Cost-based transfer pricing with the existence of a direct channel in an integrated supply chain

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Abstract

Purpose: This study analytically explores the economic role of transfer pricing in a vertically integrated supply chain with a direct channel, specifically when it uses cost-based transfer prices, as is frequently observed in management practices. We compare two representative transfer pricing methods: full-cost and variable-cost pricing. Although many firms open a direct channel, which affects the optimal decision on transfer prices, prior literature has not considered this case.

Design/methodology/approach: We demonstrate our result using a non-cooperative game theoretical approach.

Findings: Our results show that full-cost pricing is more profitable than variable-cost pricing when the fixed cost allocation to the marketing division is low, contrary to the established position in prior studies, from which we select our benchmark case. Moreover, we obtain a counterintuitive result, whereby, the firm-wide profit of a vertically integrated supply chain increases with fixed cost allocation.

Originality: Our study considers the direct channel and internal transfer pricing in a vertically integrated supply chain, while prior research only considers one or the other. This model suggests an optimal choice of cost-based transfer pricing in managerial decisions. In addition, we demonstrate the positive effect of increasing fixed cost allocation, which prior management studies do not show. The findings of this study have implications for managerial practice by providing insights into supply chain design and showing that firms should consider the competition between channels when making decisions about transfer pricing methods.

Keywords: Direct channel; Supply chain management; Decentralized firm; Transfer pricing; Game theory

1. Introduction

Nowadays, several management studies demonstrate that the intrafirm transfer pricing method in delegated organizations can affect the overall profits of an integrated supply chain and it is profitable through the coordination of benefits among multiple divisions [1]. Ernst & Young (1999) suggest that 73% of managers claim internal transfer pricing is a significant factor in maximizing a firm-wide profits. Ensuring profit for the marketing division is particularly important to enhance marketing efficiency through decision-making by its manager. The method for setting transfer prices directly affects the decisions delegated to division managers because they are frequently evaluated and compensated based on their divisions' reporting profit. For example, Apple Inc. has both online and retail stores. Consumers can buy a MacBook from Apple's online store, which is delivered by a delivery company. Suntory Beverage & Food Limited, a Japanese company, sells beverages through both retail and online stores. In practice, there are many examples of dual channels comprising a direct channel of the manufacturing division, and a marketing division or store that competes in the product market. The transfer pricing method with a direct channel distorts the decisions of marketing managers.

Using survey data, Tang (1992) examined practical transfer pricing methods. Specifically, Tang (1992) examined 143 Fortune 500 firms and found that 46.2% use cost-based transfer prices [2]. Among these, 7.7%, 53.8%, and 38.5% use variable production costs, full production costs, and full production costs plus mark-up, respectively. Tang (1992) concludes that, in practice, many firms set transfer prices using full costs.

Based on the transfer pricing practices documented in prior literature, we explore the economic role of transfer pricing in a vertically integrated supply chain, when the headquarters, which manufactures the products, opens a direct channel through electronic commerce. In particular, we examine the advantages and disadvantages of two representative cost-based transfer pricing methods in a direct channel: full-cost pricing and variable-cost pricing. We analyze an economic model based on the assumption that the direct channel is opened by the manufacturing division. We show that variable-cost transfer pricing is more profitable than full-cost transfer pricing without a direct channel because when a vertically integrated supply chain desires to enhance firm-wide profits by manipulating the transfer price in a single channel through the marketing division, it is more profitable to reduce rather than to increase the marginal cost of the marketing division.

The most important finding of this study is that full-cost transfer pricing becomes more profitable from the firm-wide perspective than variable-cost transfer pricing if the headquarters opens a direct channel and the fixed cost allocation is low. This is because while full-cost transfer pricing forces players to engage in softer competition in a product market with low fixed cost allocation, a positive effect, full-cost pricing decreases the profit of the marketing division by increasing its marginal cost, a negative effect. The trade-off decides the profitability of full-cost transfer pricing. Therefore, full-cost pricing with low fixed cost allocation provides a more appropriate incentive to the production division than variable-cost pricing. Our study demonstrates the advantage of full-cost transfer pricing for a firm integrating a supply chain under a direct channel, which no previous studies have shown.

Our findings reveal useful insights into supply chain design in multi-echelon firms. Firms should recognize the advantage of the full-cost transfer pricing method under a direct channel opened by the headquarters and exercise caution about simply implementing variable-cost transfer pricing. If the headquarters opens a direct channel through electronic commerce with a large fixed cost allocation, the internal transfer price is more likely to deviate from the optimal level, as full-cost transfer pricing becomes superior in a vertically integrated supply chain.

The economic analysis of transfer pricing under price competition from a managerial viewpoint dates to Hirshleifer (1956), who argues that an internal transfer price equaling the marginal cost alleviates double marginalization problems. Numerous mathematical analyses have since been conducted in transfer pricing research in management science and management accounting due to the difficulty in obtaining internal transfer pricing data. Some studies use mathematical programming to consider transfer pricing problems, including cost allocation in integrated supply chains (Baumol and Fabian, 1964; Hammami and Frein, 2014; Vidal and Goetshcalchx, 2001). These studies mainly assume transfer pricing and cost allocation decisions to be vested in a single player, which has convenient implications for management practices.

Some studies examine optimal transfer price decisions and cost allocation in integrated supply chains via a non-cooperative game theoretical approach, including competition with rival firms in a product market and conflicts between divisions (Alles and Datar, 1998; Hamamura, 2018, 2019; Harris *et al.*, 1982; Matsui, 2011, 2012, 2013; Narayanan and Smith, 2000) [3]. In practice, many firms face product market competition, which affects internal decisions (e.g., transfer pricing, cost allocation). Assuming product market competition, Alles and Dater (1998) demonstrate that the optimal transfer price exceeds the marginal cost by transfer pricing’s strategic effect. In price competition, those managing vertically integrated supply chains aim to engage in softer competition in a product market by tacit collusion. Transfer prices exceeding the marginal cost are important devices for softening price competition because a high marginal cost (transfer price) induces retail divisions to set a high market price.

Assuming product market competition, our model examines an optimal transfer pricing method such as Matsui (2012, 2013) and Göx (2000). As a transfer pricing method would maximize a vertically integrated supply chain's profit, as Tang (1992) proposes, choosing one is difficult. Assuming product market competition between vertically integrated supply chains, Göx (2000) demonstrates that full-cost pricing is optimal when a vertically integrated supply chain cannot observe a rival's internal transfer pricing method before the marketing division determines the market price. Matsui (2012) assumes a risk-averse manufacturing manager with uncertainty regarding fixed cost-reducing investment, and shows that variable-cost pricing is optimal to incentivize cost-reducing investment when a risk-averse manager bears relatively high risk. Matsui (2013) assumes the threat of new entrants and shows that variable-cost transfer pricing, a credible commitment device for setting a low market price, is optimal to deter entry.

Prior management studies examined optimal wholesale pricing assuming multi-channel non-integrated supply chains (e.g., Cattani *et al.*, 2006; Matsui, 2017, 2018). We explore the optimal transfer pricing method for an integrated supply chain because previous studies have not demonstrated this, although many firms face the problem of deciding on the transfer pricing method for direct channels. For example, Nike and Suntory Beverage & Food Limited have both online and retail stores to supply products to customers. Thus, the transfer pricing method has an important role in aligning cannibalism in the product market. Therefore, we consider an optimal transfer pricing method for a dual-channel supply chain based on the transfer pricing method by Matsui (2012, 2013).

Contrary to Matsui (2012, 2013), our findings show that full-cost is more profitable than variable-cost transfer pricing with high fixed cost allocation to the marketing division in a specific economic environment. When fixed cost allocation to a marketing division increases the full cost, its profit decreases due to an increase in its marginal cost. Thus, under specific conditions, a vertically integrated supply chain's profit decreases with a decline in the marketing division's profit. However, full-cost transfer pricing has a positive effect on a vertically integrated supply chain's profit. When the fixed costs allocated to the marketing division, and, therefore, its marginal cost, increase, both channels' sales quantities decrease whereas market prices increase. This positive effect is important because the increase in a vertically integrated supply chain's marginal cost and, therefore, profit, is counterintuitive. An optimal choice between full- and variable-cost transfer pricing affects the changes caused by an increase in the marginal cost, increasing market prices and decreasing marketing divisional profit.

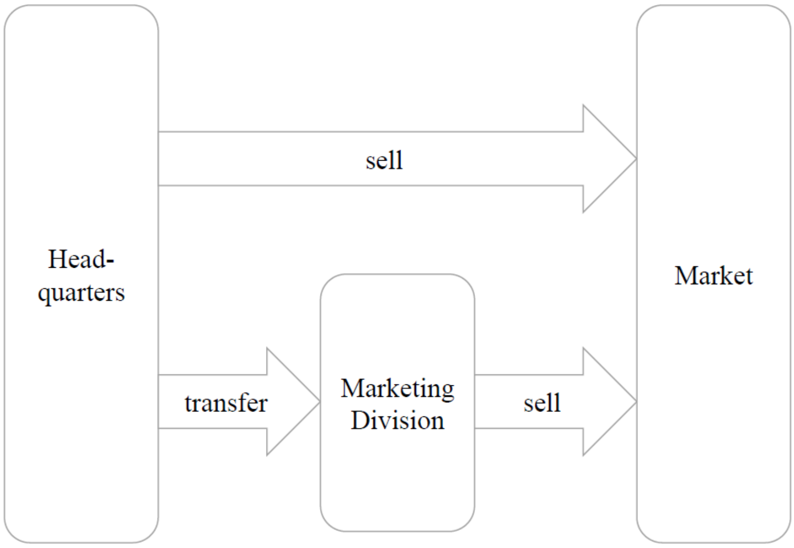
Our model analysis makes some important contributions. We explore the optimal decision on the cost-based transfer pricing method in a vertically integrated supply chain with a direct channel. The optimal transfer pricing method in management science and management accounting research has not yet analytically considered a direct channel; to bridge this gap, we investigate a case in which the supply chain has a direct channel. As many vertically integrated supply chains use a direct channel, the findings contribute to the literature by suggesting an optimal transfer pricing decision for these management practices and the importance of considering the channel's impact when firms determine the transfer pricing method. Additionally, our outcome is contrary to Matsui (2012, 2013). We introduce a perspective under which full-cost transfer pricing is optimal in specific economic conditions. Therefore, we add to the literature by considering the transfer pricing decision. Finally, we demonstrate a counterintuitive result—the profit of a vertically integrated supply chain increases with increased fixed cost allocation. While increasing the fixed cost allocation generally harms a vertically integrated supply chain's profit, by increasing divisional costs, we demonstrate the opposite, suggesting the possibility that strategic fixed cost allocation facilitates the profit of a supply chain opening a direct channel. Hence, this study suggests that, in practice, manipulating fixed cost allocation could not only affect divisional profit but also improve the profit of vertically integrated supply chains in specific economic environments with product market competition between divisions.

2. Research methodology and main model

Assume that the vertically integrated supply chain is composed of a headquarters (denoted as H) and a marketing division (denoted as M). H produces the final product to be sold on a product market and transfers the product to M, which sells the product on the market. We assume that the products are produced at marginal cost $c\ (> 0)$, transferred with transfer price t to M, and sold by H in the same market using a direct channel. The market price decided by M is p_M and the market price decided by H is p_H. Competition is assumed to exist between the direct channel and the marketing division. In practice, consumers can choose a purchasing channel by comparing factors such as price or trip cost. While we consider monopoly in the vertically integrated supply chain in the main model, we add a rival firm in the product market in Section 4.2. Figure 1 illustrates the study context.

Following prior strategic transfer pricing literature, players H and M engage in quantity competition in a product market (e.g., Arya and Mittendorf, 2007). Theoretically, firms will likely face quantity competition. Kreps and Scheinkman (1983) state that price competition ultimately transforms into quantity competition when

Figure 1. Scenario analyzed in this study



considering long-term product market competition. Thus, we follow Dixit (1979) in considering a standard duopoly setting with a linear demand function:

$$p_i = a - q_i - \theta q_j, \qquad (i,j) = (M,H),(H,M). \tag{1}$$

The degree of substitution between channels is $\theta \in (0,1]$. When θ approaches 0, division i operates a monopoly. Here, a is a positive constant. The firm is assumed to set the cost-based transfer pricing used to transfer the product from H to M. Moreover, we consider price competition in Section 4.3 as an additional case of our model.

When the firm uses a cost-based transfer pricing method, it chooses either variable or full cost. When it adopts variable-cost transfer pricing, the transfer price t is equal to the marginal cost, c ($t = c$). When it adopts full-cost transfer pricing, the transfer price t is equal to the marginal cost plus the fixed cost allocation, $c + r$ ($t = c + r$). Here, r (> 0) is the fixed cost allocation to the firm's marketing division. Thus, under full-cost transfer pricing, the transfer price corresponds to the marginal cost plus the fixed cost allocation, as also assumed in prior studies (Matsui, 2013). Analyzing the model is difficult if an endogenous fixed cost allocation is assumed. Additionally, identifying the fixed cost allocation is not important; however, the difference in outcomes between $r = 0$ and $r > 0$ is. Further, $a > c + r$ is assumed, which is the incentive for the marketing division to sell the product. We compare the profits of variable- and full-cost transfer pricing.

H manages the firm-wide total profit of a vertically integrated supply chain Π and M divisional profit π_M:

$$\Pi = (p_H - c)q_H + (p_M - t)q_M + (t - c)q_M + V - F, \tag{2}$$

$$\pi_M = (p_M - t)q_M. \tag{3}$$

In this study, $V > 0$ is the profit from the firm's other businesses (products), $F > r$ is the firm-wide fixed cost, and we assume $V > F$ to simplify the model. For simplicity, r does not affect the level of V ($dV/dr = 0$) in the initial analysis. Section 4.1 relaxes this assumption and analyses the impact of altering r on V. The first term in Eq. (2) is the direct e-commerce channel profit, the second term is the marketing division profit, and the third term is the profit from transferring the product to M. H is also assumed to maximize Eq. (2), and M maximizes Eq. (3). Table I shows the notations.

We consider the following timeline. First, H produces products at marginal cost c and transfers them to M. Next, H and M choose the sales quantities for a product market. Finally, profits are realized.

In this study, we assume a dual-channel exogenously because we can demonstrate straightforwardly that the headquarters prefers it to an indirect channel with administrated transfer pricing. While it is not easy to control other players (marketing division), a direct channel enables the headquarters to decide on its optimal strategy, which is independent from the incentives of other players.

Table I. Notations

π	Profit for the marketing division in a firm
Π	Total profit for a firm
H	Subscript that indexes headquarters
M	Subscript that indexes the marketing division
i	Subscript that indexes a player
j	Subscript that indexes a firm other than player i
p	Retail price
q	Quantity
c	Marginal cost of headquarters
r	Fixed cost allocation
t	Transfer price
a	Positive constant greater than c
V	Profit from other businesses (products)
F	Firm-wide fixed cost smaller than V
θ	Substitutability of products supplied by the two players ($0 < \theta \leq 1$; $1 - \theta$ is the degree of product differentiation)

3. Analysis

The model proposed in the previous section is analyzed using backward induction. Equilibrium is considered in two cases—variable- and full-cost transfer pricing—for specifications of the optimal transfer pricing method.

3.1 Without a direct channel

Before analyzing our main model, we consider the case where H does not open a direct channel. Here, M faces a monopoly market with the following demand function:

$$p_M = a - q_M. \tag{4}$$

In addition, the profit functions of *H* and *M* are as follows:

$$\Pi = (p_M - t)q_M + (t - c)q_M + V - F, \tag{5}$$

$$\pi_M = (p_M - t)q_M. \tag{6}$$

Here, a vertically integrated supply chain uses variable-cost (VC) and full-cost (FC) transfer pricing. Assuming these functions, we obtain the following outcome in both transfer pricing methods:

$$\begin{aligned}
q_M^{VC} &= \frac{a-c}{2}, \\
q_M^{FC} &= \frac{a-(c+r)}{2}, \\
\pi_M^{VC} &= \frac{(a-c)^2}{4}, \\
\pi_M^{FC} &= \frac{(a-c-r)^2}{4}, \\
\Pi^{VC} &= \frac{(a-c)^2}{4} - F + V, \\
\Pi^{FC} &= \frac{(a-c)^2 - r^2}{4} - F + V.
\end{aligned} \tag{7}$$

This result shows that $\Pi^{VC} > \Pi^{FC}$ because the marginal cost of *M* increases with full-cost transfer pricing.

This outcome is intuitive because a vertically integrated supply chain benefits from a single channel through the marketing division. When only *M* opens a channel, its marginal cost, including the distribution cost—0 in our model—directly affects the sales quantity and market price. In a monopoly, a higher marginal cost causes an undersupply in the final product market. Consequently, the vertically integrated supply chain cannot earn profits in a monopoly. This outcome suggests that an integrated firm must set variable-cost transfer pricing to avoid undersupply. This is similar to Hirshleifer (1956) because our result suggests that it is optimal to avoid a double marginalization problem by setting variable-cost transfer pricing.

3.2 With a direct channel and variable-cost transfer pricing

Consider that H chooses variable-cost transfer pricing, $t = c$. H chooses q_H to maximize Eq. (2) and M chooses q_M to maximize Eq. (3), leading to the following first-order condition (FOC) for each player:

$$a - c - 2\theta q_M - 2q_H = 0, \tag{8}$$

$$a - c - 2q_M - \theta q_H = 0. \tag{9}$$

From Eqs. (8) and (9), the following strategies of each player are obtained:

$$q_H^{VC} = \frac{(1-\theta)(a-c)}{2-\theta^2}, \tag{10}$$

$$q_M^{VC} = \frac{(2-\theta)(a-c)}{2(2-\theta^2)}. \tag{11}$$

In this outcome, $q_H^{VC} < q_M^{VC}$ holds because H selects strategies to maximize the profit of the vertically integrated supply chain, including M's profit. In practice, the direct channel quantity is smaller than that of the retail channel. Hence, this outcome is consistent with real-world managerial decision practices.

Additionally, the integrated supply chain's profit is expressed as follows:

$$\Pi^{VC} = \frac{(8 - 8\theta - \theta^2 + 2\theta^3)(a-c)^2}{4(2-\theta^2)^2} + V - F. \tag{12}$$

Considering that this outcome corresponds to a well-known result regarding dual channels composed of a direct channel and a retailer, it is not unique to this study. Thus, this outcome is compared with the result presented in Section 3.3.

3.3 With a direct channel and full-cost transfer pricing

Consider that H chooses full-cost transfer pricing, $t = c + r$. The difference between the best-response function in this section and that in Section 3.2 is the fixed cost allocation, r. Hence, M's best-response function is

$$a - (c + r) - 2q_M - \theta q_H = 0. \tag{13}$$

Meanwhile, H's best-response function is similar to Eq. (8) because a cost-based transfer price is adopted, which is affected by the transfer pricing method, while the transfer price is not applied in calculating H's performance of the direct channel under full-cost transfer pricing. While the third term of Eq. (2) may affect the performance of H, q_H, which is decided by H, it does not affect its performance. Hence, with the identification of the FOC of H, H's best-response function does not differ between Section 3.2 and this section. Therefore, H's best-response function corresponds to Eq. (8). From the best-response functions, the optimal strategies are as follows:

$$q_H^{FC} = \frac{(1 - \theta)(a - c) + r\theta}{2 - \theta^2}, \tag{14}$$

$$q_M^{FC} = \frac{(2 - \theta)(a - c) - 2r}{2(2 - \theta^2)}. \tag{15}$$

In addition, the integrated firm-wide profit is

$$\Pi^{FC} = \frac{(8 - 8\theta - \theta^2 + 2\theta^3)(a - c)^2 + 4r(1 - \theta)(\theta(a - c) - (1 + \theta)r)}{4(2 - \theta^2)^2} + V - F. \tag{16}$$

Proposition 1 summarizes the outcome of full-cost transfer pricing.

Proposition 1. When a firm opens a direct channel, the optimal strategies and integrated firm-wide profit with full-cost transfer pricing, respectively, are as follows:

$$q_H^{FC} = \frac{(1 - \theta)(a - c) + r\theta}{2 - \theta^2},$$

$$q_M^{FC} = \frac{(2 - \theta)(a - c) - 2r}{2(2 - \theta^2)},$$

$$\Pi^{FC} = \frac{(8 - 8\theta - \theta^2 + 2\theta^3)(a - c)^2 + 4r(1 - \theta)(\theta(a - c) - (1 + \theta)r)}{4(2 - \theta^2)^2} + V - F.$$

Proposition 2 considers the property of the integrated firm-wide profit at equilibrium.

Proposition 2. When fixed cost allocation r satisfies the following condition:

$$0 < r < \frac{\theta(a - c)}{2(1 + \theta)},$$

the integrated firm-wide profit with full-cost transfer pricing, Π^{FC}, increases with an increase in r.

Proof. Consider the first derivative of the integrated firm-wide profit with respect to r to obtain

$$\frac{\partial \Pi^{FC}}{\partial r} = \frac{4(1-\theta)\big(\theta(a-c) - 2r(1+\theta)\big)}{4(2-\theta^2)^2}. \tag{17}$$

Eq. (17) is positive when

$$r < \frac{\theta(a-c)}{2(1+\theta)}, \tag{18}$$

holds. The integrated firm-wide profit increases with an increase in the fixed cost allocation r. □

Per Proposition 2, when r is small, the integrated firm-wide profits increase as r increases. The transfer price increases M's marginal cost as the firm engages in softer competition in the product market when H chooses full- rather than variable-cost transfer pricing, thereby, increasing the integrated firm-wide profits. However, M's cost increases and profit decreases under full-cost transfer pricing when r increases. This trade-off leads to Proposition 2, when the softer competition exerts a greater impact than the decrease in M's profit, which is counterintuitive.

3.4 Variable- versus full-cost transfer pricing

Next, we compare the strategies and integrated firm-wide profits with full- and variable-cost transfer pricing and rewrite Eqs. (14)–(16) as follows:

$$q_H^{FC} = \frac{(1-\theta)(a-c)}{2-\theta^2} + \frac{r\theta}{2-\theta^2},$$

$$q_M^{FC} = \frac{(2-\theta)(a-c)}{2\big(2-\theta^2\big)} - \frac{r}{2-\theta^2}, \tag{19}$$

$$\Pi^{FC} = \frac{(8-8\theta-\theta^2+2\theta^3)(a-c)^2}{4(2-\theta^2)^2} + V - F + \frac{r(1-\theta)(\theta(a-c)-(1+\theta)r)}{(2-\theta^2)^2}.$$

The results can be represented as follows:

$$q_H^{FC} = q_H^{VC} + \frac{r\theta}{2-\theta^2},$$

$$q_M^{FC} = q_M^{VC} - \frac{r}{2-\theta^2}, \tag{20}$$

$$\Pi^{FC} = \Pi^{VC} + \frac{r(1-\theta)(\theta(a-c)-(1+\theta)r)}{(2-\theta^2)^2}.$$

Eq. (20) implies that $q_H^{FC} > q_H^{VC}$ and $q_M^{FC} < q_M^{VC}$. The transfer price is higher when H adopts full rather than variable-cost transfer pricing. Here, because H and M face quantity competition in the product market, H can supply a larger quantity by decreasing M's quantity, and thereby, prevent a collapse due to excess supply through full-cost transfer pricing.

Next, we consider the integrated firm-wide profit. From Eq. (20), the integrated firm-wide profits are equal under full-cost transfer pricing and variable-cost transfer pricing plus $r(1-\theta)(\theta(a-c)-(1+\theta)r)/(2-\theta^2)^2$. Thus, the relationship between the integrated firm-wide profits with full- and variable-cost transfer pricing is affected by the sign of $r(1-\theta)(\theta(a-c)-(1+\theta)r)/(2-\theta^2)^2$. When this expression is positive (negative), the integrated firm-wide profits are greater (lower) with full-cost transfer pricing compared to variable-cost transfer pricing. Proposition 3 summarizes this outcome.

Proposition 3. Firm-wide profits are greater under full-cost transfer pricing than under variable-cost transfer pricing when $0 < r < \theta\ (a-c)/(1+\theta)$ holds.

Proof. Proposition 3 is obtained from the condition $r(1-\theta)(\theta(a-c)-(1+\theta)r)/(2-\theta^2)^2 < 0$. □

Proposition 3 shows that the optimal transfer pricing method is affected by the economic environment. When the fixed cost allocation r is low, a vertically integrated supply chain earns a higher profit under full-cost transfer pricing because full-cost transfer pricing has a positive effect on the integrated firm-wide profit, as shown in Proposition 2, and a negative effect on M's profit. The trade-off between these effects depends on the optimality of the transfer pricing method. When r is low, the positive effect exceeds the negative effect, making full-cost transfer pricing the optimal choice for H in this case.

We define $\tilde{r} \equiv \theta(a-c)/(1+\theta)$ to consider the threshold of fixed cost allocation r in Proposition 3. Intuitively, the threshold $\tilde{r}$ is increasing in a and decreasing in c because increasing the demand function's intercept has a positive effect and increasing the marginal production cost has a negative effect on profit. Additionally, differentiating the threshold with respect to θ yields the following impact when θ increases:

$$\frac{\partial \tilde{r}}{\partial \theta} = \frac{a-c}{(1+\theta)^2} > 0. \tag{21}$$

Therefore, increasing the degree of product differentiation, θ, increases the threshold $\tilde{r}$. When $\tilde{r}$ increases, the condition in which the integrated firm-wide profit is larger under full-cost transfer pricing than under variable-cost transfer pricing becomes less important. Hence, the price increases from adopting full-cost transfer pricing yield greater benefits. Consequently, we obtain Proposition 4.

Proposition 4. The threshold $\tilde{r}$ increases as θ increases.

Proposition 4 shows that r increases with more intense competition. When competition becomes intense, the tacit collusion between H and M in using full-cost transfer pricing is effective because H and M obtain lower profits under intense quantity competition with cannibalism. When H adopts full-cost transfer pricing and increases the marginal cost of M, H and M need not engage in intense competition through excessive supply because they can soften the competition as M's marginal cost increases. Hence, gaining an advantage by increasing the degree of product differentiation, θ, under variable-cost transfer pricing is difficult.

The outcome shows that the degree of fixed cost allocation, r, has a significant impact on the choice of a transfer pricing method. However, prior research (e.g., Göx, 2000; Matsui, 2013) does not analyze a direct channel and the choice of transfer pricing method.

3.5 Numerical example

This section proposes a numerical example of the main model to demonstrate the effect of increasing the fixed cost allocation, r. Consider that $(a, c, \theta, F, V) = (1, 0.5, 0.5, 10, 15)$ holds. The combination of exogenous variables here satisfies $a > c + r$, $0 < \theta \leq 1$, and $F < V$. The outcome of the optimal strategies and integrated firm-wide profits by increasing the fixed cost allocation r is represented in Table II.

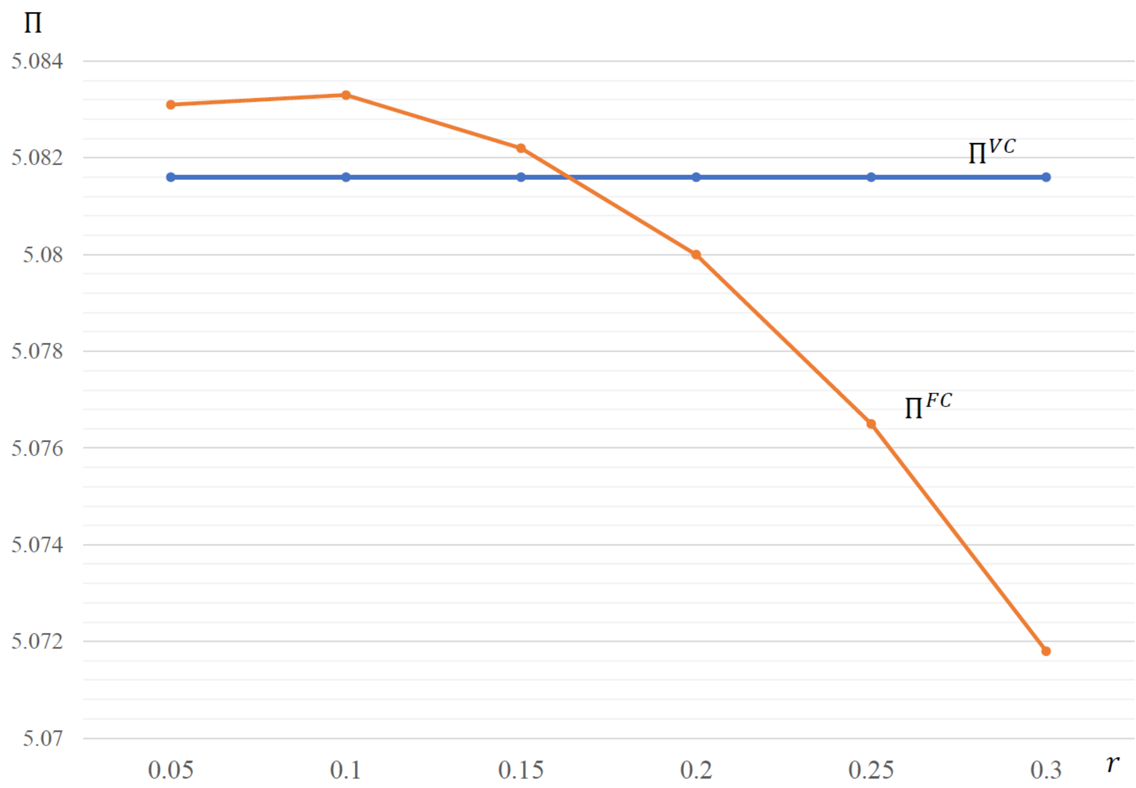
When r increases by 0.3 from 0.05, Π^{FC} changes, but Π^{VC} does not because Eq. (12) is not affected by r, while Eq. (16) is. Considering the change in Π^{FC}, when r changes to 0.1 from 0.05 (r is sufficiently small), Π^{FC} increases with r. This fact is consistent with the outcome of Proposition 2. After that, Π^{FC} decreases as r increases. Finally, when $\Pi^{FC} < \Pi^{VC}$, variable-cost transfer pricing is superior to full-cost transfer pricing (Figure 2).

Table II. Optimal strategies by increasing r when $(a, c, \theta, F, V) = (1, 0.5, 0.5, 10, 15)$

Transfer pricing method	r	Π^{VC}	Π^{FC}	q_H^{VC}	q_M^{VC}	q_H^{FC}	q_M^{FC}
Full-cost transfer pricing	0.05	5.0816	5.0831	0.1429	0.2143	0.1571	0.1857
	0.1		5.0833			0.1714	0.1571
	0.15		5.8022			0.1857	0.1286
Variable-cost transfer pricing	0.2		5.08			0.2	0.1
	0.25		5.0765			0.2143	0.0714
	0.3		5.0718			0.2286	0.0429

Note: Values have been rounded to the fifth decimal place or less.

Figure 2. Relationship between Π^{DC} and Π^{AC} by increasing r



Additionally, while q_H^{VC} is always smaller than q_M^{VC}, q_H^{FC} is smaller than q_M^{FC} only when $r = 0.05$. When $r \geq 0.1$, $q_H^{FC} > q_M^{FC}$ always holds. When the firm chooses variable-cost transfer pricing, H maximizes the integrated firm-wide profits by choosing a low quantity to soften the product market competition. When the firm chooses full-cost transfer pricing, H tries to improve the integrated firm-wide profit by increasing the quantity sold on the direct e-commerce channel because the marketing division's profit decreases with an increase in the fixed cost allocation r. Thus, the quantity sold by H exceeds the sales of M.

4. Additional analysis

4.1 Relaxing the assumption of V

While it is assumed that V does not change when r changes in the main model, this section shows how altering r impacts the profit from another product, V. The fixed cost allocated to M increases, but the fixed cost allocation to other divisions decreases. Hence, the marginal costs of other divisions will decrease, and their total profits will increase. Therefore, it is assumed that $dV/dr > 0$.

The profits from producing V differ between full- and variable-cost transfer pricing; this is important because the fixed cost allocation to M is higher with full-cost transfer pricing than with variable-cost transfer pricing. The profit from other business is V_{FC} with full-cost and V_{VC} with variable-cost transfer pricing. From $dV/dr > 0$, it is obvious that $V_{FC} > V_{VC}$ $(> F)$.

From this assumption, Eqs. (12) and (16) can be rewritten as follows:

$$\Pi^{FC} = \frac{(8 - 8\theta - \theta^2 + 2\theta^3)(a - c)^2}{4(2 - \theta^2)^2} + \frac{r(1 - \theta)(\theta(a - c) - (1 + \theta)r)}{(2 - \theta^2)^2} + V_{FC} - F, \tag{22}$$

$$\Pi^{VC} = \frac{(8 - 8\theta - \theta^2 + 2\theta^3)(a - c)^2}{4(2 - \theta^2)^2} + V_{VC} - F. \tag{23}$$

Additionally, Eq. (22) can be rewritten as follows:

$$\Pi^{FC} = \Pi^{VC} + \frac{r(1 - \theta)(\theta(a - c) - (1 + \theta)r)}{(2 - \theta^2)^2} + V_{FC} - V_{VC}. \tag{24}$$

The difference between Eqs. (20) and (24) is the additional term $V_{FC} - V_{VC}$. Hence, the threshold where the profit Π^{FC} under full-cost transfer pricing exceeds the profit under variable-cost transfer pricing differs between the main model and the additional analysis.

Consider the threshold where the profit under variable-cost exceeds the profit under full-cost transfer pricing, as follows:

$$\frac{r(1 - \theta)(\theta(a - c) - (1 + \theta)r)}{(2 - \theta^2)^2} + V_{FC} - V_{VC} < 0. \tag{25}$$

Note that the profit under full-cost transfer pricing exceeds that under variable-cost transfer pricing in Eq. (25) as follows:

$$r < \frac{\theta(a - c) + \sqrt{\theta^2(a - c)^2 + \dfrac{4(1 + \theta)(2 - \theta^2)^2(V_{FC} - V_{VC})}{1 - \theta}}}{2(1 + \theta)}, \tag{26}$$

$$r > \frac{\theta(a - c) - \sqrt{\theta^2(a - c)^2 + \dfrac{4(1 + \theta)(2 - \theta^2)^2(V_{FC} - V_{VC})}{1 - \theta}}}{2(1 + \theta)}. \tag{27}$$

However, Eq. (27) is satisfied automatically because $r > 0$. Hence, Eq. (26) is the threshold where the profit under full-cost transfer pricing is greater than that under variable-cost transfer pricing. Additionally, in Eq. (26), $V_{FC} = V_{VC} = V$, and this threshold is equal to $\theta(a-c)/(1+\theta)$, which corresponds to $\tilde{r}$. We summarize this result in Proposition 5.

Proposition 5. Assuming an increasing r affects V, the profits of a vertically integrated supply chain under full-cost transfer pricing exceed those under variable-cost transfer pricing when

$$0 < r < \frac{\theta(a-c) + \sqrt{\theta^2(a-c)^2 + \frac{4(1+\theta)(2-\theta^2)^2(V_{FC}-V_{VC})}{1-\theta}}}{2(1+\theta)}$$

holds.

This shows that full-cost transfer pricing is efficient in a specific economic environment. This threshold is defined as follows:

$$\hat{r} \equiv \frac{\theta(a-c) + \sqrt{\theta^2(a-c)^2 + \frac{4(1+\theta)(2-\theta^2)^2(V_{FC}-V_{VC})}{1-\theta}}}{2(1+\theta)}. \tag{28}$$

As a result, $\tilde{r} < \hat{r}$ from the assumption that $V_{FC} > V_{VC}$. This is because full-cost transfer pricing has the advantage of the additional term $V_{FC} > V_{VC}$. This result is intuitive and is summarized by Corollary 1.

Corollary 1. When an increasing r affects V and the firm uses cost-based transfer pricing, the threshold at which the profit of a vertically integrated supply chain under full-cost transfer pricing is less than that under variable-cost transfer pricing, $\hat{r}$, is larger than $\tilde{r}$.

The model robustly shows that full-cost transfer pricing is more effective than variable-cost transfer pricing.

4.2 Additional rival in the product market

Here, we assume competition with an additional rival firm, Firm R, in the product market and the following demand function for firm i:

$$p_i = a - q_i - \theta_j q_j - \theta_k q_k, \qquad i, j, k = M, H, R, \;\; i \neq j \neq k. \tag{29}$$

For simplicity, we assume $\theta_j = \theta_k = \theta \in (0,1]$, which here is the degree of product differentiation. Hence, the market price of firm i, p_i, is $p_i = a - q_i - \theta\left(q_j + q_k\right)$. Additionally, after all players observe the transfer pricing method of a vertically integrated supply chain, all players decide the sales quantity simultaneously.

We assume that the profit function of the additional rival firm, π_R, is

$$\pi_R = (p_R - c)q_R. \tag{30}$$

We assume the same marginal costs among firms, and Firm R is an integrated firm for simplicity.

From the above setting, we obtain the following result in variable-cost transfer pricing:

$$q_M^{VC} = \frac{(2-\theta)(a-c)}{4+\theta(2-3\theta)},$$

$$q_H^{VC} = \frac{2(1-\theta)(a-c)}{4+\theta(2-3\theta)},$$

$$q_R^{VC} = \frac{(2-\theta)(a-c)}{4+\theta(2-3\theta)},$$

$$\pi_M^{VC} = \frac{(2-\theta)^2(a-c)^2}{\left(4+\theta(2-3\theta)\right)^2},$$

$$\Pi^{VC} = \frac{(8-8\theta-\theta^2+2\theta^3)(a-c)^2}{\left(4+\theta(2-3\theta)\right)^2} - F + V, \tag{31}$$

$$\pi_R^{VC} = \frac{(2-\theta)^2(a-c)^2}{\left(4+\theta(2-3\theta)\right)^2}.$$

In addition, we obtain the following result in full-cost transfer pricing:

$$q_M^{FC} = \frac{(2-\theta)(a-c)-(2+\theta)r}{4+\theta(2-3\theta)},$$

$$q_H^{FC} = \frac{2(1-\theta)(2-\theta)(a-c)+r(4-\theta)\theta}{8-\theta^2(8-3\theta)},$$

$$q_R^{FC} = \frac{(2-\theta)^2(a-c)+2r(1-\theta)\theta}{8-\theta^2(8-3\theta)},$$

$$\pi_M^{FC} = \frac{\left((2-\theta)(a-c)-r(2+\theta)\right)^2}{\left(4+\theta(2-3\theta)\right)^2}, \tag{32}$$

$$\Pi^{FC} = \frac{\Psi}{\left(8-\theta^2(8-3\theta)\right)^2} - F + V,$$

$$\pi_R^{FC} = \frac{((2-\theta)^2(a-c)+2r(1-\theta)\theta)^2}{\left(8-\theta^2(8-3\theta)\right)^2},$$

where $\Psi = (2-\theta)^2(8-8\theta-\theta^2+2\theta^3)(a-c)^2 + 4r\theta(1-\theta)(2-\theta)(2-2\theta+\theta^2)(a-c) - 2r^2(1-\theta)(8+8\theta-8\theta^2+\theta^4)$.

From Eqs. (31) and (32), we obtain $\Pi^{VC} - \Pi^{FC}$:

$$\Pi^{VC} - \Pi^{FC}$$

$$= -\frac{2r(1-\theta)\big(2(a-c)(2-\theta)\theta(2-2\theta+\theta^2) - r(8+8\theta-8\theta^2+\theta^4)\big)}{\big(8-\theta^2(8-3\theta)\big)^2}, \qquad (33)$$

In $a > c > 0$ and $0 < \theta \leq 1$, $\Pi^{VC} - \Pi^{FC}$ is negative when the following condition is satisfied:

$$0 < r < \frac{2(a-c)(2-\theta)\theta(2-2\theta+\theta^2)}{8+8\theta-8\theta^2+\theta^4}. \qquad (34)$$

From this analysis, we obtain Proposition 6.

Proposition 6. Assuming an additional rival firm in a product market, the profit of a vertically integrated supply chain under full-cost transfer pricing exceeds that under variable-cost transfer pricing when

$$0 < r < \frac{2(a-c)(2-\theta)\theta(2-2\theta+\theta^2)}{8+8\theta-8\theta^2+\theta^4},$$

is satisfied.

This demonstrates—assuming an additional rival in the product market—that our main result holds in a specific economic environment. Further, we show that our main result holds with n $(2 \leq n < \infty)$ competitors. This result represents the strategic effect of the transfer price. When H decides on full-cost transfer pricing, all firms soften the competition by tacit collusion because the retailer in the vertically integrated supply chain would choose an excessively low quantity.

4.3 Price competition

Here, we analyze a price competition case in a product market, which is assumed in traditional transfer pricing studies (e.g., Göx, 2000; Matsui, 2012). In this case, we assume the following inverse demand function:

$$q_i = a - p_i + \theta p_j, \qquad i,j = M,H,\ \ i \neq j. \tag{35}$$

Furthermore, R and H decide the market price simultaneously.

From this setting, we obtain the following result in variable-cost transfer pricing:

$$\begin{aligned}
p_M^{VC} &= \frac{(2+\theta)a + (1+\theta)(2-\theta)c}{2(2-\theta^2)}, \\
p_H^{VC} &= \frac{(1+\theta)a + c}{2-\theta^2}, \\
\pi_M^{VC} &= \frac{(2+\theta)^2(a-(1-\theta)c)^2}{4(2-\theta^2)^2}, \\
\Pi^{VC} &= \frac{(8+8\theta-\theta^2-2\theta^3)(a-(1-\theta)c)^2}{4(2-\theta^2)^2} - F + V,
\end{aligned} \tag{36}$$

Additionally, we obtain the following result in full-cost transfer pricing:

$$\begin{aligned}
p_M^{FC} &= \frac{(2+\theta)a + (1+\theta)(2-\theta)c + 2r}{2(2-\theta^2)}, \\
p_H^{FC} &= \frac{(1+\theta)a + c + \theta r}{2-\theta^2}, \\
\pi_M^{FC} &= \frac{\Big((2+\theta)a - (1-\theta)\big((2+\theta)c + 2(1+\theta)r\big)\Big)^2}{4(2-\theta^2)^2}, \\
\Pi^{FC} &= \frac{\Phi}{4(2-\theta^2)^2} - F + V,
\end{aligned} \tag{37}$$

where $\Phi \equiv a^2(8+8\theta-\theta^2-2\theta^3)+a\big(4r\theta(1+\theta)-2c(8-9\theta^2-\theta^3+2\theta^4)\big)-(1-\theta)(4r^2(1+\theta)+4cr\theta(1+\theta)-c^2(8-9\theta^2-\theta^3+2\theta^4))$.

From Eqs. (31) and (32), we obtain $\Pi^{VC}-\Pi^{FC}$:

$$\Pi^{VC}-\Pi^{FC}=-\frac{((a-c(1-\theta))+2r)^2\theta^2+4(a-c(1-\theta))r\theta-4r^2}{4(2-\theta^2)^2} \tag{38}$$

In $a>0$, $\Pi^{VC}-\Pi^{FC}$ is negative in following economic condition.

$$\frac{(a-(1-\theta)c)\theta\left((1+\theta)-\sqrt{2(1+\theta)}\right)}{2(1-\theta)(1+\theta)}<r<\frac{(a-(1-\theta)c)\theta\left((1+\theta)+\sqrt{2(1+\theta)}\right)}{2(1-\theta)(1+\theta)}, \tag{39}$$

However, from $r>0$, when

$$0<r<\frac{(a-(1-\theta)c)\theta\left((1+\theta)+\sqrt{2(1+\theta)}\right)}{2(1-\theta)(1+\theta)}, \tag{40}$$

is hold, $\Pi^{FC}>\Pi^{VC}$ in our model, because $(1+\theta)-\sqrt{2(1+\theta)}<0$ is always hold in our assumption. From this analysis, we obtain Proposition 7.

Proposition 7. Assuming price competition in a product market, the profit of a vertically integrated supply chain under full-cost transfer pricing exceeds that under variable-cost transfer pricing in following economic environments.

$$0<r<\frac{(a-(1-\theta)c)\theta\left((1+\theta)+\sqrt{2(1+\theta)}\right)}{2(1-\theta)(1+\theta)}.$$

Proposition 7 demonstrates, assuming price competition in the product market, that our main result holds in a specific economic environment for the strategic complement of price competition. When the overhead allocation (c or $c+r$) is low, the benefit of tacit collusion is large. Therefore, where marginal cost is high, variable-cost transfer pricing is not optimal in our model. This outcome is same as our main model with quantity competition. From this proposition, the robustness of our main result is supported in a price competition setting.

4.4 Non-integrated supply chain

In this section, we consider the case where the headquarter and retail divisions are not integrated. In traditional supply chain studies, non-integrated supply chain is assumed to analyze the level of wholesale price (e.g., Arya *et al.,* 2007; Matsui, 2017; Yoon, 2016). Therefore, in this section we assume non-integrated supply chain and wholesale price which is decided by manufacturer. Here, we call the headquarter in main analysis as *supplier* (S) and marketing division in main analysis as *retailer* (R).

In this case, S manages the own profit π_S and R profit π_R is as follows:

$$\pi_S = (p_S - c)q_S + (w - c)q_R + V - F, \tag{41}$$

$$\pi_R = (p_R - w)q_R, \tag{42}$$

where w denotes wholesale price which is decided by S. In this case, S chooses wholesale price from $w = c$ (variable-cost wholesale price) or $w = c + r$ (full-cost wholesale price). In addition, demand function in this case is $p_i = a - q_i - \theta q_j$ $(i = S, R, i \neq j)$. Timeline of events are not different from main model.

Solve this model and obtain following outcome in variable-cost wholesale pricing ($w = c$).

$$q_R^{VC} = \frac{a - c}{2 + \theta},$$

$$q_S^{VC} = \frac{a - c}{2 + \theta},$$

$$\pi_R^{VC} = \frac{(a-c)^2}{(2+\theta)^2}, \tag{43}$$

$$\pi_S^{VC} = \frac{(a-c)^2}{(2+\theta)^2} + V - F.$$

In addition, we obtain following outcome in full-cost wholesale pricing ($w = c + r$).

$$q_R^{VC} = \frac{(2-\theta)(a-c) - r\theta}{(2-\theta)(2+\theta)},$$

$$q_S^{VC} = \frac{(2-\theta)(a-c) + r\theta}{(2-\theta)(2+\theta)},$$

$$\pi_R^{VC} = \frac{\big((2-\theta)(a-c) - 2r\big)^2}{(2-\theta)^2(2+\theta)^2}, \tag{44}$$

$$\pi_S^{VC} = \frac{\Sigma}{(2-\theta)^2(2+\theta)^2} + V - F,$$

where $\Sigma = (2-\theta)^2(a-c)^2 - r\big(a(2-\theta)(4+2\theta-\theta^2) - c(8-4\theta^2+\theta^3) + r(8-3\theta^2)\big)$.

From Eqs. (41) and (42), $\pi_S^{FC} - \pi_S^{VC}$ is as follows:

$$\pi_S^{FC} - \pi_S^{VC} = \frac{r\big((8-4\theta^2+\theta^3)(a-c) - r(8-3\theta^2)\big)}{(2-\theta)^2(2+\theta)^2}. \tag{45}$$

Eq. (43) and all of outcomes are positive when $0 < F < V$, $r > 0$, $0 < c < \big((2-\theta)a - 2r\big)/(2-\theta)$ and

$$r < a \leq 2r,\ \ 0 < \theta < \frac{2(a-r)}{a}, \tag{46}$$

or

$$2r < a,\ \ 0 < \theta \leq 1, \tag{47}$$

are hold. This outcome implies that our main analysis is robust in non-integrated supply chain case. We conclude this outcome as a following proposition.

Proposition 8. Assuming non-integrated supply chain, the profit of a supplier under full-cost transfer pricing exceeds that under variable-cost transfer pricing in specific economic environments.

This is because when non-integrated supply chain opens direct channel, supplier generally sets the level of wholesale prices above the marginal cost to obtain competitive advantage in a product market and the marginal profit from wholesale. Therefore, supplier chooses full-cost wholesale pricing which exceeds the marginal cost.

4.5 Endogenous decision of r

While main analysis considers exogenous overhead allocation, in this section, we consider two cases of endogenous r to check robustness of our argument. First, we identify r which maximizes total profit of supply chain using main model. We consider the following timeline to expand main model. First, H decides optimal overhead allocation, r, to maximize Π. Second, H produces products at marginal cost c and transfers them to M based on full-cost transfer pricing. Third, H and M choose the sales quantities for a product market. Finally, profits are realized. In this case, we use the outcome of section 4.1 and the headquarter decides r to maximize Eq. (16).

$$r^{end} = \frac{(a-c)\theta}{2(1+\theta)}, \tag{48}$$

where superscript end denotes endogenously decision case of r. From this outcome, $r^{end} > 0$ is obtained and positive overhead allocation implies that cost-based transfer pricing above the marginal cost is profitable to total profit on supply chain. When the endogenous decision of r has an impact on profit from other business, V, from the assumption of $\partial V / \partial r > 0$ in previous additional analysis, the headquarter has an incentive to increase r, because increasing r is profitable to profit of supply chain. Therefore, when the endogenous decision of r has an impact on profit from other business, V, also $r^{end} > 0$ is hold.

In addition, we consider the other case of endogenously decided overhead allocation. In this case, overhead r is allocated to this product and the integrated supply chain allocates r to marketing division and headquarter with α and $1 - \alpha$. Therefore, the total profit of the integrated supply chain, $\Pi^{allocate}$, is as follows:

$$\Pi^{allocate} = \pi_M^{allocate} + \big(p_H - (c + (1 - \alpha)r)\big)q_H - F + V, \tag{49}$$

where superscript $allocate$ denotes that the rate of overhead allocation is chosen by the headquarters and $\pi_M^{allocate}$ denotes the profit that the headquarters obtains from the market division. In this equation, $\big(p_H - (c + (1 - \alpha)r)\big)q_H$ is profit from direct channel. The marginal cost is $c + (1 - \alpha)r$ and $(1 - \alpha)r$ denotes allocated overhead to headquarter. Hence, marginal cost of product is different from main model. Moreover, full-cost transfer pricing is $t = c + \alpha r$, where αr denotes allocated overhead to marketing division, because overhead is allocated to divisions in cost accounting. In this case, the headquarter decides the rate of overhead allocation α to maximize total profit of vertically integrated supply chain. We consider the following timeline in this case. First, H decides optimal rate overhead allocation, α, to maximize Π. Second, H produces products at marginal cost c and transfers them to M, based on full-cost transfer pricing. Third, H and M choose the sales quantities for a product market. Finally, profits are realized. In this case, we use the outcome of Section 3.3 and the headquarters decides α to maximize Eq. (16). Because it is difficult to identify optimal α using main model, we consider the specific case ($\theta = 1$) and obtain following outcome.

$$\alpha^{allocate} = \frac{5}{7},$$

$$q_M^{allocate} = \frac{7(a-c) - 8r}{14},$$

$$q_H^{allocate} = \frac{3}{7}r, \tag{50}$$

$$\pi_M^{allocate} = \frac{1}{4}\left(a - c - \frac{8}{7}r\right)^2,$$

$$\Pi^{allocate} = \frac{1}{4}(a-c)^2 - \frac{1}{7}r^2 - F + V,$$

where $0 < r < 7(a-c)/8$ is hold, all outcomes are positive. From this analysis, $t = c + 5r/7$ and $t > c$ is hold. Therefore, full-cost transfer pricing is also optimal in this case. This is because when $\alpha = 0$, the headquarter loses profit from competition by increasing marginal cost of only the headquarter. The headquarter has no incentive to open direct channel when $\alpha = 0$. Hence, $\alpha > 0$ is chosen by the headquarter.

4.6 Quantity affects overhead allocation

In this section, we define the overhead allocation as $F/(q_M + q_H + Q)$ (Q is total quantity of other business). In cost accounting, overhead allocation is calculated as above way. Therefore, we consider overhead allocation among cost accounting regulation. However, because it is difficult to consider this case generally, we identify $a = 1$, $c = 0$, $\theta = 0.5$, $F = 0.1$ and $Q = 0.1$. Using main model, we compare outcomes variable-cost transfer pricing ($t = 0$) and full-cost transfer pricing $t = F/(q_M + q_H + Q)$. Outcomes in variable-cost transfer pricing, $t = c$, are denoted as Eqs. (10)-(12) and we use this outcome. As a result, we identify $q_M^{VC} = 0.2857$, $q_H^{VC} = 0.4286$, and $\Pi = 0.2265 + V$ numerically (values are rounded to the fifth decimal place or less).

In addition, outcomes in full-cost transfer pricing is as follows (values are rounded to the fifth decimal place or less):

$$q_M^{FC} = 0.3039,$$
$$q_H^{FC} = 0.3926, \tag{51}$$
$$\Pi^{FC} = 0.2307 + V.$$

From this analysis, in this case, $\Pi^{VC} < \Pi^{FC}$ holds. Hence, the headquarter prefers full-cost transfer pricing. This outcome supports our result of main model analysis.

In this overhead allocation, $q_M^{VC} < q_M^{FC}$ and $q_H^{VC} > q_H^{FC}$ are hold. Because increasing q_H^{FC} leads small t, the headquarter aims to increase marginal cost of marketing division, considering tacit collusion in product market competition. This explanation is observed by $q_M^{VC} + q_H^{VC} > q_M^{FC} + q_H^{FC}$. In competition, excessive supply leads low price and it suffers total profit of vertically integrated supply chain. Therefore, the headquarter wants to decrease product which is supplied to a product market. In this numerical case, the headquarter can increase the cost of marketing division by full-cost transfer pricing. However, when Q is large, the effect of increasing cost of marketing division does not have an important role in decision making. In addition, when θ is small, they do not have incentive of tacit collusion, because they do not engage intensive competition in a product market.

5. Conclusion

This study shows that full-cost transfer pricing is optimal in specific economic environments with cost based-transfer prices, which differs from the recent results of Matsui (2012, 2013) and the traditional result of Hirshleifer (1956). In the proposed model, the optimal choice of a transfer pricing method with a direct channel is affected by the level of fixed cost allocation to the marketing division. This result emerges in specific economic environments when the assumption of the basic model is relaxed.

Prior literature on strategic transfer pricing, which examines the choice of transfer pricing methods, does not assume a direct channel. Hence, this study has significant implications for managerial decision practices—when firms select a transfer pricing method, they must also consider the competition between channels.

This study has several limitations. When a vertically integrated supply chain uses full-cost transfer pricing, the marginal cost of production declines as product quantities increase in only numerical example. However, this case is difficult to solve explicitly, and Matsui (2013) considers the same setting as in this study. Hence, this study's assumption, which is related to fixed cost allocation, is observed in prior literature on strategic transfer pricing. Moreover, when there are additional rival firms with other organizational forms, decision making may be different from the case where only one firm supplies the product to a market. Therefore, our main claim may be ensured in a specific economic environment. Despite its limitations, this study contributes significantly to the strategic transfer pricing literature on the optimal choice of a transfer pricing method in vertically integrated supply chains.

Notes:

1. In management decision practice, transfer pricing in integrated supply chains is traditionally considered an important topic of investigation (e.g., Galway, 1990; Smallman and Adrien, 1981).
2. There are two types of transfer pricing methods in practice: administered and negotiated (Vaysman, 1996). Tang (1992) shows that only a few firms use negotiated transfer price. We consider the administered transfer price in this study.
3. Some studies use cooperative game theory to analyze intra-firm transfer pricing and cost allocation (e.g., Shubik, 1962). In management science research, Shubik (1962) is an elementary study exploring the assignment of joint cost and transfer pricing using cooperative game theory.

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