

Appendix

Proofs for Patent Protection with Licensing

This note illustrates that fixed-fee licensing under patent protection will always create higher R&D incentives than under no patent protection, irrespective of the tournament effect (TE). According to Wang (1998), fixed-fee licensing for the patent-holding firm is inferior to royalty licensing when the cost-reducing innovation is non-drastring. This result is also implicitly given by Rockett (1990), who considers both fixed-fee and royalty licensing and concludes that in equilibrium, the fixed-fee is zero and only the output royalty is positive. Mukherjee (2006) has already proven that royalty licensing under patent protection may always induce higher incentives for R&D investment than under no patent protection, irrespective of TE, which is introduced by Roy Chowdhury (2005). In the following, we show that fixed-fee licensing also has a similar role.

First of all, the natural restrictions and symmetry on the duopoly profits specified in Roy Chowdhury (2005) still apply. Fixed-fee licensing has a net profit transferred from the licensee (firm 2) to the licensor (firm 1). The optimal level of fixed fees charged by firm 1 should be the amount that makes firm 2 indifferent between licensing and no licensing. Given that the game is symmetric, we should have

$$G(c', c) = \pi_1(c', c) - \pi(c', c') = \pi(c', c') - \pi_2(c', c). \quad (\text{A.1})$$

In fact, this equation implies that TE equals zero. If both firms invest in R&D, the net profit transferred from the licensee to the licensor when the license is sold yields firm 1's payoff, as follows:

$$\begin{aligned} & \frac{1}{2} [(p(c', c') - c')q_1(c', c') + G(c', c)] + \frac{1}{2} [(p(c', c') - c')q_1(c', c') - G(c', c)] - F \\ &= \frac{1}{2}\pi(c', c') + \frac{1}{2}\pi(c', c') - F = \pi(c', c') - F. \end{aligned} \quad (\text{A.2})$$

where $p(c', c')$ and $q_1(c', c')$ represent the market price and the quantity produced by firm 1 when the license is sold, respectively. The fixed-fee $G(c', \tilde{c})$ under no patent protection with licensing is calculated using the same logic as (A.1), implying $G(c', \tilde{c}) = \pi(c', c') - \pi_2(c', \tilde{c}) = \pi_1(c', \tilde{c}) - \pi(c', c')$. Consequently, using $G(c', c)$ and $G(c', \tilde{c})$, the game matrices can be written as follows.

Table 2: Payoffs under no patent protection with fixed-fee licensing

	R&D	No R&D
R&D	$\pi(c', c') - F, \pi(c', c') - F$	$\pi(c', c') + G(c', \tilde{c}) - F, \pi_2(c', \tilde{c})$
No R&D	$\pi_1(\tilde{c}, c'), \pi(c', c') + G(\tilde{c}, c') - F$	$\pi(c, c), \pi(c, c)$

In both tables, the strategies of firm 1 and firm 2 are labeled vertically and horizontally. For

Table 3: Payoffs under patent protection with fixed-fee licensing

	R&D	No R&D
R&D	$\pi(c', c') - F, \pi(c', c') - F$	$\pi(c', c') + G(c', c) - F,$ $\pi(c', c') - G(c', c)$
No R&D	$\pi(c', c') - G(c, c'), \pi(c', c') + G(c, c') - F$	$\pi(c, c), \pi(c, c)$

every payoff vector, the first and second expressions represent the net equilibrium payoff of firm 1 and firm 2, respectively.

Thus, from Table 2, we know that the non-strategic and strategic incentives for R&D under no patent protection with fixed-fee licensing for each firm are $N(NPL) = \pi(c', c') - \pi(c, c) + G(c', \tilde{c}) - F$ and $S(NPL) = \pi(c', c') - \pi(\tilde{c}, c') - F$. Similarly, Table 3 gives the non-strategic and strategic incentives for R&D under patent protection with fixed-fee licensing for each firm as $N(FL) = \pi(c', c') - \pi(c, c) + G(c', c) - F$ and $S(FL) = G(c', c) - F$. The direct comparison between $S(FL)$ and $S(NPL)$ using the optimal licensing fixed fee yields

$$S(FL) - S(NPL) = \pi_1(\tilde{c}, c') - \pi_1(c, c') > 0. \quad (\text{A.3})$$

Similarly, the comparison between $N(FL)$ and $N(NPL)$ yields

$$N(FL) - N(NPL) = G(c', c) - G(c', \tilde{c}) = \pi_1(\tilde{c}, c') - \pi_1(c, c') > 0. \quad (\text{A.4})$$

This result implies that fixed-fee licensing under patent protection also generates higher incentives for R&D investment than under no patent protection, irrespective of TE. This is because TE becomes zero under this regime, and patent protection eliminates the technology spillover from the innovating firm to the non-innovating firm.

References

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