Online Appendix to "Open or Closed? Technology Sharing, Supplier Investment, and Competition"

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In the proofs, we slightly revise the notation. When a superscript is followed by a number, it refers to the subcase currently being considered, where the subcases will be defined ad hoc.

Proof of Lemma 1. Consider the scenario in which T_1 is open, and T_2 is closed. We next prove that if the supplier invests in only one technology, she must invest in T_1.

If the supplier invests in T_1, then the two manufacturers will compete in the same market with the market size $\widehat{A} = A + \gamma(1-A) = \gamma + (1-\gamma)A$. In Stage 4, given wholesale price w_1, M_1 and M_2 engage in Cournot competition with symmetric profit functions $\pi_{i,4}^{\mathrm{OC}} = (\widehat{A} - q_1 - q_2 - w_1)q_i$, $i = m1, m2$. Thus the equilibrium order quantities are $q_{i,4}^{\mathrm{OC}} = (\widehat{A} - w_1)/3$, and the corresponding supplier's profit is $\pi_{s,4}^{\mathrm{OC}} = 2(\widehat{A} - w_1)w_1/3$. To maximize her expected profit, the supplier sets w_1^*, leading to equilibrium order quantities $\widehat{A}/6$, and equilibrium profits $\pi_{s,4}^{\mathrm{OC2}} = \widehat{A}^2/6$, $\pi_{m1,4}^{\mathrm{OC}} = \pi_{m2,4}^{\mathrm{OC}} = \widehat{A}^2/36$. By taking the expectation with respect to A, the firms' Stage 2 expected profits are $\pi_{s,2}^{\mathrm{OC}} = (1+\gamma+\gamma^2)/18 - K$, $\pi_{m1,2}^{\mathrm{OC}} = \pi_{m2,2}^{\mathrm{OC}} = (1+\gamma+\gamma^2)/108$.

If the supplier invests in T_2, then M_2 will stay in his own market, while M_1 has to exit the market. By an analogous analysis of Scenario CC Case 2, the supplier's expected profit from investing T_2 is $\pi_{s,2}^{\mathrm{OC2}} = 1/24 - K$.

Comparing the expected profits from investing T_1 and T_2, the supplier clearly prefers investing T_1, because $(1+\gamma+\gamma^2)/18 > 1/24$ for all $\gamma \in [0,1]$. $\square$

Proof of Proposition 2. In summary, the supplier's expected profits in the three cases are given by:

$$\begin{aligned}
&\text{Case 1: } \pi_{s,2}^{\mathrm{OC1}} = 0;\\
&\text{Case 2: } \pi_{s,2}^{\mathrm{OC2}} = \frac{1+\gamma+\gamma^2}{18} - K;\\
&\text{Case 3: } \pi_{s,2}^{\mathrm{OC3}} = \frac{1}{12} + \frac{37+40\gamma-20\gamma^2}{36(5-2\gamma)^3} - 2K.
\end{aligned}$$

Define Condition I: $(1+\gamma+\gamma^2)/18 \le K$ and $\frac{1}{12} + \frac{37+40\gamma-20\gamma^2}{36(5-2\gamma)^3} - 2K \le 0$. Clearly, the firm will choose Case 1, i.e., investing in neither technology, *if and only if* Condition I holds. Notice that $\frac{1}{12} + \frac{37+40\gamma-20\gamma^2}{36(5-2\gamma)^3} < \frac{1+\gamma+\gamma^2}{9}$ for any $\gamma \in [0,1]$. Hence, if $(1+\gamma+\gamma^2)/18 \le K$, then $2K \ge \frac{1}{12} + \frac{37+40\gamma-20\gamma^2}{36(5-2\gamma)^3}$ always holds. It implies that Condition I can be reduced to $(1+\gamma+\gamma^2)/18 \le K$. That is, if $K \ge \beta_1^{\mathrm{OC}}(\gamma) = (1+\gamma+\gamma^2)/18$, the supplier has no incentive to invest in either technology, and then, $\pi_{s,2}^{\mathrm{OC}} = 0$, and $\pi_{m1,2}^{\mathrm{OC}} = 0$ and $\pi_{m2,2}^{\mathrm{OC}} = 0$.

When $K < \beta_1^{\mathrm{OC}}(\gamma)$, we only need to compare Cases 2 and 3. By the definition,

$$\beta_2^{\mathrm{OC}}(\gamma) = \frac{1}{12} + \frac{37+40\gamma-20\gamma^2}{36(5-2\gamma)^3} - \frac{1+\gamma+\gamma^2}{18} = \frac{(3-2\gamma)(3-\gamma)(4\gamma^3-8\gamma^2-11\gamma+9)}{18(5-2\gamma)^3}.$$

If $\beta_2^{\mathrm{OC}}(\gamma) \le K < \beta_1^{\mathrm{OC}}(\gamma)$, then $\pi_{s,2}^{\mathrm{OC2}} \ge \pi_{s,2}^{\mathrm{OC3}}$, i.e., the supplier will only invest in Technology 1; otherwise, the supplier will invest in both technologies. $\square$

Proof of Proposition 3. By taking the square root of all payoffs, we can derive an equivalent form (see Table A1) of the game in Table S1.

Firm 1 \ Firm 2	T_1	T_2
T_1	$(\frac{A+\gamma(1-A)}{6}, \frac{A+\gamma(1-A)}{6})$	$(\frac{A}{4}, \frac{1-A}{4})$
T_2	$(\frac{1-A}{4}, \frac{A}{4})$	$(\frac{1-A+\gamma A}{6}, \frac{1-A+\gamma A}{6})$

Table A1 An Equivalent Form of Game in Table S1

We first consider the case with $\gamma \le 1/2$. In this case, we have $\frac{3-2\gamma}{5-2\gamma} \ge \frac{2}{5-2\gamma}$.

If $A \ge \frac{3-2\gamma}{5-2\gamma}$, then $\frac{A+\gamma(1-A)}{6} \ge \frac{1-A}{4}$, and $\frac{A}{4} > \frac{1-A+\gamma A}{6}$. It implies that (T_1, T_1) is a unique Nash equilibrium.

If $\frac{2}{5-2\gamma} < A < \frac{3-2\gamma}{5-2\gamma}$, then $\frac{A+\gamma(1-A)}{6} < \frac{1-A}{4}$, and $\frac{A}{4} > \frac{1-A+\gamma A}{6}$. In this case, there exist two Nash equilibria, i.e., (T_1, T_2) and (T_2, T_1). We assume that manufacturers never exchange their technologies—that is, the equilibrium (T_2, T_1) never happens. As a result, (T_1, T_2) is the only Nash equilibrium.

If $A \le \frac{2}{5-2\gamma}$, then $\frac{A+\gamma(1-A)}{6} < \frac{1-A}{4}$, and $\frac{A}{4} \le \frac{1-A+\gamma A}{6}$, which implies that (T_2, T_2) is a unique Nash equilibrium.

Now, we consider the case with $\gamma > 1/2$. In this case, we have $\frac{3-2\gamma}{5-2\gamma} < \frac{2}{5-2\gamma}$.

If $A \ge \frac{2}{5-2\gamma}$, then $\frac{A+\gamma(1-A)}{6} > \frac{1-A}{4}$, and $\frac{A}{4} \ge \frac{1-A+\gamma A}{6}$. Similarly, it implies that (T_1, T_1) is a unique Nash equilibrium.

If $\frac{3-2\gamma}{5-2\gamma} < A < \frac{2}{5-2\gamma}$, then $\frac{A+\gamma(1-A)}{6} > \frac{1-A}{4}$, and $\frac{A}{4} < \frac{1-A+\gamma A}{6}$. In this case, there exist two Nash equilibria, i.e., (T_1, T_1) and (T_2, T_2). In both equilibria, manufacturers earn the same profit, i.e., $\frac{(A+\gamma(1-A))^2}{36}$ for (T_1, T_1) and $\frac{(1-A+\gamma A)^2}{36}$ for (T_2, T_2). Note that $\frac{3-2\gamma}{5-2\gamma} \le \frac{1}{2} \le \frac{2}{5-2\gamma}$. If $\frac{3-2\gamma}{5-2\gamma} < A < \frac{1}{2}$, both manufacturers would like to adopt T_2; if $\frac{1}{2} \le A < \frac{2}{5-2\gamma}$, both manufacturers prefer adopting T_1. That is, (T_1, T_1) is the Pareto-dominant Nash equilibrium if $\frac{1}{2} \le A < \frac{2}{5-2\gamma}$ and (T_2, T_2) is the Pareto-dominant Nash equilibrium if $\frac{3-2\gamma}{5-2\gamma} < A < \frac{1}{2}$.

If $A \le \frac{3-2\gamma}{5-2\gamma}$, then $\frac{A+\gamma(1-A)}{6} \le \frac{1-A}{4}$, and $\frac{A}{4} < \frac{1-A+\gamma A}{6}$, which implies that (T_2, T_2) is a unique Nash equilibrium.

In summary, for the case with $\gamma > 1/2$, the unique or Pareto-dominant Nash equilibrium is (T_1, T_1), if $A \ge \frac{1}{2}$ and (T_2, T_2), if $A < \frac{1}{2}$. $\square$

Proof of Proposition 4. For $\gamma \le \frac{1}{2}$, the supplier's expected profits in three cases are given by:

$$\text{Case 1: } \pi_{s,2}^{\text{OO1}} = 0;$$
$$\text{Case 2: } \pi_{s,2}^{\text{OO2}} = \frac{1+\gamma+\gamma^2}{18} - K;$$
$$\text{Case 3: } \pi_{s,2}^{\text{OO3}} = \frac{1}{12} + \frac{37+40\gamma-20\gamma^2}{18(5-2\gamma)^3} - 2K.$$

By the definition of $\beta_1^{\text{OO}}(\gamma)$ and $\beta_2^{\text{OO}}(\gamma)$, we know that the supplier prefers Case 2 than Case 1 *if and only if* $K < \beta_1^{\text{OO}}(\gamma)$ and Case 3 than Case 2 *if and only if* $K < \beta_2^{\text{OO}}(\gamma)$. It can be proved that $\beta_1^{\text{OO}}(\gamma) \ge \beta_2^{\text{OO}}(\gamma)$. Therefore, if $K \ge \beta_1^{\text{OO}}(\gamma)$, the supplier will choose Case 1, i.e., invest in neither technology; if $\beta_2^{\text{OO}}(\gamma) \le K < \beta_1^{\text{OO}}(\gamma)$, Case 2 will be chosen, i.e., the supplier only invest in one technology; if $K < \beta_2^{\text{OO}}(\gamma)$, then the supplier will choose Case 3, i.e., invest in both technologies.

For $\gamma > \frac{1}{2}$, note that $\beta_1^{\text{OO}}(\gamma) \ge \beta_3^{\text{OO}}(\gamma)$. Then, the result can be proved by a similar proof to $\gamma \le \frac{1}{2}$. □

Proof of Theorem 1. Define $\widetilde{\gamma}$ as a solution of $\widehat{\beta}(\gamma) = \frac{1}{24}$. Then one can prove that $\widehat{\beta}(\gamma) > \frac{1}{24}$ if $0 \le \gamma < \widetilde{\gamma}$ and otherwise, $\widehat{\beta}(\gamma) \le \frac{1}{24}$. Thus, Part (ii) can be rewritten as: If $1/24 < K < \beta_1^{\text{OC}}(\gamma)$, the unique perfect equilibrium of the Stage 1 game is that *both* manufacturers *open* technologies. The ensuing outcome in Stage 2 is:

(ii-1) When $0 \le \gamma < \widetilde{\gamma}$,

(ii-1-1) if $\widehat{\beta}(\gamma) \le K < \beta_1^{\text{OC}}(\gamma)$, the supplier invests in only *one* technology.

(ii-1-2) if $1/24 \le K < \widehat{\beta}(\gamma)$, the supplier invests in *both* technologies.

(ii-2) When $\widetilde{\gamma} \le \gamma \le 1$,

(ii-2-1) if $1/24 \le K < \beta_1^{\text{OC}}(\gamma)$, the supplier invests in only *one* technology.

We will prove the results by considering four subcases: (i) $K \ge \beta_1^{\text{OC}}(\gamma)$; (ii) $\widehat{\beta}(\gamma) \le K < \beta_1^{\text{OC}}(\gamma)$ and $0 \le \gamma < \widetilde{\gamma}$; (iii) $\frac{1}{24} \le K < \widehat{\beta}(\gamma)$ and $0 \le \gamma < \widetilde{\gamma}$; and (iv) $\frac{1}{24} \le K < \beta_1^{\text{OC}}(\gamma)$ and $\widetilde{\gamma} \le \gamma \le 1$. Table A2 presents the payoff matrix of the Nash Game under four subcases.

(i) $K \ge \beta_1^{\text{OC}}(\gamma)$. Regardless of manufacturers' decisions, the supplier invests neither technology and all parties earn zero profit. Table A2 (i) presents the payoff matrix of the corresponding game. Clearly, the equilibrium is {XX, Neither}.

(ii) $\widehat{\beta}(\gamma) \le K < \beta_1^{\text{OC}}(\gamma)$ and $0 \le \gamma < \widetilde{\gamma}$. From Proposition 1 (i), if both manufacturers close technologies, then the supplier invests in neither technology and all parties' profits are zero. From Proposition 2 (ii) and Proposition 4 (ii), we know that if at least one manufacturer opens technology, then the supplier will invest in only one open technology. Table A2 (ii) presents the payoff matrix of the corresponding game. Notice that there exist three Nash equilibria, i.e., {OC, One}, {CO, One}, and {OO, One}. We choose the unique trembling hand perfect equilibrium {OO, One}.

(iii) $\frac{1}{24} \le K < \widehat{\beta}(\gamma)$ and $0 \le \gamma < \widetilde{\gamma}$. Unlike (ii), if both manufacturers open technologies, then the supplier will invest in both technologies. From Table A2 (iii), there exists a unique Nash equilibrium {OO, Both}.

(iv) $\frac{1}{24} \le K < \beta_1^{\mathrm{OC}}(\gamma)$ and $\widetilde{\gamma} \le \gamma \le 1$. Like subcase (ii), there also exist three Nash equilibria, i.e., {OC, One}, {CO, One}, and {OO, One}. We again choose the unique trembling hand perfect equilibrium {OO, One}. □

	(i): $K \ge \beta_1^{\mathrm{OC}}(\gamma)$	
Firm 1 \ Firm 2	C	O
C	(0,0)	(0,0)
O	(0,0)	(0,0)
	(ii): $\widehat{\beta}(\gamma) \le K < \beta_1^{\mathrm{OC}}(\gamma)$ and $0 \le \gamma < \widetilde{\gamma}$	
Firm 1 \ Firm 2	C	O
C	(0,0)	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
	(iii): $\frac{1}{24} \le K < \widehat{\beta}(\gamma)$ and $0 \le \gamma < \widetilde{\gamma}$	
Firm 1 \ Firm 2	C	O
C	(0,0)	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2})$
	(iv): $\frac{1}{24} \le K < \beta_1^{\mathrm{OC}}(\gamma)$ and $\widetilde{\gamma} \le \gamma \le 1$	
Firm 1 \ Firm 2	C	O
C	(0,0)	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$

Note: $\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2} > \frac{1+\gamma+\gamma^2}{108}$, for any $\gamma \in [0, \widetilde{\gamma}]$.

Table A2 Nash Game with $K \ge \frac{1}{24}$

Proof of Theorem 2. We prove the results by considering three subcases: (i) $\min\{\frac{1}{24}, \widehat{\beta}(\gamma)\} \le K < \frac{1}{24}$; (ii) $\beta_2^{\mathrm{OC}} \le K < \min\{\frac{1}{24}, \widehat{\beta}(\gamma)\}$; and (iii) $K < \beta_2^{\mathrm{OC}}$. Table A3 presents the payoff matrix of the Nash games for these subcases. In the case $K < \frac{1}{24}$, Proposition 1 (ii) indicates that if both manufacturers close technologies, then the supplier invests in both technologies.

(i) $\min\{\frac{1}{24}, \widehat{\beta}(\gamma)\} \le K < \frac{1}{24}$. From Proposition 2 (ii) and Proposition 4 (ii), we know that if at least one manufacturer opens technology, then the supplier will invest in only one open technology. Referring to Table A3 (i), as $\frac{1}{48} > \frac{1+\gamma+\gamma^2}{108}$ for any $\gamma \in [0, 17/38]$, thus {CC, Both} is a unique Nash equilibrium.

(ii) $\beta_2^{\mathrm{OC}} \le K < \min\{\frac{1}{24}, \widehat{\beta}(\gamma)\}$. Unlike (i), if both manufacturers open technologies, then the supplier will invest in both technologies. Table A3 (ii) presents the payoff matrix for the game of this subcase. As $\frac{1}{48} > \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2} > \frac{1+\gamma+\gamma^2}{108}$ for any $\gamma \in [0, 17/38]$, both {CC, Both} and {OO, Both} are Nash equilibria. However, {CC, Both} is a Pareto-dominant Nash equilibrium.

(iii) $K < \beta_2^{\mathrm{OC}}$. In this subcase, the supplier will invest in both technologies regardless of manufacturers' decision. Referring to Table A3 (iii), unlike (ii), {OO, Both} is not a Nash equilibrium. Thus, {CC, Both} is a unique Nash equilibrium. □

	(i): $\min\{\frac{1}{24}, \widehat{\beta}(\gamma)\} \le K < \frac{1}{24}$	
Firm 1 \ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
	(ii): $\beta_2^{\mathrm{OC}} \le K < \min\{\frac{1}{24}, \widehat{\beta}(\gamma)\}$	
Firm 1 \ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2})$
	(iii): $K < \beta_2^{\mathrm{OC}}$	
Firm 1 \ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2}, \frac{1}{48} - \frac{49-46\gamma}{216(5-2\gamma)^2})$
O	$(\frac{1}{48} - \frac{49-46\gamma}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2})$	$(\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2})$

Note: 1. $\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2} > \frac{1}{48} > \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2} > \frac{1+\gamma+\gamma^2}{108}$, for any $\gamma \in [0, 17/38]$.

Table A3 Nash Game with $K < \frac{1}{24}$ and $\gamma < \frac{17}{38}$

Proof of Theorem 3. Now we consider the case with $K < \frac{1}{24}$ and $\gamma \ge \frac{17}{38}$. Table A4 presents the payoff matrix of Nash games under different subcases, by combing the results in Propositions 1, 2 and 4. Again, as $K < \frac{1}{24}$, Proposition 1 (ii) indicates that if both manufacturers close technologies, then the supplier invests in both technologies.

(i) $K < \beta_2^{\mathrm{OC}}(\gamma)$ and $\frac{17}{38} \le \gamma \le \frac{1}{2}$. In this subcase, by Propositions 1, 2 and 4, the supplier will invest in both technologies regardless of manufacturers' decision. See Table A4 (i). Note that $\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2} > \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2}$ for any $\gamma \in [17/38, 1/2]$. Thus, the strategy {CC, Both} is a unique equilibrium.

(ii) $K < \beta_2^{\mathrm{OC}}(\gamma)$ and $\frac{1}{2} < \gamma \le 1$. Like (i), the supplier will invest in both technologies regardless of manufacturers' decision. However, parties' profits are different if both manufacturers open technologies. See Table A4 (ii). $\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2} > \frac{7+4\gamma+\gamma^2}{432}$ for any $\gamma \in [1/2, 1]$, the strategy {CC, Both} is a unique equilibrium.

(iii) $\beta_2^{\mathrm{OC}}(\gamma) \le K < \widehat{\beta}(\gamma)$ and $\frac{17}{38} \le \gamma \le \frac{1}{2}$. By Proposition 2 (ii), if only one manufacturer opens technologies, the supplier will only invest in this open technology; if both are open, the supplier will invest in both technologies. See Table A4 (iii). As $\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2} > \frac{1}{48} > \frac{1+\gamma+\gamma^2}{108}$, for any $\gamma \in [17/38, 1/2]$, the strategy {OO, Both} is a unique Nash equilibrium.

(iv) $\beta_2^{\mathrm{OC}}(\gamma) \le K < \widehat{\beta}(\gamma)$ and $\frac{1}{2} < \gamma \le 1$. The analysis is similar to that in (iii). See Table A4 (iv). Note that $\frac{7+4\gamma+\gamma^2}{432} > \max\{\frac{1}{48}, \frac{1+\gamma+\gamma^2}{108}\}$, for any $\gamma \in [1/2, 1]$. Thus, {OO, Both} is a Pareto-dominant equilibrium.

	(i): $K < \beta_2^{\mathrm{OC}}(\gamma)$ and $\frac{17}{38} \le \gamma \le \frac{1}{2}$	
Firm 1 $\setminus$ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2}, \frac{1}{48} - \frac{49-46\gamma}{216(5-2\gamma)^2})$
O	$(\frac{1}{48} - \frac{49-46\gamma}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2})$	$(\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2})$
	(ii): $K < \beta_2^{\mathrm{OC}}(\gamma)$ and $\frac{1}{2} < \gamma \le 1$	
Firm 1 $\setminus$ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2}, \frac{1}{48} - \frac{49-46\gamma}{216(5-2\gamma)^2})$
O	$(\frac{1}{48} - \frac{49-46\gamma}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2})$	$(\frac{7+4\gamma+\gamma^2}{432}, \frac{7+4\gamma+\gamma^2}{432})$
	(iii): $\beta_2^{\mathrm{OC}}(\gamma) \le K < \widehat{\beta}(\gamma)$ and $\frac{17}{38} \le \gamma \le \frac{1}{2}$	
Firm 1 $\setminus$ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2}, \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2})$
	(iv): $\beta_2^{\mathrm{OC}}(\gamma) \le K < \widehat{\beta}(\gamma)$ and $\frac{1}{2} < \gamma \le 1$	
Firm 1 $\setminus$ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{7+4\gamma+\gamma^2}{432}, \frac{7+4\gamma+\gamma^2}{432})$
	(v): $\widehat{\beta}(\gamma) \le K < \frac{1}{24}$	
Firm 1 $\setminus$ Firm 2	C	O
C	$(\frac{1}{48}, \frac{1}{48})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$
O	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$	$(\frac{1+\gamma+\gamma^2}{108}, \frac{1+\gamma+\gamma^2}{108})$

Note: 1. $\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2} > \frac{7+4\gamma+\gamma^2}{432} > \max\{\frac{1}{48}, \frac{1+\gamma+\gamma^2}{108}\}$, for any $\gamma \in [1/2, 1]$;
2. $\frac{1}{48} + \frac{4-\gamma}{27(5-2\gamma)^2} > \frac{1}{48} + \frac{38\gamma-17}{216(5-2\gamma)^2} > \frac{1}{48} > \frac{1+\gamma+\gamma^2}{108}$, for any $\gamma \in [17/38, 1/2]$.

Table A4 Nash Game with $K < \frac{1}{24}$ and $\gamma \ge \frac{17}{38}$

(v) $\widehat{\beta}(\gamma) \le K < \frac{1}{24}$. In this subcase, if at least one technology is open, then the supplier will invest in only one open technology. See Table A4 (v). By the definition of $\widehat{\gamma}$, if $\gamma < \widehat{\gamma}$, $\frac{1}{48} > \frac{1+\gamma+\gamma^2}{108}$ and thus {CC, Both} is a unique equilibrium; if $\gamma \ge \widehat{\gamma}$, $\frac{1}{48} \le \frac{1+\gamma+\gamma^2}{108}$ and thus {OO, One} is a unique equilibrium. $\square$