Vertical Separation and Collusion

Kuo-Feng Kao and Chin-Sheng Chen*

Abstract

This paper examines an integrated firm's incentive to undertake vertical separation with forward-looking behavior. In an infinitely repeated game we show that tacit collusion among firms in a final good market is more likely to be sustained under vertical separation than under vertical integration. The integrated firm tends to vertically separate its business if the discount factor is at a medium level and the input price is sufficiently low. Finally, an increase in the input price is socially beneficial if it prevents vertical separation.

Keywords: Vertical Separation, Trigger Strategy, Collusion
JEL Classification: D43, L13, L41

* Corresponding author: Chin-Sheng Chen, Associate Professor in the Department of International Business, Soochow University, No. 56, Sec. 1, Kueiyang St., Chungcheng Dist., Taipei City 100006, Taiwan, R.O.C., Tel: 886-2-23111531 ext. 3692, E-mail: cschen0709@scu.edu.tw. Kuo-Feng Kao, Associate Professor in the Department of Industrial Economics, Tamkang University, No. 151, Yingzhuan Rd., Tamsui Dist., New Taipei City 251301, Taiwan, R.O.C., Tel: 886-2-26215656 ext. 3335, E-mail: kuofeng@mail.tku.edu.tw. The authors are very grateful to Professor Hong Hwang, Professor Cheng-Hau Peng, two anonymous referees and the participants at the international trade workshop of National Taiwan University for their helpful comments and suggestions.

Received February 1, 2018; revised July 17, 2018; accepted June 26, 2019.

經濟研究 (Taipei Economic Inquiry), 56:2 (2020), 243-266。
臺北大學經濟學系出版

1. Introduction

Vertical separation, whereby an integrated firm separates its upstream and downstream businesses into two independent entities, is quite a common phenomenon in many industries. For example, as the competition among OEMs (original equipment manufacturer) became more and more intensive, Acer vertically separated its DMS (design, manufacturing and services) unit into an independent firm, Wistron, in 2000. In 2008, ASUSTek vertically separated its OEM unit into an independent firm, Pegatron, in order to focus more of its business on branding. Those concrete examples motivate this paper to set up a model to examine the profitability of vertical separation and how a low input price (or OEM price) may encourage such vertical separation activities from the perspective of firms' forward-looking behaviors.

Many studies in the industrial organization literature have been devoted to investigating the profitability of vertical separation.[1] Vickers (1985) shows that a manufacturer employing a two-part tariff contract provides its input to its retailer at a price below the production cost and then extracts all the rents via a fixed fee. Vertical separation is profitable, because the manufacturer can subsidize its retailer so as to enjoy a competitive advantage over its rivals in the final good market. Bonanno and Vickers (1988) consider Bertrand competition and also present that vertical separation is profitable to a manufacturer if two-part tariff contracts are available. Since retailers' prices are strategically complementary, they show that the manufacturer with vertical separation tends to raise input prices in order to mitigate downstream competition. Chen (2005) points out that, under vertical separation, the separated upstream firm can achieve economies of scale in input production by

[1] In the Industrial Organization literature, the incentive for vertical integration, under which a downstream firm and an upstream firm merge into one entity, has also been discussed in the context of successive oligopoly. See, Greenhut and Ohta (1979), Salinger (1988) and Wang et al. (2005), among others.

selling the input to independent downstream firms and finds that vertical separation is profitable if and only if the industry profit can subsequently rise. Lin (2006) offers that a downstream firm, when entering backward into an upstream market, can enjoy a larger upstream market share by creating a newly dependent upstream entity. If the number of downstream firms is large enough, then such a vertical separation strategy is profitable.

This paper examines an integrated firm's incentive for vertical separation from a different angle. In contrast to the setting in the papers mentioned above, our focus is on the forward-looking behavior of firms. Our model initially includes an integrated firm, which consists of an upstream business and a downstream business, and an independent downstream firm in a final good market. The two firms compete in Cournot fashion repeatedly over an infinite time horizon. The upstream business provides inputs for the downstream business as well as the independent downstream firm. However, we assume there are other input suppliers in the input market and firms in the input market compete in prices. The setting of a competitive input market herein has the merit of excluding the influence of vertical integration on input price.[2] In the existing related literature, Ordover et al. (1990) and Chen (2005) examine the relationship between input price changes and vertical integration (separation) activities. Chen (2005) investigates the effect of strategic purchasing behavior on the incentive for vertical separation. Ordover et al. (1990) explore the relationship between competition in the input market and the incentive to engage in vertical integration. By contrast, our focus is on the forward-looking behavior of firms. Moreover, the assumption of a competitive input market can reflect the real world phenomenon where competition among OEM firms is intensive,

[2] Another alternative explanation for this competitive input market is that the independent downstream firm can pay a small fixed-fee (which can be ignored in our model) and backward integrates with an inferior input production technology with the marginal production cost w. This setup follows Inderst and Valletti (2009) and will generate the same result as the competitive input market.

especially in the industries of telecommunications, consumer electronics, and information technology.

In our model we find that the discount factor is crucial to the integrated firm when considering a separation decision as well as the input price. First, we show a necessary condition for collusive equilibrium to be individually rational is that the input price is low. Note that in our model the input price is main cost difference between the integrated firm and the independent downstream firm. As the input price increases, the cost advantage of the integrated firm increases, which enlarges the profit of the integrated firm. Nevertheless, this profit increase is more significant under Cournot competition than under collusion, thereby decreasing the incentive for the integrated firm to collude. This result holds true under both vertical integration and vertical separation. Second, we show that if the discount factor is at a medium level, then tacit collusion prevails in the final good market under vertical separation, but not under vertical integration. Note that under vertical separation the cost difference between firms vanishes, which makes firms have higher incentives to collude as the joint profit is higher under tacit collusion than that under Cournot competition. Accordingly, we find when the discount factor is in the medium range, it is possible that firms collude under vertical separation, but not under vertical integration. In such a circumstance, vertical separation can be a commitment to sustain such tacit collusion, it is thus profitable to the integrated firm when the input price is sufficiently low. This result may explain why some notebook computer companies conducted separation activities when OEM prices decreased too much.

According to the US and EU non-horizontal merger guidelines, vertical integration may facilitate firms collude in the upstream market. This idea has been illustrated by Nocke and White (2007) and Normann (2009). Instead of considering collusion in upstream markets, we examine collusion in downstream markets and show that vertical separation is more likely to facilitate downstream collusion. This result suggests that if collusion is an important concern, policy authorities may regulate not

only vertical mergers, but also vertical separation by integrated firms in vertically related industries.

We further compare the welfare levels under the regimes of both vertical separation and vertical integration, finding that vertical integration is more socially desirable than vertical separation. In vertically related markets it is well known that a higher input price will reduce social welfare. Opposite to conventional wisdom, in our model if the discount factor lies in a medium range, then it is socially desirable to increase the input price so as to prevent the integrated firm from engaging in vertical separation. Under such a circumstance, the integrated firm will not collude with the independent downstream firm, thereby resulting in higher social welfare.

The remainder of the paper proceeds as follows. Section 2 presents the model. Section 3 derives the equilibrium under vertical integration where the integrated firm maintains the status quo. Section 4 derives the equilibrium under vertical separation when the integrated firm vertically separates its business. Section 5 investigates the integrated firm's incentive for vertical separation and the resulting welfare implications. Section 6 concludes this paper.

2. The Model

We use a simple model with a vertically related market, composed of one competitive input market and one final good market. In the final good market there are initially two competing firms: one integrated firm and one independent downstream firm. The inverse demand function of the final good is specified as $P(q+Q)=a-b(q+Q)$, where Q and q are the quantities supplied by the integrated firm and the independent downstream firm, respectively.

We assume that both the downstream business of the integrated firm and the independent downstream firm incur a constant marginal cost in producing the final good, which is denoted as $c \geq 0$. Moreover, we

assume that one unit of the final good production requires one unit of input. The upstream business of the integrated firm can produce the input at zero marginal cost. However, the independent downstream firm need to buy the input from the input market. In addition to the integrated firm, there are other suppliers of the input and their marginal cost is assumed to be w and $0 < w \leq (a-c)/2$. We assume that in the input market firms compete in Bertrand fashion. Since a profit-maximizing firm will always choose the cheaper supplier, the independent downstream firm will purchase the input from the upstream business of the integrated firm if the input price charged by the integrated firm is not higher than w. Hence, in equilibrium the integrated firm (its upstream business) sells its input to the downstream rival at the price $w-\varepsilon$, where ε is a very small amount. For simplicity, we assume $\varepsilon = 0$ and the downstream firm buys the inputs from the integrated firm.[3]

With this model we shall investigate whether the integrated firm has an incentive to separate its upstream and downstream businesses. With vertical integration, the independent downstream firm buys the input from the upstream business of the integrated firm. On the other hand, in the regime of vertical separation, the integrated firm divides its upstream and downstream businesses into one independent upstream firm and one independent downstream firm, and then the two firms maximize their own profits. In addition, the two independent downstream firms buy the input from the upstream firm which provides the inputs with the lowest price, and the input prices are well known to all downstream firms. Since

[3] It is worth noting that if the integrated firm also monopolizes the input market, then it has no incentive to sell its inputs to the independent downstream firm. The integrated firm then will monopolize the final good market, and this is also the highest industry profit that the integrated firm can earn, which implies the integrated firm has no incentive to vertically separate. To focus on the effects of separation actions, we shall not consider this foreclosure case. Moreover, we need to assume that w is lower than the monopoly input price charged by the integrated firm, i.e., $w \leq (a-c)/2$, so as to make sure the input price is w when there are other suppliers in the input market. Please see Appendix for the related discussion. We thank an anonymous referee for suggesting this.

the input market is competitive, we assume the upstream firms can only adopt linear pricing.

The profit function of the independent downstream firm is:

$$\pi = \left[P(q+Q) - w - c\right]q. \tag{1}$$

The profits of the upstream business (Ω) and downstream business (Π) of the integrated firm are:

$$\Omega = w(q+Q) \quad \text{and} \quad \Pi = \left[P(q+Q) - w - c\right]Q. \tag{2}$$

By summing up Ω and Π, the profit of the integrated firm is given as:

$$\Lambda = wq + \left[P(q+Q) - c\right]Q. \tag{3}$$

In our model the two competing downstream firms are forward-looking and care about their future profits. We consider an infinitely repeated game. At the beginning of the game, the vertically-integrated firm determines whether to vertically separate its business into one independent upstream firm and one independent downstream firm. We assume that the market structure is unchanged once it is chosen. Also, the firms in the final good market are assumed to compete in Cournot fashion.

In the regime of vertical integration, let π_t and Λ_t respectively denote the profits of the independent downstream firm and the integrated firm in time period t, where $t = 1,...,\infty$. The independent downstream firm's profit is then $\pi_1 + \delta\pi_2 + \delta^2\pi_3 + ... + \delta^{t-1}\pi_t + ...$, and the integrated firm's profit is $\Lambda_1 + \delta\Lambda_2 + \delta^2\Lambda_3 + ... + \delta^{t-1}\Lambda_t + ...$, where $\delta \in [0,1]$ is the discount factor.[4] On the other hand, in the regime of vertical separation the separated downstream firm competes with the independent

[4] Note that the discount factor can be derived by using $\delta = 1/(1+r)$, where r is the interest rate. In other words, the discount factor stands for the present value of future cash flow.

downstream firm. The discounted profit of the separated downstream firm is now defined as $\Pi_1 + \delta\Pi_2 + \delta^2\Pi_3 + ... + \delta^{t-1}\Pi_t + ...$, where Π_t is its profit in period *t*.

In the infinitely repeated game, tacit collusion among the competing firms in the final good market may arise. We assume that firms, if colluding, tacitly maximize their joint profit by choosing individual outputs according to their market shares under the non-cooperative Cournot equilibrium. This set-up is similar to that of Tyagi (2001) who also assumes that firms divide their profits under collusion according to the output ratio under Cournot equilibrium. Under such a tacit collusion the collusive firms' profits come from their final products being sold, as any side payments are illegal. It is therefore reasonable to exclude the case that all the outputs are produced by the most efficient firm, whereas the less efficient firm still can share the profits without selling any outputs. Furthermore, for the collusion to be sustainable, we assume the collusive firms adopt a trigger strategy whereby if any firm has deviated in the past, then both firms revert to playing a Cournot strategy forever.

With the above settings, we first derive the conditions under which tacit collusion in the final good market is sustainable under either regime. Next, we investigate how the discount factor affects the profitability of vertical separation from the viewpoint of the integrated firm.

3. Collusive Equilibrium under Vertical Integration

This section derives the conditions under which tacit collusion is sustainable in the vertical integration regime. To this end, we shall derive the Cournot-Nash profits, the collusive profits, and the cheating profits of firms in a period of time.

We first derive the Cournot-Nash profits. By differentiating (1) with respect to *q* and (3) with respect to *Q*, the equilibrium Cournot outputs in a period of time can be derived by simultaneously solving the first-order conditions $\partial\pi/\partial q = 0$ and $\partial\Lambda/\partial Q = 0$. The outputs of the independent

downstream firm and the integrated firm are:

$$q^* = \frac{a-c-2w}{3b} \quad \text{and} \quad Q^* = \frac{a-c+w}{3b}, \tag{4}$$

where the "asterisk" denotes the equilibrium under Cournot competition. Let $s\,(1-s)$ represent the market share of the independent downstream firm (the integrated firm). From (4), we have:

$$s = \frac{q^*}{q^* + Q^*} = \frac{a-c-2w}{2a-2c-w}. \tag{5}$$

By substituting (4) into (1) and (3), the profits of the independent downstream firm and the integrated firm are respectively:

$$\pi^{*VI} = \frac{(a-c-2w)^2}{9b} \quad \text{and} \quad \Lambda^{*VI} = \frac{(a-c)^2 + 5(a-c)w - 5w^2}{9b}, \tag{6}$$

where hereafter the superscript "*VI*" represents the variables associated with the equilibrium under vertical integration.

Second, under collusion the two firms in the final good market choose their individual outputs so as to maximize the joint profit by following the output allocation rule, which is decided by their market shares under Cournot competition (5). Their profit maximization problems are specified as: $\max_q (\Lambda + \pi)$, s.t. $q = s(q+Q)$ and $\max_Q (\Lambda + \pi)$, s.t. $Q = (1-s)(q+Q)$. The solutions to the profit maximization problems yield:

$$\bar{q} = \frac{(a-c)(a-c-2w)}{2b(2a-2c-w)} \quad \text{and} \quad \bar{Q} = \frac{(a-c)(a-c+w)}{2b(2a-2c-w)}, \tag{7}$$

where hereafter the "upper bar" denotes the collusive equilibrium. By substituting (7) into (1) and (3), the collusive profits of the independent downstream firm and the integrated firm are respectively:

$$\bar{\pi}^{VI}=\frac{(a-c)(a-c-2w)^2}{4b(2a-2c-w)} \quad \text{and} \quad \bar{\Lambda}^{VI}=\frac{(a-c)(a-c-w)(a-c+4w)}{4b(2a-2c-w)}. \tag{8}$$

Third, we calculate the profits from cheating during the collusion. Given the output of the independent downstream firm as $\bar{q}$, if the integrated firm decides to deviate from the collusive output, then its optimal output is determined by solving $\partial(\Lambda|_{q=\bar{q}})/\partial Q=0$ with respect to Q. The cheating profit of the integrated firm is:

$$\tilde{\Lambda}^{VI}=\frac{(a-c)\left[9(a-c)^3+16(a-c)^2w-40(a-c)w^2+16w^3\right]}{16b(2a-2c-w)^2}, \tag{9}$$

where hereafter variables with an upper "tilde" are associated with the cheating equilibrium. Similarly, by solving $\partial(\pi|_{Q=\bar{Q}})/\partial q=0$, we can derive the optimal output for the independent downstream firm under deviation, and its cheating profit is derivable as:

$$\tilde{\pi}^{VI}=\frac{(a-c-2w)^2(3a-3c-w)^2}{16b(2a-2c-w)^2}. \tag{10}$$

Ensuring the collusive equilibrium is individually rational requires that $\bar{\pi}^{VI}\geq\pi^{*VI}$ and $\bar{\Lambda}^{VI}\geq\Lambda^{*VI}$ in any given time period, which requires $w\leq(a-c)/5$. We present this result as the following lemma.

Lemma 1.

In the model the necessary condition for the collusive equilibrium to be individually rational under the case of vertical integration is that the input price is sufficiently low such that $w\leq(a-c)/5$.

Note that the independent downstream firm has a higher production cost due to the input price. If the input price is large, i.e., $w>(a-c)/5$, then the integrated firm enjoys an overwhelming competitive advantage over the independent downstream firm and therefore will never have the

incentive to collude. Hence, we assume that $w \le (a-c)/5$ throughout the paper.

The collusive output equilibrium in (7) is sustainable only if any unilateral deviation is not profitable. We shall solve the minimal discount rate that is required for the collusion to be sustainable. By utilizing (6), (8) and (9), the integrated firm adheres to the tacit collusion if and only if $(1+\delta+\delta^2+...)\bar{\Lambda}^{VI} \ge \tilde{\Lambda}^{VI} + (\delta+\delta^2+...)\Lambda^{*VI}$, which requires that $\delta \ge 9(a-c)^2/(17a-17c-10w)(a-c-2w) \equiv D^{VI}$. Similarly, from (6), (8) and (10), the independent downstream firm will not deviate from the collusive equilibrium if and only if $(1+\delta+\delta^2+...)\bar{\pi}^{VI} \ge \tilde{\pi}^{VI} + (\delta+\delta^2+...)\pi^{*VI}$, which requires that $\delta \ge 9(a-c-w)^2/(17a-17c-7w)(a-c+w) \equiv d^{VI}$. As $D^{VI} \ge d^{VI}$, the minimal required discount rate is D^{VI}. It is worth noting that $\partial D^{VI}/\partial w > 0$ and $D^{VI} = d^{VI} = 9/17$ only if $w = 0$. The intuition behind this is that cost asymmetry makes collusion difficult. Note that *w* here stands for the cost difference between integrated firm and the independent downstream firm. As *w* is higher, the market share of the integrated firm under Cournot is also higher, which implies the Cournot profit of the integrated firm increases as well. Therefore, the incentive of the integrated firm to collude decreases as *w* increases. By Lemma 1, if $w > (a-c)/5$, then the integrated firm has no incentive to collude. We thus obtain the following proposition.

Proposition 1.

In the case of vertical integration, tacit collusion in the downstream market is sustainable if $\delta \ge D^{VI}$. *Moreover, a lower input price is more likely to induce tacit collusion.*

4. Collusive Equilibrium under Vertical Separation

Under the regime of vertical separation, the integrated firm separates

its business into one independent upstream firm and one independent downstream firm. There are now two independent downstream firms in the final good market. This section shall examine the sustainability of tacit collusion for the two downstream firms by deriving their Cournot-Nash profits, collusive profits, and cheating profits in a period of time.

By simultaneously solving the first-order conditions of the downstream firms ($\partial\pi/\partial q = 0$ and $\partial\Pi/\partial Q = 0$), the Cournot-Nash outputs are derived as:

$$q^* = Q^* = \frac{a-c-w}{3b}. \tag{11}$$

From (11), the two competing downstream firms have the same market share due to their cost symmetry. By substituting (11) into (1) and (2), we derive the profit of the two downstream firms as:

$$\pi^{*VS} = \Pi^{*VS} = \frac{(a-c-w)^2}{9b}, \tag{12}$$

where the superscript "*VS*" represents the equilibrium under vertical separation. Substituting (11) into (3), the aggregate profit of the integrated firm is:

$$\Lambda^{*VS} = \frac{(a-c-w)(a-c+5w)}{9b}. \tag{13}$$

Under the case of tacit collusion, the collusive firms choose their outputs, q and Q, to maximize the joint profit ($\Pi + \pi$). Due to cost symmetry they produce the same outputs:

$$\overline{q} = \overline{Q} = \frac{a-c-w}{4b}. \tag{14}$$

Substituting (14) into (1) and (2) yields the independent downstream firms' profits as:

$$\bar{\pi}^{VS} = \bar{\Pi}^{VS} = \frac{(a-c-w)^2}{8b}. \tag{15}$$

Substituting (14) into (3) yields the aggregate profit of the integrated firm as:

$$\bar{\Lambda}^{VS} = \frac{(a-c-w)(a-c+3w)}{8b}. \tag{16}$$

The equilibrium outputs under unilateral deviations can be derived by solving $\partial(\Pi|_{q=\bar{q}})/\partial Q = 0$ with respect to Q and solving $\partial(\pi|_{Q=\bar{Q}})/\partial q = 0$ with respect to q. The cheating profits are then derivable as:

$$\tilde{\Pi}^{VS} = \tilde{\pi}^{VS} = \frac{9(a-c-w)^2}{64b}. \tag{17}$$

By using (12), (15) and (17), the conditions for the tacit collusion to be sustained are $(1+\delta+\delta^2+...)\bar{\Pi}^{VS} \geq \tilde{\Pi}^{VS} + (\delta+\delta^2+...)\Pi^{*VS}$ and $(1+\delta+\delta^2+...)\bar{\pi}^{VS} \geq \tilde{\pi}^{VS} + (\delta+\delta^2+...)\pi^{*VS}$. From these conditions, the required minimal discount rate is 9/17. It should be noted that under vertical separation the minimum discount factors for firms to collude are the same since the downstream firms' marginal production costs are the same. We now obtain the second proposition.

Proposition 2.

In the vertical separation regime, if $\delta \geq 9/17$, *then the tacit collusion is sustained in the downstream market.*

5. Profitability and Welfare Effects of Vertical Separation

5.1 Profitability of Vertical Separation

We are now in a position to investigate the incentive of the integrated firm to engage in vertical separation. The previous findings show that the collusion is more likely to endure under vertical separation than under vertical integration since $\partial D^{VI}/\partial w > 0$ and $D^{VI}\big|_{w=0} = 9/17 = d^{VS} = D^{VS}$.

It should be noted that the integrated firm has less incentive to collude under the case of vertical integration as it has a higher cost advantage over the independent downstream firm. This is because that the cost advantage makes collusion less profitable to the integrated firm under the case of vertical integration. The reasons are given as follows. First, due to the cost advantage, the independent downstream firm produces at a smaller market share under collusion. This implies that given the independent firm produces the colluded output level, the integrated firm can produce more output once it deviates from the collusion. If the cost advantage is larger, then the colluded output of the independent downstream firm is smaller, and thus the integrated firm can even produce more outputs when deviating from the collusion and receive an even higher profit after the deviation. Second, the punishment after the deviation has less impact on the integrated firm as it is more efficient than its rival. Both aspects indicate that collusion is less profitable to the integrated firm and makes tacit collusion less likely to be sustained under vertical integration than under vertical separation.

By using the two required discount rates offered by Proposition 1 and Proposition 2, the values of the discount rate can be divided into three ranges. In what follows, we shall first analyze whether it is profitable for the integrated firm to undertake vertical separation for each of the three ranges and then investigate the welfare implications.

According to the required discount factors, Figure 1 summarizes the profits of the integrated firm under the regimes of vertical integration and vertical separation.

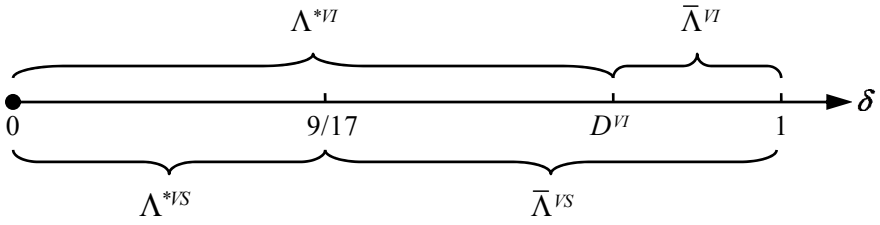

Figure 1 The profits of the integrated firm

From Figure 1, we now compare the profits between vertical separation and vertical integration for the three different intervals of the discount factor. First, for $\delta \in [0, 9/17)$, the downstream firms compete in Cournot fashion in each time period game under both vertical integration and vertical separation. Deducting Λ^{*VS} from Λ^{*VI} ((6) and (13), respectively) yields $\Lambda^{*VI} - \Lambda^{*VS} = (a-c)w/9b > 0$. Therefore, the integrated firm will not vertically separate if the firms are myopic, i.e., they care less about future profits.

Second, for $\delta \in (D^{VI}, 1]$, the downstream firms collude under both vertical integration and vertical separation. By employing (8) and (16), we thus have $\overline{\Lambda}^{VI} - \overline{\Lambda}^{VS} = 3w\left[(a-c)^2 - w^2\right]/8b(2a-2c-w) > 0$. Hence, the integrated firm will not vertically separate if the firms are extremely forward-looking. We summarize these results in the third proposition.

Proposition 3.

In the infinitely repeated game, if the competing firms are either myopic or extremely forward-looking, then the integrated firm will not vertically separate.

The intuition behind this is as follows. If firms are myopic, then they care less about future profits. Firms will thus not tacitly collude and compete in Cournot fashion in every period. Since vertical separation implies a higher marginal production cost, the integrated firm always prefers to maintain the integrated state under such circumstances.[5] If firms are extremely forward-looking, then collusion is sustained under either regime. In our model, collusive firms produce their outputs according to their market shares under Cournot competition. Hence, the integrated firm prefers vertical integration as can enjoy a larger market share.

Finally, for $\delta \in [9/17, D^{VI}]$, the competing firms collude under vertical separation, but engage in Cournot competition under vertical integration. Deducting Λ^{*VI} from $\bar{\Lambda}^{VS}$ yields $\bar{\Lambda}^{VS} - \Lambda^{*VI} = \left[(a-c)^2 - 22(a-c)w + 13w^2\right]/72b$. The sign of the profit difference is ambiguous and is dependent on the input price level. This implies that vertical separation is profitable if and only if $w \le (11-6\sqrt{3})(a-c)/13$. We summarize this result with the fourth proposition.

Proposition 4.

In the infinitely repeated game, if the discount factor is at a medium level, then the integrated firm tends to vertically separate when the input price is low as vertical separation facilitates tacit collusion.

Proposition 4 is in line with Chen (2005) that an integrated firm has incentives to do vertical separation. Nevertheless, his reasons are quite different to ours. Chen (2005) points out that integrated firm can commit its downstream division not to enjoy a competitive advantage from paying a lower input price. This encourages its downstream rival to purchase the input from the integrated firm's upstream division, which can thus realize economies of scale. Nevertheless, in our model, vertical

[5] In the literature on successive oligopoly, it is well known that the problem of double marginalization is eliminated under vertical integration, e.g., Greenhut and Ohta (1979) and Salinger (1988).

separation is profitable to the integrated firm because it can make collusion more sustainable under some circumstances. The intuition behind this goes as follows. Under vertical integration, the integrated firm enjoys a lower production cost than its rival, but this advantage becomes smaller as the input price decreases. By contrast, under vertical separation, firms have reached tacit collusion and the collusive profit increases as the input price decreases. It is clear that a lower production cost implies a higher industry profit. Accordingly, when the input price decreases, the profit of the integrated firm becomes higher under vertical separation, but turns lower under vertical integration. If the input price is sufficiently low, then the integrated firm prefers to vertically separate. This result reveals that vertical separation can work as a credible commitment to induce tacit collusion, because the cost difference between the collusive firms can thus be eliminated. On the other hand, in addition to the changes of input price, the change of interest rate is also important to the firms' incentive of collusion as it directly affects the discount factor. Note that our result is different from Nocke and White (2007) and Normann (2009) which show that vertical integration may facilitate firms collude in the upstream market. In our model, we show that in some circumstance vertical separation may facilitate firms collude in the downstream market. Therefore, if collusion is an important concern, policy authorities may regulate not only vertical mergers, but also vertical separations.

5.2 Welfare Effects of Vertical Separation

This section shall investigate the welfare effect of vertical separation. Social welfare (SW) is defined as the sum of the firms' profits and consumer surplus (CS), presented as: $SW \equiv CS + \pi + \Lambda$, where $CS = b(q+Q)^2/2$. Therefore, the discounted social welfare for infinite periods is derivable as follows: $SW + \delta SW + \delta^2 SW + ... = SW/(1-\delta)$. According to the results in Proposition 3 and Proposition 4, the welfare effects can be examined in three circumstances: $\delta \in [0, 9/17)$, $\delta \in (D^{VI}, 1]$ and $\delta \in [9/17, D^{VI}]$. We define the difference of discounted

social welfare for infinite period between vertical separation and vertical integration as $(SW^{VS} - SW^{VI})/(1-\delta)$. By using the corresponding equilibria, the welfare difference is derivable as:

$$\frac{1}{1-\delta}(SW^{VS} - SW^{VI}) = \begin{cases} \frac{1}{1-\delta}\frac{-w(2a-2c+3w)}{18b} & \text{if } \delta \in [0,9/17) \\ \frac{1}{1-\delta}\frac{-5(a-c+w)^2}{72b} & \text{if } \delta \in [9/17, D^{VI}], \\ \frac{1}{1-\delta}\frac{-w(2a-2c+w)}{8b} & \text{if } \delta \in (D^{VI},1] \end{cases} \quad (18)$$

which is always negative for the relevant discount factors.

The welfare results show that vertical integration is always more socially desirable than vertical separation. The intuition is quite straightforward as vertical integration can eliminate the problem of double marginalization. This means that the integrated firm's equilibrium choice does not always line up with the interest of social welfare. More specifically, in the case of an intermediate discount factor level, i.e., $\delta \in [9/17, D^{VI}]$, if the input price is sufficiently low, then the integrated firm tends to undertake vertical separation. We thus establish the fifth and final proposition.

Proposition 5.

In the infinitely repeated game, if the discount factor is at a medium level, then an increase in input price enhances social welfare as it prevents the integrated firm from undertaking vertical separation.

It is generally believed that in vertically related markets a more competitive input market will lead to a lower input price and a higher welfare level since the output of the final good market increases. However, Proposition 5 shows that a lower input price may not always be socially desirable. When the forward-looking behaviors of firms are taken into account, a lower input price may induce the integrated firm to

vertically separate. This not only raises the problem of double marginalization, but also induces collusion, thus reducing social welfare.

6. Conclusions

In this paper we use a simple model to investigate why an integrated firm has an incentive to vertically separate its business. First of all, for the collusive equilibrium to be individually rational, we show that the necessary condition is for the input price to be low. Moreover, by taking the forward-looking behavior of firms into consideration, the integrated firm vertically separates if the discount factor is at a medium level and the input price is low. This implies that vertical separation may work as a commitment to induce tacit collusion in the final good market, thus raising the profit of the integrated firm. Finally, our analysis also reveals that vertical separation can further deteriorate social welfare by inducing collusion. One important policy implication thus obtained is that authorities may prefer a high input price in vertically related industries, because a low input price could encourage welfare-reducing vertical separation.

Although our model is too simplified to derive a general result as we assume linear demand, a competitive input market, the independent downstream firm is unable to backward integrate, and so on, it still sheds some light on the possibility that an integrated firm may have the incentive to vertically separate to reach a collusive equilibrium. Hence, as collusion is an important concern, policy authorities may regulate not only vertical mergers (integrations), but also vertical separation by integrated firms in vertically related industries.

In this paper, we only allow the integrated firm to choose whether to vertically separate its business in the beginning of the game; however, it is possible that the firm can choose either to vertically separate or vertically integrate at any given time period if the cost to restructuring its business is not too large. In such a circumstance, the integrated firm may

use vertical integration or separation combined with Cournot strategy as the punishment for deviation. The extension considering this possibility is theoretically interesting, but beyond the scope of the present paper. Hence, we leave this issue for future study.

Appendix

In this appendix, we would like to investigate the incentive of an integrated firm to separate if it monopolizes the input market. In this circumstance, the game structure is as follows. In the first stage, the integrated firm determines the input price. In the second stage, the integrated firm and the independent downstream firm determines their outputs in Cournot fashion. We use backward induction to derive the subgame perfect equilibrium.

In the second stage, the integrated firm and the independent downstream firm choose their outputs to maximize profits. The profit function of the independent downstream firm and the integrated firm are the same as (1) and (3), respectively. Routine calculations show that the outputs of the independent downstream firm and the integrated firm are the same as those in (4). Substituting (4) into (3), we can have the profit function of the integrated firm as follows:

$$\Lambda = (w-c)\frac{a-c-2w}{3b} + \frac{(a-c+w)^2}{9b}. \tag{A1}$$

Differentiating (A1) with respect to w yields:

$$w^M = \frac{a-c}{2}, \tag{A2}$$

where the superscript M denotes the equilibrium under the input monopoly case. Substituting (A2) into (4), we can show the equilibrium outputs of the firms are as follows: $q^{*M} = 0$ and $Q^{*M} = (a-c)/2b,$ which implies the integrated firm monopolizes the final good market. The profit of the integrated firm is:

$$\Omega^M = \frac{(a-c)^2}{4b}. \tag{A3}$$

Note that (A3) is also the maximum profit for the industry. Accordingly, the integrated firm has no incentive to vertically separate its upstream and downstream businesses.

From the above results, we can conclude that in the case with competitive input market, if other suppliers' marginal cost is larger than w^M, i.e., $w > w^M$, then the integrated firm can still monopolize the final good market by charging w^M, and thus has no incentive to engage in vertical separation. This is not our main focus and we therefore assume this possibility away from the current paper. Hence, when the input market is competitive, we shall assume the marginal cost of other input supplier to be smaller than w^M, i.e., $w \le (a-c)/2$. Under such circumstances, since firms compete in Bertrand fashion in the input market and the integrated firm has cost advantage over other input suppliers, the integrated firm will set its input price at $w-\varepsilon$ and the independent downstream firm will produce positive outputs in the final good market.

References

Bonanno, G. and J. Vickers (1988), "Vertical Separation," *The Journal of Industrial Economics*, 36:3, 257-265.

Chen, Y. (2005), "Vertical Disintegration," *Journal of Economics & Management Strategy*, 14:1, 209-229.

Greenhut, M. L. and H. Ohta (1979), "Vertical Integration of Successive Oligopolists," *The American Economic Review*, 69:1, 137-141.

Inderst, R. and T. Valletti (2009), "Price Discrimination in Input Markets," *The RAND Journal of Economics*, 40:1, 1-19.

Lin, P. (2006), "Strategic Spin-offs of Input Divisions," *European Economic Review*, 50:4, 977-993.

Nocke, V. and L. White (2007), "Do Vertical Mergers Facilitate Upstream Collusion?" *The American Economic Review*, 97:4, 1321-1339.

Normann, H. T. (2009), "Vertical Integration, Raising Rivals' Costs and Upstream Collusion," *European Economic Review*, 53:4, 461-480.

Ordover, J. A., G. Saloner and S. C. Salop (1990), "Equilibrium Vertical Foreclosure," *The American Economic Review*, 80:1, 127-142.

Salinger, M. A. (1988), "Vertical Mergers and Market Foreclosure," *The Quarterly Journal of Economics*, 103:2, 345-356.

Tyagi, R. K. (2001), "Why Do Suppliers Charge Larger Buyers Lower Prices?" *The Journal of Industrial Economics*, 49:1, 45-61.

Vickers, J. (1985), "Delegation and the Theory of the Firm," *The Economic Journal*, 95, 138-147.

Wang, K. C., H. W. Koo and T. J. Chen (2005), "Strategic Buying or Selling? The Behavior of Vertically-Integrated Firms in the Intermediate Goods Market," *Journal of Economic Integration*, 20:2, 366-382.

垂直分割與勾結

高國峯、陳金盛*

摘 要

本文探討當廠商的行為具前瞻性時，整合廠商從事垂直分割的誘因。利用一無限期重複賽局，我們發現相較於垂直整合，最終財市場的勾結在垂直分割的市場結構下較容易達成。當廠商的折現因子適中且中間財價格夠低時，此整合廠商將進行垂直分割。此外，如中間財價格的提高能有效阻止廠商進行垂直分割，則社會福利將隨中間財價格上升而增加。

關鍵詞：垂直分割、觸發策略、勾結
JEL 分類代號：D43, L13, L41

* 兩位作者分別為通訊作者：陳金盛，東吳大學國際經營與貿易學系副教授，100006 臺北市中正區貴陽街一段 56 號，電話：02-23111531 轉 3692，E-mail: cschen0709@scu.edu.tw；高國峯，淡江大學產業經濟學系副教授，251301 新北市淡水區英專路 151 號，電話：02-26215656 轉 3335，E-mail: kuofeng@mail.tku.edu.tw。作者由衷感謝黃鴻教授、彭正浩教授、兩位匿名審查委員及臺灣大學國際貿易研討小組的成員對本文的寶貴意見與建議。

投稿日期：民國 107 年 2 月 1 日；修訂日期：民國 107 年 7 月 17 日；
接受日期：民國 108 年 6 月 26 日。