} \qquad \mathrm{R}(e) = Ae^2. \tag{10}$$

We assume $A > \frac{1}{3}$, which ensures that both firms produce positive outputs irrespective of licensing. We avoid corner solutions, since that will not add much to our main point.

Given the functions in (10), the equilibrium tariff rates and the lobbying expenditures under no licensing and licensing are respectively

$$t(e_n^*) = e_n^* = \frac{a-2c}{9A-1} \tag{11}$$

$$t(e_l^*) = e_l^* = \frac{a}{9A-1}. \tag{12}$$

Therefore, the costs of lobbying under no licensing and licensing are respectively

$$\mathrm{R}(e_n^*) = \frac{A(a-2c)^2}{(9A-1)^2} \tag{13}$$

$$\mathrm{R}(e_l^*) = \frac{Aa^2}{(9A-1)^2}. \tag{14}$$

The equilibrium outputs of firms D and F under no licensing are respectively $q_{d,lo,n} = \frac{3A(a-2c)}{9A-1} > 0$ and $q_{f,lo,n} = \frac{a(3A-1)+c(3A+1)}{9A-1} > 0$. The industry profits under no licensing is $\Omega_{lo,n} = \frac{a^2(1+A(-7+18A))-2ac(1+A(-2+9A))+\mathrm{c}^2(1+A(2+45A))}{(9A-1)^2}$.

The equilibrium outputs of firms D and F under licensing are respectively $q_{d,lo,l} = \frac{3Aa}{9A-1} > 0$ and $q_{f,lo,n} = \frac{a(3A-1)}{9A-1} > 0$. The industry profits under licensing is $\Omega_{lo,l} = \frac{a^2(1+A(-7+18A))}{(9A-1)^2}$.

Technology licensing is profitable if $\Omega_{lo,l} > \Omega_{lo,n}$ or

$$c < \frac{2a(1+A(9A-2))}{1+A(2+45A)} \equiv c'', \tag{15}$$

where $c'' < c'$,[8] implying that lobbying reduces the incentive for licensing when both firms produce positive outputs under no licensing and licensing, which gives the following result immediately.

Proposition 3: *If both firms produce positive outputs under no licensing and licensing, technology licensing with a fixed-fee occurs for* $c < \frac{2a(1+A(9A-2))}{1+A(2+45A)} \equiv c''$. *Since* $c'' < c'$, *lobbying in this situation reduces the possibility of licensing compared to no lobbying.*

The reason for the above result is as follows. There are two opposing effects of lobbying on the incentive for licensing compared to free trade that occurs under no lobbying in this section. First, if the foreign firm faces the same tariff rate irrespective of the licensing decision, it increases the possibility of licensing by reducing the cost difference between the domestic and foreign firms.[9] This is similar to Kabiraj and Marjit (2003). Second, higher lobbying effort and higher tariff rate under licensing compared to no licensing tends to reduce the benefit from licensing. On the balance, the second effect dominates the first effect and lobbying reduces the incentive for licensing.

2.3. The implications of lobbying on the consumers

It is easy to understand that if licensing occurs either irrespective of lobbying or only without lobbying, lobbying reduces consumer surplus compared to no lobbying since lobbying reduces the industry output by imposing a tariff.

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[8] $c'' = c'$ at $A = \frac{1}{3}$.

[9] If the foreign firm faces the same tariff rate under licensing and no licensing, the benefit from licensing is given by $\left(\frac{a+t}{3}\right)^2 + \left(\frac{a-2t}{3}\right)^2 - \left(\frac{a-2c+t}{3}\right)^2 - \left(\frac{a-2t+c}{3}\right)^2$ and it increases with t.

The following proposition is immediate from the above discussion.

Proposition 4: T*he consumers are worse off under lobbying compared to no lobbying, irrespective of the effects of lobbying on licensing.*

4. Licensing under lobbying: political contribution approach

In Section 3, we considered a situation where tariff determination through lobbying did not care about welfare. Although it helped to show that the implications of tariff on technology licensing and consumer surplus can differ significantly when tariff is not determined to maximise welfare, a more general framework may need to focus also on welfare when lobbying by the domestic firm influence the tariff rate. To do this, we consider in this section the widely used political contribution approach of Grossman and Helpman (1994), where the government maximises the tariff rate by giving weights on welfare and political contribution.

Following Grossman and Helpman (1994), we consider that the domestic government maximises

$$H = L + \alpha(\pi_{d,lo} + CS + T) \equiv L + \alpha W, \qquad (16)$$

where $W = (\pi_{d,lo} + CS + T)$, L is the domestic firm's political contribution, $\pi_{d,lo}$ is the domestic firm's gross profit (i.e., profit including the political contribution), *CS* is domestic consumer surplus and T is the tariff revenue.[10] We assume $\alpha > 2$ to ensure that both firms produce positive outputs irrespective of licensing.

[10] As explained in Grossman and Helpman (1994), one can consider the government's objective function as $G = \alpha_1 L + \alpha_2(\pi_{d,lo} - L + CS + T)$, where α_1 is the weight on the political contribution of the domestic firm and α_2 is the weight on the net domestic welfare. Maximizing *G* is equivalent to maximizing *H* in (16) with $\alpha = \frac{\alpha_2}{\alpha_1 - \alpha_2}$ if $\alpha_1 > \alpha_2$, which is assumed to hold, i.e., the politicians value one pound to their political account more than to the hands of the public.

Following Grossman and Helpman (1994), we will consider feasible and coalition-proof truthful political contribution by the domestic firm, implying that the domestic firm's political contribution will be non-negative and can't be more than its profit, and it will satisfy the following two conditions:

$$\underset{t}{Max}\ (\pi_{d,lo} - L) + H\ , \tag{17}$$

$$L^* = \alpha(\widehat{W} - W^*)\ , \tag{18}$$

where $(L^* + \alpha W^*)$ is the maximum value of $(L + \alpha W)$ with respect to t and $\alpha\widehat{W}$ is the maximum value of αW with respect to t (i.e., when the domestic firm does not lobby and the government determines welfare maximising tariff).

As suggested in Grossman and Helpman (1994), condition (17) suggests that the government policy must maximise the joint welfare of the domestic firm and the government, given the political contribution of the domestic firm, because, if that is not the case, the domestic firm can adjust its contribution to induce the government to choose the jointly optimal tariff and can appropriate some of the surplus generated from the switch in government policy. Condition (18) suggests that to induce the government to change the policy by accepting the domestic firm's contribution, in equilibrium, the domestic firm needs to give the government at least the same level of utility that the government could get if it did not accept the domestic firm's contribution and determined the tariff to maximise αW.

Maximising (16) we get $\frac{\partial H}{\partial t} = 0$ and maximising (17), we get $\frac{\partial \pi_{d,lo}}{\partial t} - \frac{\partial L}{\partial t} + \frac{\partial H}{\partial t} = 0$.

These two conditions give $\frac{\partial \pi_{d,lo}}{\partial t} = \frac{\partial L}{\partial t}$. Hence, we will determine the tariff and the contribution by maximising H subject to $\frac{\partial \pi_{d,lo}}{\partial t} = \frac{\partial L}{\partial t}$ and (18).

Consider the following game in this section. At stage 1, the foreign firm decides

whether to license the technology. At stage 2, the domestic firm decides on the political contribution. At stage 3, the government determines the tariff on the foreign firm's output. At stage 4, the firms compete like Cournot duopolists and the profits are realised. We solve the above game through backward induction.

First consider the case under no licensing. If there is no licensing, at stage 4, given the political contribution and the tariff rate, the domestic and foreign firms maximise the following expressions to determine the respective outputs:

$$\underset{q_d}{Max}(a-q-c)q_d - L \tag{19}$$

$$\underset{q_f}{Max}(a-q-t)q_f \,. \tag{20}$$

We get the equilibrium outputs of firms D and F under no licensing as $q_{d,lo} = \frac{a-2c+t}{3}$ and $q_{f,lo} = \frac{a-2t+c}{3}$. The corresponding equilibrium profits are $\pi_{d,lo} = \left(\frac{a-2c+t}{3}\right)^2 - D$ and $\pi_{f,lo} = \left(\frac{a-2t+c}{3}\right)^2$.

At stage 3, the government determines the tariff rate by maximising the following expression:

$$\underset{t}{Max}\, H = \underset{t}{Max}\, L + \alpha\left(\left(\frac{a-2c+t}{3}\right)^2 + \frac{1}{2}\left(\frac{2a-c-t}{3}\right)^2 + \frac{t(a-2t+c}{3}\right) \tag{21}$$

subject to $\frac{\partial \pi_{d,lo}}{\partial t} = \frac{\partial L}{\partial t}$.

The equilibrium tariff rate is

$$t^*_{lo,n} = \frac{a(2+3\alpha)-4c}{9\alpha-2}\,. \tag{22}$$

Given the equilibrium tariff rate, the equilibrium outputs and profits are respectively $q^*_{d,lo,n} = \frac{2\alpha(2a-3c)}{9\alpha-2}$, $q^*_{f,lo,n} = \frac{a(\alpha-2)+c(2+3\alpha)}{9\alpha-2}$, $\pi_{d,lo,n} = \left(\frac{2\alpha(2a-3c)}{9\alpha-2}\right)^2 - L^*_{lo,n}$ and $\pi_{f,lo,n} = \left(\frac{a(\alpha-2)+c(2+3\alpha)}{9\alpha-2}\right)^2$, where $L^*_{lo,n}$ is derived below.

We get

$$\alpha W^*_{lo,n} = \frac{\alpha\left[a^2(-4+7\alpha(9\alpha-4))+4ac(4+3(4-9\alpha)\alpha)+3c^2(3\alpha-2)(9\alpha+2)\right]}{2(9\alpha-2)^2}. \quad (23)$$

The equilibrium political contribution of the domestic firm is given by $L^* = \alpha(\widehat{W} - W^*)$, as shown in (18), where $\alpha\widehat{W}$ is the maximum value of αW with respect to *t*.

Maximising αW with respect to *t*, we get the welfare maximising tariff rate in the absence of the domestic firm's political contribution. We find that $\hat{t} = \frac{a}{3}$ maximises αW,[11] where $\hat{t} = \frac{a}{3} < t^*_{lo,n} = \frac{a(2+3\alpha)-4c}{9\alpha-2}$, and the value of αW at $\hat{t} = \frac{a}{3}$ is

$$\alpha\widehat{W}_n = \frac{\alpha(7a^2-12ac+9c^2)}{18}. \quad (24)$$

Hence, we get

$$L^*_{lo,n} = \alpha(\widehat{W}_n - W^*_{lo,n}) = \frac{8\alpha(2a-3c)^2}{9(9\alpha-2)^2}. \quad (25)$$

The industry profits under no licensing is

$$\Omega_{lo,n} = \frac{a^2(36+17\alpha(9\alpha-4))-6ac(12+\alpha(63\alpha-4))+9c^2(4+\alpha(4+45\alpha))}{9(9\alpha-2)^2}. \quad (26)$$

Now consider the case under licensing, which can be found by considering $c = 0$ in the above-mentioned values.

[11] Since this value is independent of licensing, we do not use any subscript for this value.

The equilibrium tariff rate and the domestic firm's political contribution under licensing are respectively

$$t^*_{lo,l} = \frac{a(2+3\alpha)}{9\alpha-2} \tag{27}$$

$$L^*_{lo,l} = \alpha(\widehat{W}_n - W^*_{lo,n}) = \frac{32a^2\alpha}{9(9\alpha-2)^2}. \tag{28}$$

We get the following result immediately from (22), (25), (27) and (28).

Proposition 5: *If both firms produce positive outputs, the domestic firm's political contribution and the tariff rate are higher under licensing compared to no licensing.*

The intuition for Proposition 5 is similar to that of under Proposition 2.

The equilibrium outputs and profits under licensing are respectively $q^*_{d,lo,l} = \frac{4a\alpha}{9\alpha-2}$, $q^*_{f,lo},l = \frac{a(\alpha-2)}{9\alpha-2}$, $\pi_{d,lo} = \left(\frac{4a\alpha}{9\alpha-2}\right)^2 - L^*_{lo,l}$ and $\pi_{f,lo} = \left(\frac{a(\alpha-2)}{9\alpha-2}\right)^2$.

The industry profits under licensing is

$$\Omega_{lo,l} = \frac{a^2(36+17\alpha(9\alpha-4))}{9(9\alpha-2)^2}. \tag{29}$$

Now we are in a position to consider when licensing is profitable. We get from (26) and (29) that $\Omega_{lo,l} - \Omega_{lo,n} = \frac{c\left[2a(12+\alpha(63\alpha-4)) - 3c(4+\alpha(4+45\alpha))\right]}{9(9\alpha-2)^2} > 0$ for $c < \frac{24a-8a\alpha+126a\alpha^2}{12+12\alpha+135\alpha^2} \equiv c^*$, where $c^* < \frac{a}{2}$, implying that licensing is profitable for any $c \in (0, \frac{a}{2})$.

The following result is immediate from the above discussion.

Proposition 6: *If both firms produce positive outputs under no licensing and licensing, technology licensing with a fixed-fee occurs for* $c < \frac{24a - 8a\alpha + 126a\alpha^2}{12 + 12\alpha + 135\alpha^2} \equiv c^*$. *Since* $\frac{a}{2} < c^*$, *licensing is profitable for any* $c \in (0, \frac{a}{2})$ *and lobbying in this situation increases the possibility of licensing compared to free trade.*

Proposition 6 is different from Proposition 3. Like the previous section, which considered tariff-function formation approach, the domestic firm's cost of lobbying (the political contribution in this situation) and the tariff rate increase also in this section, where we consider the political contribution model. However, lobbying in this section increases the incentive for licensing.

Like the previous section, lobbying creates two opposing effects also in this section compared to free trade.[12] First, like Kabiraj and Marjit (2003), if the foreign firm faces the same tariff rate irrespective of the licensing decision, it increases the possibility of licensing by reducing the cost difference between the domestic and foreign firms. Second, higher lobbying effort and higher tariff rate under licensing compared to no licensing tends to reduce the benefit from licensing. We find in this section that the first effect dominates the second effect and lobbying increases the possibility of licensing compared to free trade.

[12] Note that no lobbying in this section does not mean free trade. If there is no lobbying in this section, we get the welfare maximising tariff rate of $\hat{t} = \frac{a}{3}$ and it follows from Kabiraj and Marjit (2003) that licensing occurs for $c \in (0, \frac{a}{2})$ in this situation.

4.1. The implications of lobbying on the consumers

Now we want to see the implications of lobbying on the consumer surplus. To show this, we consider three situations – free trade, tariff under lobbying and the welfare maximising tariff. Since consumer surplus is $\frac{q^2}{2}$, it will be enough for us to compare total outputs under these situations.

It is immediate that if licensing occurs under all these three situations – free trade, tariff under lobbying and the welfare maximising tariff, consumer surplus will be maximum under free trade and minimum under lobbying, since there is no tariff under free trade and the tariff rate is maximum under lobbying.

Now compare the situation under "free trade and no licensing" to that of under "lobbying and licensing", since, as we have seen licensing will always be profitable under lobbying.[13] The equilibrium outputs are $q^*_{ft,n} = \frac{2a-c}{3}$ and $q^*_{lo,l} = \frac{a(5\alpha-2)}{9\alpha-2}$ under "free trade and no licensing" and "lobbying and licensing" respectively. We get that

$$q^*_{ft,n} - q^*_{lo,l} = \frac{a(2+3\alpha)-c(9\alpha-2)}{3(9\alpha-2)} \gtreqless 0 \ \text{for} \ c \gtreqless \frac{a(2+3\alpha)}{9\alpha-2} \equiv c''', \tag{30}$$

where $c''' - c^{\max} = \frac{3a(\alpha-2)}{2(2-9\alpha)} < 0$ but $c''' - c' = \frac{a(14-3\alpha)}{5(9\alpha-2)} \gtreqless 0 \ \text{for} \ \alpha \gtreqless \frac{14}{3}$.

Since we are considering a situation where licensing does not occur under free trade, we are assuming here that $c \in (c', c^{\max})$. We get from the above discussion that $c''' \in (c', c^{\max})$ if $\alpha < \frac{14}{3}$ but $c''' < c'$ (i.e., below the relevant range of $c \in (c', c^{\max})$) if $\alpha > \frac{14}{3}$. Hence, we can

[13] It follows from Kabiraj and Marjit (2003) that licensing will always occur under the welfare maximising tariff. Hence, "welfare maximising tariff and no licensing" is not an option here.

say that if $\alpha < \frac{14}{3}$, $q^*_{ft,n} < (>) q^*_{lo,l}$ *for* $c \in (c''', c^{\max})(c \in (c', c'''))$ but if $\alpha > \frac{14}{3}$, $q^*_{ft,n} < q^*_{lo,l}$ *for* $c \in (c', c^{\max})$.

The following result is immediate from the above discussion.

Proposition 7: (a) *If licensing occurs under lobbying but not under free trade, the consumers are better (worse) off under lobbying compared to free trade if either* $\alpha < \frac{14}{3}$ and $c \in (c''', c^{\max})$ or $\alpha > \frac{14}{3}$ and $c \in (c', c^{\max})$ (if $\alpha < \frac{14}{3}$ and $c \in (c', c''')$).

(b) When licensing occurs under free trade, lobbying and welfare maximising tariff, the consumer surplus is maximum under free trade and it is minimum under lobbying.

Figure 1 shows Proposition 7(a).

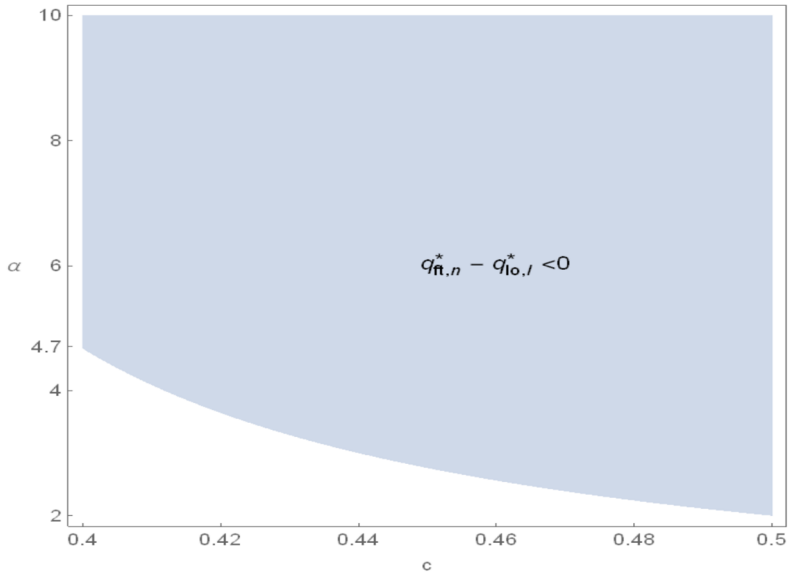

Figure 1: $q^*_{ft,n} - q^*_{lo,l}$ for $c \in (c', c^{\max})$ and $\alpha \in [2,10]$ with *a = 1*

We plot in Figure 1 $q^*_{ft,n} - q^*_{lo,l}$ for $c \in (c', c^{\max})$, $\alpha \in [2,10]$ and $a = 1$.[14] The blue shaded (white) area shows that $q^*_{ft,n} - q^*_{lo,l} < (>) 0$.

Proposition 7(a) contrasts both the result of Kabiraj and Marjit (2003) and Proposition 4 of the previous section. In contrast to Kabiraj and Marjit (2003), it shows that consumer surplus may reduce under tariff protection through lobbying compared to free trade when licensing occurs only under tariff protection. This happens if the government's weight on welfare is relatively low. On the other hand, in contrast to Proposition 4, Proposition 7(a) shows that consumer surplus may be higher under lobbying and licensing compared to free trade, if either the government's weight on welfare is sufficiently high or the cost difference between the firms is sufficiently large.

The reasons for the above-mentioned differences are as follows. First compare with Kabiraj and Marjit (2003). They showed that if the welfare maximising tariff attracts licensing, it always increases consumer surplus compared to free trade with no licensing. This happens because the benefit from licensing dominates the distortion due to tariff. In our analysis, lobbying increases the tariff rate compared to the welfare maximising tariff, thus increasing the distortion due to tariff. Further, the tariff rate under lobbying increases as α falls, i.e., as the government's relative weight on the political contribution increases. On the other hand, a relatively lower c tends to increase the consumer surplus under free trade with no licensing. Hence, if both α and c are relatively low, consumer surplus under free trade with no licensing is higher compared to consumer surplus under lobbying and licensing.

Now compare Proposition 7(a) and Proposition 4. In Section 3, lobbying imposes tariff and also reduces the possibility of licensing compared to the free trade. Both these adverse effects of lobbying reduce consumer surplus under lobbying compared to free trade. In contrast,

[14] If $a = 1$, we have $c' = 0.4$ and $c^{\max} = 0.5$.

lobbying in this section imposes tariff but increases the possibility of licensing. This benefit from licensing can outweigh the adverse effect of tariff, and consumer surplus may be higher under lobbying compared to free trade.

5. Conclusion

It is argued that tariff protection helps to attract superior foreign technologies through international technology licensing, which, in turn, benefits domestic consumers. We show in this paper that this conclusion may not hold true if the tariff rate is influenced by lobbying by the domestic firm.

In contrast to the existing literature, we show that lobbying for a tariff protection may decrease or increase technology licensing compared to free trade, depending on the way lobbying affects the tariff rate. The effects of lobbying on consumer surplus also depend on the lobbying process. Hence, how tariffs are determined – by welfare maximising governments or through lobbying by the domestic firms – and how lobbying affects tariffs are important for international technology licensing and the corresponding effects on the consumers.

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