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Entry deterrence through credible commitment to transfer pricing at direct cost

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Abstract

This paper examines the choice between direct and absorption costing in a cost-based transfer pricing system for duopolistic firms competing with product market prices. Existing literature has shown that the adoption of an absorption costing system, which drives up the intrafirm transfer price, strategically dominates direct costing for the two firms, regardless of whether the transfer price is publicly observable, thereby constituting a subgame perfect Nash equilibrium (SPNE). However, we demonstrate that direct costing can strategically dominate absorption costing when one of the two firms is an incumbent, whereas the other is a potential entrant. Stated differently, the well-known result in the strategic cost allocation problem reverses if we consider entry threats. More specifically, we show that if the incumbent credibly commits to an observable transfer price, the upfront adoption of a direct costing system enables the incumbent to deter the entry of the potential rival in the SPNE. As a commitment device for the observable price, we consider the regulation of transfer prices that usually exists in oligopolistic network industries. We show that a regulator that pursues social welfare maximization approves direct costing but not absorption costing. Therefore, the firms and the regulator can share a mutual interest in the adoption of a direct costing system, a state thus sustained as the SPNE. This result yields managerial accounting implications for a divisionalized firm facing the threat of potential competitors entering the market in that the firm can use this accounting system to help monopolize the market.

Keywords: Cost-based transfer pricing; Cost allocation; Access price regulation; Commitment; Management accounting

1. Introduction

The choice of a particular transfer pricing system in a divisionalized company operating within a variety of economic environments has commanded significant attention in the managerial accounting literature. In one of a series of surveys of Fortune 500 and Fortune 1000 firms (Tang, 1992, 1993, 2002), Tang (2002) reports that 46.2 percent of the transfer pricing methods of 143 Fortune 500 firms are cost based, suggesting that this is the most prevalent transfer pricing method in practice. Of these same firms, 53.8 percent employ actual or standard full production costs, 38.5 percent full production costs plus a markup, and 7.7 percent variable costs of production, thus indicating that full cost rather than variable cost transfer prices are more common. Mills (1988) also asserts that cost-based methods are the principal basis for determining prices based on a survey of the largest 3,500 British companies. In addition, Mills (1988) suggests that noncost considerations generally modify cost-based prices, of which the prices of competitors are the most important, implying that oligopolistic firms commonly make use of internal transfer prices as a strategic tool to compete with rivals.

Transfer prices certainly work as a strategic device, as found by the significant number of studies following Hirshleifer (1956). However, firms in advanced economies are not completely free to set internal prices between divisions as they are frequently subject to regulation. For the most part, authorities in advanced countries tend to impose strict regulation, particularly on tax-motivated transfer pricing (Ernst and Young, 2012). When we consider incentives for transfer pricing other than tax evasion, the regulation of transfer prices also becomes important in oligopolistic industries where a divisionalized company potentially exerts significant market power. Accordingly, the regulation of internal transfer prices especially pertains to network industries, such as public utilities. This is because the price considerably affects social welfare if another firm purchases the network service at an access price, which is typically set to equal the transfer price.[1] Consequently, the management of a

[1] Fjell and Foros (2008) present several cases in which European regulators provide

firm operating in an industry where few firms operate should properly balance not only the strategic situation but also the regulatory regime surrounding the firm that to some extent dictates the transfer price.

In light of the considerable debate on the most desirable accounting method and regulation for transfer pricing, this paper investigates the economic outcomes of two representative cost-based transfer-pricing methods for duopolistic firms facing product market competition; namely, direct costing and absorption costing. We first construct a model where firms act without any transfer pricing regulation to focus on their incentives for the choice of costing system. The extant literature has shown that the adoption of an absorption costing system, which drives up intrafirm transfer prices, can strategically dominate direct costing for both firms, regardless of whether the transfer price is publicly observable, thereby constituting a subgame perfect Nash equilibrium (SPNE).

However, we demonstrate that the direct costing system can strategically dominate absorption costing when one of the two firms is an incumbent and the other is a potential entrant. Stated differently, the well-known result in the strategic cost allocation problem

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guidelines on transfer pricing for public utilities in the telecommunications and electricity supply industries. For example, European Competitive Telecommunications Association (2003, p. 4) documents that "The SMP (Significant Market Power) operator must publish to the NRA (National Regulatory Authority) and third parties its internal transfer prices for SMP products, and its methodology for cost accounting and accounting separation..." Moreover, European Regulators Group (2006, p. 44) provides the following statement on electronic communications networks and services: "Accounting separation should ensure that a vertically integrated company makes transparent its wholesale prices and its internal transfer prices especially where there is a requirement for non-discrimination." Regulators in advanced economies outside Europe present similar guidelines for utility industries. For example, in the US, the Public Utility Commission of Texas (1998) notes that "there is a strong likelihood that a utility will favor its affiliates where these affiliates are providing services in competition with other, non-affiliated entities ... there is a strong incentive for regulated utilities or their holding companies to subsidize their competitive activity with revenues or intangible benefits derived from their regulated monopoly businesses." Likewise, in Asia, the Central Asia Regional Economic Cooperation (2005, p. 17) refers to electricity sector regulations as follows: "Countries vary with respect to the sequencing of sector reforms. However, the elements of these reform packages either already include or are likely to include the following: ... (ii) vertical unbundling, which includes measures to make the performance of each company transparent and to publish transfer prices among generation, transmission, and distribution ...".

reverses if we consider the threat of entry. More specifically, if the incumbent credibly commits to an observable transfer price, we show that the upfront adoption of the direct costing system enables the incumbent to deter the entry of the potential rival and to monopolize the market in the SPNE. This result yields important managerial accounting implications for a divisionalized firm facing the threat of potential competitors entering the market in that the incumbent firm can use the accounting system to bind itself to more aggressive market behavior, creating a virtual barrier to entry.

The rationale behind this result is as below. If one of the two firms installs the absorption costing system in advance as a Stackelberg leader, the other firm subsequently enters the market by introducing the absorption costing system because the latter may earn sufficient positive revenue to counterbalance any business entry costs. Consequently, the leader is obliged to share the market with the follower. Conversely, if the leader strategically adopts the direct costing system, the follower cannot earn sufficient revenue to cancel out any entry costs, irrespective of its choice of accounting system upon entering the market. Eventually, the follower surrenders entering the market. The key implication of this analysis is that an upfront direct costing system choice enables the leader to increase profits through monopoly in the SPNE.

To derive this result, the observability of the transfer prices of competing firms is an essential assumption, even though internally chosen prices are generally unobservable outside the firm. To ensure the observability in our model, we next consider the regulation of transfer prices that usually exists in oligopolistic network industries, such as a public utility. Specifically, we propose a model extension where firms operating in a network industry make transfer-pricing decisions in the presence of a regulator that pursues social welfare maximization. Because access prices in network industries affect social welfare significantly, regulators monitor the prices for improving social welfare.[2] Using this model, we show that

[2] Bromwich and Hong (2000) examine accounting separation and hierarchical costing systems in the UK telecommunications industry, concentrating on use by British Telecom and the telecommunications regulator. They suggest that transparency and accounting separation

the regulator approves the direct costing system but not the absorption costing system. Therefore, the firms and the regulator can share a mutual interest in the adoption of a direct costing system, a state thus sustained as the SPNE.

The remainder of the paper is structured as follows. Section 2 provides a comprehensive review of the literature relating to transfer pricing from a managerial accounting viewpoint. Section 3 presents the basic settings that underpin our analytical transfer-pricing model. Section 4 presumes that firms are free from any regulation in order to highlight their equilibrium incentive for transfer pricing system choice. Subsection 4.1 first assumes that both firms are incumbents and thus competing on retail price immediately from the start of the game, identifying the subgame perfect dominant strategy equilibrium as the benchmark. Subsection 4.2 then develops the benchmark model by assuming that one of the two firms is an incumbent while the other is a potential entrant. We demonstrate that entry deterrence and the development of a monopoly position by the incumbent firm through the adoption of the direct costing system take place as the SPNE, contrary to the results of the benchmark model. In Section 5, we incorporate transfer-pricing regulation into each of the models constructed in Section 4, showing that firms and the regulator can agree on the benefit of adopting a direct costing system in the SPNE. Section 6 performs comparative statics of our results and theoretically reveals that the strategic situation and the regulatory environment together drive desirable managerial accounting design. Section 7 provides our concluding remarks.

2. Literature review

The study of the economic effects of transfer pricing from a managerial viewpoint

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are complementary obligations used to implement a cost-based access price, which inform competing firms about the costs of network components and help them to assess whether they should invest in their own infrastructure. Specifically, they state "... Such separated costs are also meant to aid in ensuring that charges to other operators do not differ from the comparable transfer prices used within BT." (Bromwich and Hong, 2000, p. 141)

dates back at least to Hirshleifer (1956). Hirshleifer (1956) advocated the setting of internal transfer prices equal to marginal cost in order to alleviate attendant double marginalization problems. Subsequently, many works have discussed the alternative pricing forms available and the effect on decentralized firms of any resulting distortions.[3] Among these, several analytical accounting studies investigate the strategic effects of transfer prices using a game theoretic approach (e.g., Alles and Datar, 1998; Göx, 2000; Narayanan and Smith, 2000; Göx and Schöndube, 2004; Fjell and Foros, 2008; Shor and Chen, 2009; Dürr and Göx, 2011; Matsui, 2011, 2012).

Pioneering studies by Alles and Datar (1998), Göx (2000), and Narayanan and Smith (2000) develop a strategic transfer-pricing model where a symmetric duopoly with price competition serves the downstream market. In this model, these studies examine how firms in the duopolistic market set transfer prices in such a way that purposefully changes the pricing behavior of divisional managers, thereby showing that full-cost transfer pricing constitutes a Nash equilibrium strategy when compared with variable cost transfer pricing. The logic underlying their finding is that strategic driving up of the intrafirm transfer price through the allocation of fixed costs (e.g., full or absorption costing) to a downstream selling division softens the reaction of other competitors when the control variable for firms is a strategic complement (e.g., the retail price). Faced with increased transfer prices, the managers of downstream divisions charge a higher price in the final product market when compared with a firm that sets prices based on marginal cost through a variable costing method, thereby reducing the intensity of competition. Therefore, the consensus in the literature is that some cost allocation to transfer prices is the dominant strategy compared with no-cost allocation.

However, we should note that most of the studies in this particular research strand rely implicitly on the assumption that the managers of firms simultaneously observe the transfer prices of their competitors before deciding on the pricing strategy for their product, even though intrafirm transfer prices are normally unobservable in practice. Transfer pricing has

[3] Göx and Schiller (2007) provide a comprehensive perspective of accounting research on

no strategic effect if firms cannot commit to publicly observable transfer prices above marginal costs because the division managers cannot react to something that they do not observe (Katz, 1991; Bagwell, 1995). In response, Göx (2000), Narayanan and Smith (2000), and Göx and Schöndube (2004) construct strategic transfer pricing models based on the assumption that the transfer price is not publicly unobservable. Göx (2000) shows that the dominance of absorption costing also holds, even if transfer prices are unobservable, as long as the absorbed overhead allocation to a downstream division is not excessively high. Narayanan and Smith (2000) analyze the transfer pricing policy in a duopoly that operates in different tax jurisdictions, showing that a difference in tax rates may work as a signal that transfer prices deviate from marginal costs, and this makes strategic transfer pricing credible. Göx and Schöndube (2004) analyze strategic transfer pricing with risk- and effort-averse managers and find that the presence of an agency problem is sufficient to signal to the competitor the use of transfer prices above marginal cost.

Of these studies, Göx (2000) is the first to provide a unique viewpoint that the commitment to a particular cost accounting system works as a credible observable signal of pricing strategy. Indeed, the choice of an accounting system is typically a long-term commitment usually observable by competitors because its introduction requires substantial investments associated with the installation of the system. Nonetheless, no subsequent study has developed a strategic transfer-pricing model based on this premise. This paper aims to reconsider this issue.

Moreover, we should not overlook another literature relating to managerial accounting system design in the strategic context. In this work, Johnson and Kaplan (1987), Shank and Govindarajan (1993), and Chenhall and Langfield-Smith (1998), among others, propose that managerial accounting design should be driven by the company's strategic situation. Specifically, Chenhall and Langfield-Smith (1998) suggest that traditional financial accounting performance measures are insufficient for assessing how production processes

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transfer pricing following Hirshleifer (1956).

support a variety of customer-focused strategies if a company emphasizes product differentiation strategies. Because our model explicitly incorporates parameters measuring product differentiation, it will also contribute to this literature by analyzing how strategic factors surrounding the firm impact upon the equilibrium accounting system.

Finally, along with the managerial accounting literature, a number of studies in industrial economics have addressed the strategic delegation issue. As in the accounting literature, these studies, which are referred to as strategic incentive theory, also showed that strategic delegation is the dominant strategy for oligopolistic firms (e.g., Vickers, 1985; Fershtman and Judd, 1987; Sklivas, 1987). In the main, our assertion that the upfront commitment of a firm to some specific strategy leads to entry deterrence ultimately stems from industrial economic work by Dixit (1979). Dixit (1979) pointed out that an incumbent firm can deter the entry of a potential rival by supplying a larger quantity than the level that would be optimal under a duopoly. In this respect, we can summarize the primary contribution of this paper as being the theoretical incorporation of the entry threat proposed by Dixit (1979) into the strategic transfer-pricing model.

Despite the many studies already investigating the strategic effects of transfer pricing, this brief overview suggests that research incorporating the possibility of entry deterrence into transfer-pricing models appears in neither the accounting nor economic literature. Hence, no previous study has pointed out that the upfront adoption of a specific costing system can serve as a barrier to entry. Accordingly, the current paper is the first to derive this result on the basis of a rigorous game theory framework, providing managerial accounting insights for business practitioners.

3. Model assumptions

In this section, we first describe the common assumptions used for the series of analytical models presented in this paper. Table 1 lists the variables used in our models. Suppose that two existing symmetric firms, denoted Firms 1 and 2, produce a differentiated

product and compete to sell this product to consumers. Although the two firms earn profits from another product, our model focuses on the market for a specific product. Each firm has two divisions that handle the product: an upstream manufacturing division and a downstream marketing division. The manufacturing division produces the product at a direct manufacturing cost of c per unit, with fixed manufacturing costs of F_U.[4] After producing the product, the manufacturing division sells it to the marketing division, which subsequently resells it after incurring fixed retailing costs, F_D. We assume that both F_U and F_D are sunk costs that an incumbent firm in the industry has already paid before the beginning of the game.[5]

[Table 1]

The headquarters of each firm adopts either direct or absorption costing as its preferred cost-based transfer pricing system. Let "strategy D" and "strategy A" denote the adoption of the direct and absorption costing systems, respectively. If a firm takes strategy D, the headquarters of the firm does not impose any indirect manufacturing costs on the downstream marketing division. Accordingly, the transfer price per unit is merely the direct cost, c. Hence, the profit for the marketing division in Firm i, π_i, is:

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[4] We assume that both firms have an identical cost structure, mainly because we consider an oligopolistic network industry as an empirical example in our model. It is common for regulated network firms, as in telecommunications and electricity production, to be originally state-owned enterprises and subsequently privatized in developed economies (Vickers and Yarrow, 1991). In such an industry, it is also natural that the incumbent monopolist began the business before any potential entrant firm, even without a cost advantage (or disadvantage). Indeed, recent analytical studies investigating entry into regulated network industries often assume symmetric firms for better model tractability (e.g., Fjell and Foros, 2008; Böckem and Schiller, 2010). That is, they assume that the incumbent firm providing a certain network has neither a cost advantage nor disadvantage. We follow these previous studies to employ this assumption.

[5] Our model relates to contestable market theory because it examines how the presence of a threat of entry in oligopoly impacts upon economic consequences. Note, however, that our model does not warrant perfect contestability because the fixed costs incurred by the upstream and downstream divisions (F_U and F_D, respectively) are also sunk costs. To warrant contestability, an incumbent firm should not have a cost advantage relative to a potential entrant to ensure free entry and exit. The existence of sunk costs in our model represents the cost advantage for the incumbent. Baumol et al. (1982) provide a detailed explanation of the conditions required to ensure contestability.

$$\pi_i = (p_i - c)q_i - F_D, \tag{1}$$

where p_i and q_i are the retail price and quantity of product for Firm i (i = 1, 2), respectively.

Alternatively, if Firm i selects strategy A, the firm headquarters imposes positive indirect overhead costs per unit, r, on the marketing division. Because transfer price per unit amounts to $c + r$ under absorption costing, the marketing divisional profit is:

$$\pi_i = (p_i - c - r)q_i - F_D. \tag{2}$$

Under either form of cost-based transfer pricing, headquarters delegates the retail pricing decision to the marketing division. Total profit for Firm i is then:

$$\Pi_i = (p_i - c)q_i - F + V_i, \tag{3}$$

where $F \equiv F_U + F_D$. V_i represents the profit for Firm i from another product, which we hereafter define as the second product for Firm i.[6] We assume that V_i does not depend on the strategy of Firm j because Firms 1 and 2 do not compete in the second product market.

When price competition arises between Firms 1 and 2, Firm i faces the following inverse demand function for product i:[7]

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[6] While we regard V_i for simplicity as the profits for Firm i from another single product, we may also interpret V_i as the profits from the bundle of all products that Firm i produces and sells other than q_i. The reason why we include the second product is to ensure that both firms earn positive profits, even if they adopt a direct costing system that may generate negative profits from this product.

[7] Because our main aim is to point out the possibility that direct costing can strategically dominate absorption costing under certain circumstances, we limit our analysis to a linear demand schedule to provide a more intuitive example. Indeed, previous studies have primarily employed linear demand in the context of strategic transfer pricing (e.g., Alles and Datar, 1998; Hughes and Kao, 1998; Shor and Chen, 2009; Matsui, 2011) or entry barriers (Dixit, 1979). Because these extant works form the basis of our model, we also apply linear demand.

$$p_i = a - q_i - \theta q_j . \tag{4}$$

Henceforth, (i, j) represents either (1, 2) or (2, 1). $\theta \in (0, 1)$ represents the degree of substitution between products, and a is a positive constant greater than c. The products become more differentiated as θ approaches zero and more similar as θ approaches unity. Simultaneously solving Equation (4) gives each demand quantity as a function of the prices:

$$q_i = \left((1-\theta)a - p_i + \theta p_j\right)/\left((1-\theta)(1+\theta)\right). \tag{5}$$

If Firm i avoids competition and monopolizes the market, the firm faces the following inverse demand function:

$$p_i = a - q_i . \tag{6}$$

Lastly, the exogenous parameters are assumed to satisfy the following inequality: $V_i + (1-\theta)(a-c)^2 / \left((2-\theta)^2(1+\theta)\right) - F > 0$ (i = 1 or 2), which means that the profit from the second product is sufficiently large to compensate for the loss from the product considered when both firms employ a direct costing strategy. Using the above settings, Section 4 examines the incentive for the choice of transfer pricing system in the absence of price regulation, followed by the incorporation of regulation in Section 5.

4. Transfer pricing system choice incentives for firms

4.1. Benchmark model: a game with two incumbent firms

Using the specification in the previous section, we first consider the situation where firms are operating in a generally unregulated industry and thus can freely choose the internal transfer price because of the absence of access price regulation. Following the transfer-

pricing model in Göx (2000), the costing system determines the transfer prices. That is, firms do not set their transfer prices strategically but instead compute them mechanically according to allocation rules. Therefore, throughout this section, the overhead allocation, r, is exogenously fixed in both firms.[8] For the remainder of this subsection, we assume that both firms are incumbents (operating in the industry from the start of the game) and construct an analytical model based on this assumption, although the main purpose of this paper is to show that the adoption of direct costing can be the dominant strategy given the presence of a potential entrant that is not an incumbent. In the ensuing subsection, we extend the model and compare the results of the benchmark model with an extended model.

Fig. 1 depicts the timeline of events in this benchmark model. To simplify the solutions, let us denote $M_k^{(S_1,S_2)}$ as revenue for Firm k when Firm 1 takes strategy S_1, whereas Firm 2 takes strategy S_2 where $S_i \in$ (D, A) (i = 1, 2). Table 2 details the equilibrium revenues resulting from price competition. Table 3 provides the payoffs for each firm given by each combination of strategies in the benchmark model.[9] The first and second rows in parentheses represent the payoffs for Firms 1 and 2, respectively. The next proposition directly comes from Table 3 (all derivations of the payoffs and the proofs for the propositions and corollaries are in the Appendix).

[Fig. 1]

[Table 2]

[Table 3]

[8] Although this section follows Göx (2000) in assuming that r is given because we initially examine the incentives for the firms to adopt a particular transfer pricing system, the situation where r is endogenously determined is more natural. Hence, we endogenously determine r by introducing a regulatory framework in Section 5. In most regulated industries, the transfer price usually relates to the regulated access price (Fjell and Foros, 2008).

[9] Because F is not only fixed costs but also sunk costs in our model, if one of the two firms exited from this industry and concentrated on other businesses, then it would collect a profit of $V_i - F$, which is smaller than $M_i^{(D,\,D)} + V_i - F$. Hence, the incumbent firms would remain engaged in this business, even when both chose the direct costing system in the benchmark model.

Proposition 1.

(i) If $r < \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)$*, the adoption of the absorption costing system is the dominant strategy compared with that of the direct costing system in the benchmark model. Consequently, the combination of strategies (A, A) constitutes the subgame perfect dominant strategy equilibrium.*

(ii) If $r > \theta^2(1-\theta)(2+\theta)(a-c)/\left(4-2\theta^2-\theta^3\right)$*, the adoption of the direct costing system is the dominant strategy compared with that of the absorption costing system in the model. Consequently, the combination of strategies (D, D) constitutes the subgame perfect dominant strategy equilibrium.*

(iii) If $\theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right) \le r \le \theta^2(1-\theta)(2+\theta)(a-c)/\left(4-2\theta^2-\theta^3\right)$*, no dominant strategy arises.*

The prerequisite $r < \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)$ for case (i) in Proposition 1 indicates that the overhead allocation is not excessively large such that a positive overhead allocation to the transfer price is more advantageous for the firms than a zero allocation. This inequality corresponds to the prerequisite for Proposition 3 in Göx (2000, p. 341) that symmetric absorption costing is a dominant strategy equilibrium if full cost-based transfer prices are located in a certain range around the optimal strategic transfer prices that would be set if the transfer price were observable. As Göx (2000) suggests that such transfer prices are reasonable if we consider the cost structure of most modern manufacturing industries, case (i) is the most relevant to practical overhead allocation among the three cases and is largely consistent with the preceding literature. Therefore, we hereafter concentrate on case (i) by assuming $r < \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)$.

The existing literature (Göx, 2000; Göx and Schiller, 2007) has demonstrated the applicability of the above proposition using more general functional forms.[10] Göx (2000) shows that even if the transfer price is publicly unobservable, the profit under absorption

[10] See also Göx and Wagenhofer (2007) for a numerical example where absorption costing

costing can exceed that under direct costing because the commitment to the former enables the firm to boost the price closer to the level of the strategic transfer price when the price is observable. Considering the benchmark outcomes, we proceed to construct another dynamic game where the timing of the introduction of the accounting system differs between the two firms.

4.2. Extended model: a game with one incumbent and one entrant

This subsection extends the benchmark model by considering the following entry game. Specifically, we change the earlier scenario such that one of the two firms is an incumbent operating in the industry, and the other firm is a potential entrant. Suppose that Firm 1 is the incumbent and Firm 2 the entrant. Because the timing of accounting method choice differs between the two firms, we employ the SPNE as the equilibrium concept in the game.

Fig. 2 depicts the timeline of events. One of the major differences between the events in this and the previous model is that we include Date 0. At Date 0, Firm 1 adopts either direct costing or absorption costing before Firm 2. We assume that the adoption of the accounting system is irreversible at subsequent dates. At Date 1, Firm 2 decides whether to enter the market, which would involve incurring fixed manufacturing costs to start the business, F, and selects an accounting system if it does decide to enter. Therefore, in this extended model, F represents not only fixed costs but also an entry fee for Firm 2, whereas it represents fixed and sunk costs for Firm 1 because it has already paid F. Accordingly, Firm 2 can take another alternative strategy, i.e., not enter the market, which we denote "strategy NE".

[Fig. 2]

As Figs. 1 and 2 illustrate, the event at Date 2 is the same as that of the benchmark model if Firm 2 enters the market. Because in this case price competition arises, the demand function that Firm i encounters is represented by Equation (5). Conversely, if Firm 2 does not

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surpasses direct costing with use of a linear demand function as in the present analysis.

enter, Firm 1 monopolizes the market, choosing the monopoly price for the purpose of overall profit maximization at Date 2. In this case, Firm 1 faces the demand function described by Equation (6). Using the above settings, Table 4 displays the payoffs for each firm based on the combinations of strategies in the extended model. The first and second rows in parentheses represent the payoffs to Firm 1 and Firm 2, respectively. The following proposition arises from Table 4.

[Table 4]

Proposition 2.

(i) If $M_2^{(D,A)} < F < M_2^{(A,A)}$*, then, if Firm 1 chooses strategy D, Firm 2 does not enter the market in the SPNE, while if Firm 1 chooses strategy A, Firm 2 does enter the market.*

(ii) If $F > M_2^{(A,A)}$*, then Firm 2 does not enter the market irrespective of whether Firm 1 selects strategy D or A. Therefore, in this case, strategies (D, NE) constitute the SPNE.*

(iii) If $F < M_2^{(D,A)}$*, then Firm 2 enters the market irrespective of the strategy chosen by Firm 1. Hence, strategy A remains the dominant strategy for the incumbent, and strategies (A, A) constitute the SPNE.*

In case (i), Firm 1 "deters" the entry of Firm 2 and monopolizes the market through the adoption of the direct costing system. In case (ii), the substantial costs of entry preclude Firm 2 from earning positive profits under either strategy taken by Firm 1. Hence, Firm 1 chooses strategy D to alleviate double marginalization, meaning that Firm 1 "blockades" the entry of Firm 2. Finally, in case (iii), the low entry fees allow Firm 2 to earn positive profits under either strategy by Firm 1, indicating that Firm 1 "accommodates" the entry of Firm 2.[11] In summary, Firm 1 as the Stackelberg leader has the initiative to choose either (D, NE) or (A, A) for the equilibrium only when $M_2^{(D,A)} < F < M_2^{(A,A)}$ holds.

In Proposition 2, let us highlight case (i) because it provides the most important

[11] See Tirole (1988, p. 306) for the differences in meaning between "accommodate",

implication. Even though strategy A strictly dominates strategy D as long as the overhead falls into a reasonable range in the benchmark model (case (i) in Proposition 1), a result already demonstrated in the literature (Göx, 2000), strategy D dominates strategy A for Firm 1 in case (i) of Proposition 2. That is, the result found in the existing literature can reverse in the current extended model.

Note that Firm 1 adopts the seemingly disadvantageous strategy in advance in case (i). At first impression, direct costing (strategy D) is less favorable for Firm 1 because in the benchmark model shown in Subsection 4.1 strategy D is dominated by absorption costing (strategy A). However, this is no longer the case in the extended model including the threat of entry. If Firm 1 adopts absorption costing at Date 0, then Firm 2 enters the market by introducing absorption costing at Date 1. Eventually, Firm 1 has to share the market with Firm 2, leading to less profit. To prevent this unfavorable equilibrium, Firm 1 should instead undertake the direct costing strategy at Date 0, even though it is apparently disadvantageous because it lowers the firm's own profits compared with the absorption costing strategy if duopolistic price competition takes place. However, the upfront adoption of the direct costing system by Firm 1 actually prevents Firm 2 from earning sufficient revenue to counterbalance its costs of entry, F, irrespective of the choice of accounting system by Firm 2 when it enters the market. Consequently, Firm 2 gives up entering the market. In summary, the upfront installation of the direct costing system enables Firm 1 to monopolize the market, thereby boosting its profits in the SPNE.

5. Regulation as a commitment device for transfer prices

5.1. Regulatory process

Up to now, we have assumed that each firm observes the transfer price of its rival, deriving equilibrium payoff functions in Tables 3 and 4 that depend on overhead allocation, r.

"blockade", and "deter".

In practice, however, internally chosen overhead rates are often unobservable outside the firm. If a divisionalized firm attempts to make not only the type of the costing system but also the transfer price itself observable, the firm needs to utilize some other means as a commitment device to ensure the observability. To address this problem, we assume in this section that the firms are operating in a network industry, such as a public utility, where strict transfer pricing regulation prevails. Many previous studies have discussed cost-based access pricing in a variety of network industries (e.g., Fjell and Foros, 2008; Böckem and Schiller, 2010), because entry into these industries frequently arises with the establishment of an entity that accesses a network provider that is a division of the incumbent firm. Because access prices affect social welfare considerably, regulators monitor the prices in network industries for the purpose of social welfare enhancement. Accordingly, the regulator usually requires the incumbent firm in these industries to disclose overhead rates. This mandatory disclosure plays the role of a commitment device that ensures the observability of transfer prices in our model. In addition, oligopoly with a very small number of firms (i.e., a monopoly or a duopoly) that our model supposes is typical of regulated network industries.

To reflect regulatory practice in network industries, we alter the scenario of the models in the previous section as follows. Figs. 3 and 4 illustrate the timeline of events of the benchmark and extended models, respectively. At the initial date, the incumbent chooses either direct costing or absorption costing, proposing to the regulator the chosen overhead allocation, r, for the purpose of maximization of its own profits.[12] Subsequently, the regulator decides whether to approve the proposed overhead based on the following process. If there is another overhead that achieves greater social welfare, the regulator forcibly modifies the proposed overhead to such a welfare-maximizing overhead.[13] If there is not, the regulator

[12] Note that in this section, the choice of r by an incumbent firm can be either binary, like the model in Section 4 (i.e. r is chosen from zero as the direct costing or a fixed positive value as the absorption costing) or not (i.e. the incumbent directly chooses the level of r to maximize its profits). This is because the regulator will forcibly modify the value of r for the purpose of welfare maximization subsequent to the choice made by the firm.

[13] Böckem and Schiller (2010) investigate transfer prices in regulated industries, specifically focusing on the economic effects of an access price equal to the long-run incremental cost.

approves the proposed overhead because it automatically maximizes welfare. After this process, each firm must use the overhead directed by the regulator. Incorporation of this process enables us to endogenize *r* and to describe more realistic business environments. In summary, the difference of the model in this section from that in the previous section is that the regulator's behavior is added in the benchmark scenario (Date 2 in Fig. 3) and in the extended scenario (Date 1 in Fig. 4), respectively. Events other than the approval process are the same as those without regulation, as shown in Figs. 1 and 3 (the benchmark model) and Figs. 2 and 4 (the extended model).

[Fig. 3]

[Fig. 4]

5.2. Benchmark model: a game by two incumbent firms with the regulator

Based on the above settings, this subsection investigates how the introduction of transfer pricing regulation alters the SPNE in the benchmark model involving two incumbent firms. The following proposition summarizes the SPNE under regulation.

Proposition 3. *In a game with two incumbent firms, the state where the regulator approves and obliges firms to adopt only the direct costing system is sustained as the SPNE.*

Proposition 3 strongly contrasts with case (i) in Proposition 1 where there is no regulation of transfer prices. Without regulation, firms have an incentive to install an absorption costing system to inflate the equilibrium retail price as long as the overhead takes a reasonable value. However, if we additionally consider the process where the transfer price requires approval by the regulator, the regulator always approves only the direct costing

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They construct a model where the regulator—not a firm—determines the markup over unit costs of capital. Our setting that the regulator substantially sets the overhead follows their assumption.

system in pursuit of social welfare.[14] In this respect, the firms and the regulator exhibit a conflict of interest on the form of a transfer pricing system. Namely, while both incumbent firms wish to adopt the absorption costing system, the regulator forcibly modifies the overhead to zero.[15]

Remember that Göx (2000) shows that the absorption costing system constitutes the SPNE, if not the transfer price itself, but the costing system is observable to competitors. Proposition 3 indicates that if firms utilize the regulatory framework to make the transfer price as well as the costing system observable to the rival, the firms fail to adopt the absorption costing system because of regulation. However, as shown in the following subsection, the firms and the regulator in the entry game can have a mutual interest in the adoption of a direct costing system, contrary to the result of the game with two incumbents.

5.3. Extended model: a game by one incumbent and one entrant with the regulator

We now move to investigate the extended model under the presence of regulation on transfer prices. The following proposition identifies the domains of exogenous parameters determining whether direct costing or absorption costing is adopted and whether monopoly or duopoly arises in the SPNE under transfer pricing regulation.

Proposition 4.

(i) If $F \geq 3(5-3\theta)(a-c)^2/64$ *and* $\theta \geq 1/3$, *or* $F \geq (a-c)^2/(4(1+\theta))$ *and* $\theta < 1/3$, *then the state where the regulator approves only the direct costing system constitutes the unique SPNE.*

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[14] The existing economic literature has demonstrated under various circumstances the result that transfer prices equal to marginal cost maximize social welfare (e.g., Hirshleifer, 1956). Hence, the imposition of the direct costing system by the regulator is a natural outcome for an oligopoly.

[15] We should note that Proposition 3 rests on our assumption that transfer prices are solely for the purpose of the coordination of intrafirm trade. The existing literature has shown that if we consider the role of transfer prices in motivating divisional investment incentives, optimal prices that establish a desirable compromise between trade coordination and investment incentives are typically based on full cost (e.g., Pfeiffer et al., 2011). Hence, the proposition may not hold if we alternatively assume that the objective for the regulator is to implement

In this SPNE, the incumbent monopolizes the market because a potential entrant does not enter the market.

(ii) If $(1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right) < F < 3(5-3\theta)(a-c)^2/64$ *and* $\theta \geq 1/3$, *or* $(1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right) < F < (a-c)^2/(4(1+\theta))$ *and* $\theta < 1/3$, *then the regulator approves only the absorption costing at* $r = \left((a-c)\theta - (2-\theta)\sqrt{(a-c)^2 - 4(1+\theta)F}\right)/2$ *in the SPNE. A potential entrant enters the market in this SPNE, leading to duopoly.*

(iii) If $F \leq (1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right)$, *the regulator approves only the direct costing in the SPNE, leading to duopoly.*

The condition $F \geq 3(5-3\theta)(a-c)^2/64$ and $\theta \geq 1/3$, or $F \geq (a-c)^2/(4(1+\theta))$ and θ <1/3 in case (i) of Proposition 4 is derived by rearranging the condition that social welfare under monopoly with direct costing adoption exceeds that under duopoly with absorption costing adoption. Fig. 5 plots the graph of social surplus for case (i) in Proposition 4 when *r* varies, illustrating that only the direct costing system attains maximum social welfare when $F \geq 3(5-3\theta)(a-c)^2/64$ and $\theta \geq 1/3$ is met. This figure suggests that social surplus is discontinuous at $r = \left((a-c)\theta - (2-\theta)\sqrt{(a-c)^2 - 4(1+\theta)F}\right)/2$ because monopoly through entry deterrence arises on the left-hand side of the point, while duopoly through entry accommodation arises on the right-hand side. Therefore, if the incumbent proposed a positive value of *r*, the regulator would forcibly modify this to zero because only a zero overhead achieves the highest social welfare.

[Fig. 5]

Note that this result totally differs from the case shown in Subsection 5.2 where both firms are incumbents. In the benchmark model, a conflict of interest concerning the transfer pricing system arises between the firms and the regulator; that is, the firms wish to install the

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the 'right' balance between investment incentives and welfare-maximizing consumer prices.

absorption costing system to maximize profit whereas the regulator approves only direct costing to maximize welfare. By way of contrast, the regulator is willing to adopt the direct costing system leading to monopoly in this entry game if the exogenous parameters are in the region that satisfies $F \geq 3(5-3\theta)(a-c)^2/64$ and $\theta \geq 1/3$, or $F \geq (a-c)^2/(4(1+\theta))$ and θ <1/3. Moreover, if the overhead approval process by the regulator were removed from the timeline in Fig. 4, then the game would return to that in Subsection 4.2 where the incumbent would have an incentive to adopt the direct costing system if $F > M_2^{(D,A)}$ as suggested by Proposition 2. Hence, if the exogenous parameters satisfy both $F > M_2^{(D,A)}$ and, $F \geq 3(5-3\theta)(a-c)^2/64$ when $\theta \geq 1/3$ or $F \geq (a-c)^2/(4(1+\theta))$ when θ<1/3, the incumbent firm and the regulator share a mutual interest in adopting the direct costing system that leads to monopoly (Propositions 2 and 4), contrary to the game with two incumbents (Propositions 1 and 3). In summary, this subsection demonstrates that entry deterrence through precommitment to transfer pricing at direct cost is sustained as the SPNE under realistic business circumstances.

6. Comparative statics

Previous management accounting research empirically examined how internal accounting system depends on the strategic situation surrounding the firm, such as product differentiation or profitability. Because our models explicitly involve exogenous parameters capturing these strategic factors, we expect comparative statics of the models constructed to provide practical insights into accounting system design. Therefore, as a final requirement, this section conducts comparative statics to investigate how the parameters influence the equilibrium cost system choice.

We first focus on the case without regulation in Section 4, where we should analyze how the boundary condition generating entry deterrence in Proposition 2 (i.e., $M_2^{(D,A)} < F < M_2^{(A,A)}$) depends on parameters including a, c, and θ. Recall that θ is the substitutability of the product. Because a is the vertical intercept of the linear demand curve and c is the marginal

cost, $a–c$ measures the profitability of the product. Profitability, $a–c$, and product substitutability, θ, affect the dominance of the direct costing strategy in the following way.

Corollary 1. *Without regulation, the domain of F that generates entry deterrence ($M_2^{(D, A)} < F < M_2^{(A, A)}$) is positively related to profitability, a–c, and is inversely related to the substitutability of the products, θ.*

As profitability, $a–c$, increases, the revenue for each firm under duopoly grows. Accordingly, the threshold of fixed costs that counterbalance this increased revenue and eliminate profits for a potential entrant also increases. Hence, when $a–c$ takes a relatively high value, the values of the fixed costs that engender the possibility that the incumbent firm deters entry of an entrant through direct costing tend to be higher. On the other hand, as θ decreases, the products supplied by the two firms become more differentiated, which drives up revenue for each firm under duopoly. Hence, the threshold for entry costs that counterbalance this increased revenue and eliminate profit for the entrant also increases. Consequently, as θ becomes lower, the values of fixed costs that engender the possibility that direct costing by the incumbent firm deters entry tend to be higher, as shown in Corollary 1.

We next move to conduct the comparative statics of the scenario under the presence of the regulator in Section 5. The following corollary summarizes the result.

Corollary 2. *When regulation is imposed on firms, the domain of F where a potential entrant does not enter the market ($F \geq 3(5–3\theta)(a–c)/64$ when $\theta \geq 1/3$, or $F \geq (a–c)^2/(4(1+\theta))$ when $\theta < 1/3$) is positively related to profitability, a–c, and is inversely related to the substitutability of the products, θ.*

Observe that the result in Corollary 2 is quite similar to the case without the regulator shown in Corollary 1 because the rationale behind the two corollaries is essentially the same. The condition of $F \geq 3(5–3\theta)(a–c)/64$ when $\theta \geq 1/3$, or $F \geq (a–c)^2/(4(1+\theta))$ when $\theta < 1/3$

tends to hold when F or θ is large, or $a–c$ is small. If fixed cost, F, is relatively large, a "natural monopoly" is more favorable from a welfare viewpoint as is often the case with utility industries because the economy saves additional fixed costs. On the other hand, if product substitutability, θ, is large, or profitability, $a–c$, is small, the entrant would earn little revenue after entry. Also in this case, monopoly without additional entry costs is more favorable from a welfare perspective. The following remark summarizes the eventual results from Corollaries 1 and 2, yielding practical implications.

Remark 1. *There arises the possibility that the adoption of the direct costing system leads to a monopoly in the market by the incumbent firm when the fixed costs associated with the industry have a relatively high value, assuming circumstances where (1) products are more differentiated or (2) profitability of the market is high. In addition, such a possibility also arises when the fixed costs take a relatively low value in the cases where (1) products are less differentiated or (2) profitability is low.*

To associate the main result of comparative statics in Remark 1 with management accounting practice, recall that previous accounting studies argue that the strategic factors surrounding the firm should drive cost system design (e.g., Johnson and Kaplan, 1987; Shank and Govindarajan, 1993; Chenhall and Langfield-Smith, 1998). For example, Shank and Govindarajan (1993) argue that a desirable cost management system depends crucially on which of the two archaic strategies identified by Porter (1985) the firm pursues: efficient large-scale production or product differentiation. Chenhall and Langfield-Smith (1998) empirically show that high-performing firms that place a strong emphasis on product differentiation gain larger benefits from management accounting practices such as balanced performance measures. Remark 1 suggests that the choice of a desirable cost system depends on exogenous circumstances, including fixed costs, the profitability of the market, and product differentiation, consistent with the empirical managerial accounting literature. In this sense, our analytical model supports empirical findings provided by existing accounting

strategy studies from a theoretical perspective.

7. Conclusion and discussion

This paper investigates the cost-based transfer pricing method choice between direct costing and absorption costing for duopolistic firms in interfirm rivalry. The existing work has concluded that the dominant strategy involves a fixed cost allocation to the transfer price, regardless of whether the price is publicly observable (Alles and Datar, 1998; Shor and Chen, 2009; Matsui, 2011) or unobservable (Göx, 2000; Narayanan and Smith, 2000; Göx and Schöndube, 2004; Göx and Schiller, 2007). Unlike this conventional outcome, our analysis demonstrates that no fixed cost allocation to the subordinate division through the direct costing strategy can dominate the absorption costing if one of the two firms is the incumbent and the other is an entrant; namely, the familiar result arising from the earlier series of transfer pricing models reverses when we consider entry threats. More specifically, we show that if the incumbent credibly commits to an observable transfer price, a potential entrant does not enter the market, and the incumbent can thus monopolize the market through the direct costing system in the SPNE.

Finally, while we have concentrated on competition through price throughout the present paper, it would be interesting to examine the potential impact of a change in the nature of competition from prices to quantities on the equilibrium outcomes of the entry game. Recall that the earlier literature has shown that if the transfer price is observable, the transfer price is below the marginal cost. That is, subsidization to the downstream division constitutes the Nash equilibrium when the strategic variable is quantity (e.g., Fershtman and Judd, 1987). However, this equilibrium is not mutually desirable, as the payoffs for both firms can improve if they both change to marginal cost transfer pricing. In this sense, the Nash equilibrium in quantity competition is an example of the so-called "prisoners' dilemma". This insight indicates that if we consider Cournot-type quantity competition, transfer pricing equal to direct cost can no longer work as a barrier to entry. If the potential entrant decides to enter

the market, a transfer price below marginal cost is the dominant strategy for the entrant compared with transfer pricing equal to marginal cost. If the incumbent takes the strategy of transfer pricing at direct cost in this situation, the payoff for the entrant increases and the entrant then has a greater incentive to enter the market than under a transfer price below marginal cost for the incumbent. Hence, the incumbent never commits to direct costing in the entry game as well as in the game with two incumbents, a counter result to the model under price competition.

Overall, an equilibrium transfer price below marginal cost is unrealistic, especially given that a number of studies by Tang (1992, 1993, 2002) find that it is seldom used in actual business practice. Indeed, given the transfer pricing practice, most previous game theory models deal only with price competition that drives up the equilibrium transfer price above marginal cost (e.g., Alles and Datar, 1998; Göx, 2000; Narayanan and Smith, 2000; Göx and Schöndube, 2004; Fjell and Foros, 2008; Dürr and Göx, 2011; Matsui, 2011). In this respect, price competition is more appropriate than quantity competition to describe strategic transfer pricing.

Appendix

Calculation of payoffs in Table 3.

We calculate payoffs by the combination of strategies undertaken by the two firms. The first letter in parentheses below represents the strategy chosen by Firm 1 while the second letter indicates the strategy chosen by Firm 2.

Case (1): strategy (D, D)

Because no overhead indirect costs are imposed on the marketing division under direct costing, the profit for the division in Firm i (i = 1, 2) at Date 2 is as follows:

$$\begin{aligned}\pi_i &= (p_i - c)q_i - F_D \\ &= (p_i - c)\left((1-\theta)a - p_i + \theta p_j\right)/\left((1-\theta)(1+\theta)\right) - F_D\end{aligned}. \tag{A1}$$

Jointly solving the first-order conditions for Firms 1 and 2 ($\partial\pi_1/\partial p_1 = 0$ and $\partial\pi_2/\partial p_2 = 0$) gives the following equilibrium price:

$$p_i = \left((1-\theta)a + c\right)/(2-\theta). \tag{A2}$$

One may easily confirm that the second-order derivative of the profit of each firm is negative, i.e., $\partial^2\pi_i/\partial p_i^2 < 0$. Substituting Equation (A2) into Equation (5) yields the quantity as:

$$q_i = (a-c)/\left((2-\theta)(1+\theta)\right). \tag{A3}$$

Inserting Equations (A2) and (A3) into Equation (3) yields the total profit for the firms as:

$$\Pi_i = (1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right) - F + V_i = M_i^{(D,D)} - F + V_i.$$

Case (2): strategy (A, D)

Profits for the marketing division in Firm 1 under absorption costing are:

$$\begin{aligned}\pi_1 &= (p_1 - c - r)q_1 - F_D \\ &= (p_1 - c - r)\left((1-\theta)a - p_1 + \theta p_2\right)/\left((1-\theta)(1+\theta)\right) - F_D\end{aligned}. \tag{A4}$$

Meanwhile, the divisional profit in Firm 2 adopting direct costing is:

$$\begin{aligned}\pi_2 &= (p_2 - c)q_2 - F_D \\ &= (p_2 - c)\left((1-\theta)a - p_2 + \theta p_1\right)/\left((1-\theta)(1+\theta)\right) - F_D\end{aligned}. \tag{A5}$$

Solving $\partial\pi_1/\partial p_1 = 0$ and $\partial\pi_2/\partial p_2 = 0$ at Date 2 yields the following prices:

$$p_1 = \frac{(2+\theta)((1-\theta)a+c)+2r}{(2-\theta)(2+\theta)},\ p_2 = \frac{(2+\theta)((1-\theta)a+c)+\theta r}{(2-\theta)(2+\theta)}. \quad \text{(A6)}$$

Substituting Equation (A6) into Equation (5) yields the quantity as:

$$q_1 = \frac{(1-\theta)(2+\theta)(a-c)-(2-\theta^2)r}{(2-\theta)(1-\theta)(1+\theta)(2+\theta)},\ q_2 = \frac{(1-\theta)(2+\theta)(a-c)+\theta r}{(2-\theta)(1-\theta)(1+\theta)(2+\theta)}. \quad \text{(A7)}$$

Plugging Equations (A6) and (A7) into Equation (3) gives total profit for the two firms as:

$$\Pi_1 = \frac{((1-\theta)(2+\theta)(a-c)+2r)((1-\theta)(2+\theta)(a-c)-(2-\theta^2)r)}{(2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2} - F + V_1 = M_1^{(A,D)} - F + V_1,$$

$$\Pi_2 = \frac{((1-\theta)(2+\theta)(a-c)+\theta r)^2}{(2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2} - F + V_2 = M_2^{(A,D)} - F + V_2.$$

Case (3): strategy (D, A)

Because this case lies symmetrically opposite to that of Case (2) (A, D) with respect to the firm strategies, equilibrium profits are given by interchanging the profits between Firm 1 and Firm 2 and V_1 and V_2 in Case (2).

Case (4): strategy (A, A)

If both firms adopt the absorption costing system, the profits of the marketing division in each firm at Date 2 are as follows:

$$\begin{aligned}\pi_1 &= (p_1 - c - r)q_1 - F_D \\ &= (p_1 - c - r)((1-\theta)a - p_1 + \theta p_2)/((1-\theta)(1+\theta)) - F_D\end{aligned}, \quad \text{(A8)}$$

$$\begin{aligned}\pi_2 &= (p_2 - c - r)q_2 - F_D \\ &= (p_2 - c - r)((1-\theta)a - p_2 + \theta p_1)/((1-\theta)(1+\theta)) - F_D\end{aligned}. \quad \text{(A9)}$$

Solving $\partial\pi_1/\partial p_1 = 0$ and $\partial\pi_2/\partial p_2 = 0$ yields the following prices:

$$p_1 = p_2 = ((1-\theta)a + c + r)/(2-\theta). \quad \text{(A10)}$$

Substituting Equation (A10) into Equation (5) yields the quantity as:

$$q_1 = q_2 = (a - c - r)/(2-\theta)(1+\theta). \quad \text{(A11)}$$

Plugging Equations (A10) and (A11) into Equation (3) gives the total profits for the two firms as:

$$\begin{aligned}\Pi_i &= (a-c-r)((1-\theta)(a-c)+r)/((2-\theta)^2(1+\theta)) - F + V_i \\ &= M_i^{(A,A)} - F + V_i\end{aligned}. \quad \square$$

Proof of Proposition 1.

Initially, suppose that Firm 2 takes strategy D. Then, Table 3 suggests that the profit for Firm 1 when it takes strategy D is:

$$\Pi_1^{(D,D)} = (1-\theta)(a-c)^2 / \left((2-\theta)^2(1+\theta)\right) - F + V_1,$$

while its profit under strategy A is:

$$\Pi_1^{(A,D)} = \frac{\left((1-\theta)(2+\theta)(a-c)+2r\right)\left((1-\theta)(2+\theta)(a-c)-\left(2-\theta^2\right)r\right)}{(2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2} - F + V_1.$$

The difference between the profits is calculated as:

$$\Pi_1^{(A,D)} - \Pi_1^{(D,D)} = r\left(\theta^2(1-\theta)(2+\theta)(a-c) - 2\left(2-\theta^2\right)r\right) / \left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right). \quad \text{(A12)}$$

Equation (A12) is positive if $r < \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)$ and negative if $r > \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)$.

Secondly, suppose that Firm 2 takes strategy A. Then, if Firm 1 takes strategy D, its profit is:

$$\Pi_1^{(D,A)} = \left((1-\theta)(2+\theta)(a-c)+\theta r\right)^2 / \left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right) - F + V_1,$$

whereas its profit under strategy A is:

$$\Pi_1^{(A,A)} = (a-c-r)\left((1-\theta)(a-c)+r\right) / \left((2-\theta)^2(1+\theta)\right) - F + V_1.$$

The difference between the profits is:

$$\Pi_1^{(A,A)} - \Pi_1^{(D,A)} = r\left(\theta^2(1-\theta)(2+\theta)(a-c) - \left(4-2\theta^2-\theta^3\right)r\right) / \left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right). \quad \text{(A13)}$$

Equation (A13) is positive if $r < \theta^2(1-\theta)(2+\theta)(a-c)/\left(4-2\theta^2-\theta^3\right)$ and negative if $r > \theta^2(1-\theta)(2+\theta)(a-c)/\left(4-2\theta^2-\theta^3\right)$.

Finally, as shown in Table 3, observe that the payoffs are symmetric for the two firms with respect to their strategies. Hence, if both Equations (A12) and (A13) are positive, strategy A is dominant and strategies (A, A) constitute the subgame perfect dominant strategy equilibrium, as stated in case (i). In contrast, if both Equations (A12) and (A13) are negative, strategy D is dominant and strategies (D, D) constitute the subgame perfect dominant strategy equilibrium, as in case (ii). □

Calculation of payoffs in Table 4.

Notice that if and only if Firm 2 enters the market, the game is similar to that of the model in Subsection 4.1; namely, the event at Date 2 is the same as shown in Figs. 1 and 2. Therefore, the payoffs under strategies (D, D), (A, D), (D, A), and (A, A) are identical to those shown in Table 3. Hence, we concentrate only on the case where Firm 2 does not enter the market (strategy NE) in this calculation. Obviously, the payoffs for Firm 2 are V_2, irrespective of the strategy taken by Firm 1.

Case (1): strategy (D, NE)

If Firm 1 takes strategy D at Date 0, the profit for the marketing division at Date 2 is:

$$\pi_1 = (p_1 - c)q_1 - F_D = (p_1 - c)(a - p_1) - F_D . \tag{A14}$$

Solving $\partial\pi_1/\partial p_1 = 0$ yields $p_1 = (a+c)/2$. Replacing p_1 in Equation (6) with this gives $q_1 = (a–c)/2$. Substituting $p_1 = (a+c)/2$ and $q_1 = (a–c)/2$ into Equation (3) gives the equilibrium total profit of $\Pi_1 = (a-c)^2/4 - F + V_1 = M_1^{(D,NE)} - F + V_1$.

Case (2): strategy (A, NE)

If Firm 1 takes strategy A at Date 0, the marketing divisional profit at Date 2 is:

$$\pi_1 = (p_1 - c - r)q_1 - F_D = (p_1 - c - r)(a - p_1) - F_D . \tag{A15}$$

Solving $\partial\pi_1/\partial p_1 = 0$ gives $p_1 = (a+c+r)/2$. Replacing p_1 in Equation (6) with $(a+c+r)/2$ gives $q_1 = (a–c–r)/2$. Lastly, putting $p_1 = (a+c+r)/2$ and $q_1 = (a–c–r)/2$ into Equation (3) yields equilibrium profit as: $\Pi_1 = (a-c-r)(a-c+r)/4 - F + V_1 = M_1^{(A,NE)} - F + V_1$. □

Proof of Proposition 2.

First, suppose that Firm 1 selects strategy D at Date 0. Remember that if Firm 1 chooses strategy D, strategy A dominates strategy D for Firm 2 in the benchmark model according to Proposition 1. When Firm 2 selects strategy A at Date 1 and enters the market, Table 4 suggests that its profit is as follows:

$$\Pi_2^{(D,A)} = M_2^{(D,A)} - F + V_2 . \tag{A16}$$

If Equation (A16) is less than V_2, i.e., $F > M_2^{(D,A)}$, Firm 2 will not enter the market in equilibrium because of the loss from the product under duopoly. Conversely, if $F < M_2^{(D,A)}$,

then Firm 2 enters the market irrespective of the strategy chosen by Firm 1. Hence, strategy A remains the dominant strategy for the incumbent, and strategies (A, A) constitute the SPNE as shown in case (iii).

Second, suppose that Firm 1 selects strategy A at Date 0. Proposition 1 suggests that strategy A also dominates strategy D for Firm 2 in the benchmark model if Firm 1 selects strategy A. If Firm 2 selects strategy A at Date 1 and enters the market, its profit is as follows:

$$\Pi_2^{(A,A)} = M_2^{(A,A)} - F + V_2 . \tag{A17}$$

Note that Firm 2 will enter the market in this case as long as Equation (A17) is greater than V_2; that is, $F < M_2^{(A,A)}$. Conversely, if $F > M_2^{(A,A)}$, then Firm 2 does not enter the market irrespective of whether Firm 1 selects strategy D or A. In this case, Firm 1 chooses strategy D to alleviate double marginalization, and strategies (D, NE) constitute the SPNE, which is case (ii). Consequently, if $M_2^{(D,A)} < F < M_2^{(A,A)}$ holds, Firm 2 enters the market if Firm 1 selects strategy A, but it does not enter if Firm 1 selects strategy D.

Next, we prove that the monopoly profits achieved by Firm 1 through strategy D ($\Pi_1^{(D,NE)} = M_1^{(D,NE)} - F + V_1$) are greater than the duopoly profits ($\Pi_1^{(A,A)} = M_1^{(A,A)} - F + V_1$) achieved through strategy A. Let $\Delta\Pi$ denote $\Pi_1^{(D,NE)} - \Pi_1^{(A,A)}$. Note first that $\Delta\Pi$ is convex with respect to r because of the following inequality:

$$\frac{\partial^2 \Delta\Pi}{\partial r^2} = 2/\left((2-\theta)^2(1+\theta)\right) > 0 .$$

Solving $\partial\Delta\Pi/\partial r = 0$ gives $r = \theta(a-c)/2$, suggesting that $\Delta\Pi$ takes the minimum value when $r = \theta(a-c)/2$ if r changes. We reevaluate $\Delta\Pi$ at $r = \theta(a-c)/2$ as:

$$\Delta\Pi\big|_{r=\theta(a-c)/2} = \theta(a-c)^2/\left(4(1+\theta)\right) > 0 . \tag{A18}$$

which suggests that $\Delta\Pi > 0$ always holds, meaning that (D, NE) is the unique SPNE as in case (i) if $M_2^{(D,A)} < F < M_2^{(A,A)}$ holds.

Lastly, notice that the following inequality is met:

$$M_2^{(A,A)} - M_2^{(D,A)} > M_2^{(D,A)} - M_2^{(D,D)} > 0. \tag{A19}$$

Inequality (A19) ensures the existence of the domain of F satisfying the inequality $M_2^{(D,A)} < F < M_2^{(A,A)}$. □

Proof of Proposition 3.

First, we formulate surplus functions because the model in this section considers welfare maximization by a regulator. Singh and Vives (1984) show that the following utility function of a representative consumer yields the inverse demand function represented by Equation (4).

$$U(q_1, q_2) = a(q_1 + q_2) - (q_1^2 + q_2^2 + 2\theta q_1 q_2)/2 \tag{A20}$$

Given this utility, consumer surplus, *CS*, is stated as:

$$CS = U(q_1, q_2) - (p_1 q_1 + p_2 q_2) = a(q_1 + q_2) - (q_1{}^2 + q_2{}^2 + 2\theta q_1 q_2)/2 - (p_1 q_1 + p_2 q_2). \tag{A21}$$

We can confirm that maximization of this equation with respect to q_1 and q_2 (i.e., $\partial CS/\partial q_1 = 0$ and $\partial CS/\partial q_2 = 0$) yields the inverse demand function represented by Equation (4). Using the profit of Firm *i* described by Equation (3), we state the total social surplus under duopoly as:

$$\begin{aligned} SS &= CS + \Pi_1 + \Pi_2 = U(q_1, q_2) - (p_1 q_1 + p_2 q_2) + \Pi_1 + \Pi_2 \\ &= (a - c)(q_1 + q_2) - (q_1^2 + q_2^2 + 2\theta q_1 q_2)/2 - 2F + V_1 + V_2 \end{aligned}. \tag{A22}$$

Likewise, social surplus under monopoly is:

$$SS = CS + \Pi_1 + \Pi_2 = U(q_1, 0) - p_1 q_1 + \Pi_1 + \Pi_2 = (a - c)q_1 - q_1^2/2 - F + V_1 + V_2. \tag{A23}$$

From Case (4) in the calculation of Table 3 in this Appendix, the quantities supplied by the two firms are: $q_1 = q_2 = (a - c - r)/((2 - \theta)(1 + \theta))$. Substituting these quantities into Equation (A22) derives social welfare as:

$$SS = (a - c - r)((3 - 2\theta)(a - c) + r)/((2 - \theta)^2(1 + \theta)) - 2F + V_1 + V_2.$$

One may confirm that *SS* is maximized at $r = 0$ if r varies because r is nonnegative. Consequently, the regulator approves only direct costing ($r = 0$), regardless of the r that the firms proposed at Date 1. □

Proof of Proposition 4.

Case (2) in the calculation of Table 4 in this Appendix suggests that the quantities supplied by the firms under monopoly are: $(q_1, q_2) = ((a–c–r)/2, 0)$. Substituting these values into Equation (A23), we obtain social welfare under monopoly, denoted by SS^M, as:

$$SS^M = (a-c-r)(3a-3c+r)/8 - F + V_1 + V_2 . \quad \text{(A24)}$$

Given that r is nonnegative, SS^M is maximized at $r = 0$ as:

$$SS^M\big|_{r=0} = 3(a-c)^2/8 - F + V_1 + V_2 . \quad \text{(A25)}$$

Meanwhile, if the entrant enters the market, Case (4) in calculation of Table 3 shows that quantities supplied by the two firms are: $q_1 = q_2 = (a-c-r)/((2-\theta)(1+\theta))$. Substitution of these quantities into Equation (A22) gives social welfare under duopoly, denoted by SS^D, as:

$$SS^D = (a-c-r)((a-c)(3-2\theta)+r)/\left((2-\theta)^2(1+\theta)\right) - 2F + V_1 + V_2 . \quad \text{(A26)}$$

If r can vary in the real number region, SS^D is maximized at $r = -(a-c)(1-\theta)$, which is negative.

The profit for the entrant when entering the market is stated as:

$$\Pi_2 = (a-c-r)((1-\theta)(a-c)+r)/\left((2-\theta)^2(1+\theta)\right) - F + V_2 . \quad \text{(A27)}$$

The condition that the entrant enters the market is derived by solving Equation (A27) such that Π_2 is greater than V_2. One may confirm that if $F \geq (a-c)^2/(4(1+\theta))$, $\Pi_2 > V_2$ never holds irrespective of exogenous parameters, leading to monopoly by the incumbent. Conversely, if $F < (a-c)^2/(4(1+\theta))$, solving $\Pi_2 > V_2$ for r yields $\underline{r} < r < \overline{r}$, where $\underline{r} \equiv \left((a-c)\theta - (2-\theta)\sqrt{(a-c)^2 - 4(1+\theta)F}\right)/2$ and $\overline{r} \equiv \left((a-c)\theta + (2-\theta)\sqrt{(a-c)^2 - 4(1+\theta)F}\right)/2$. In this case, the potential entrant enters the market if $0 < \underline{r} < r < \overline{r}$, while the entrant does not enter the market if $0 \leq r \leq \underline{r}$ or $\overline{r} \leq r$. Therefore, SS^D is maximized at $r = \underline{r}$ as:

$$SS^D\big|_{r=\underline{r}} = \left((a-c)^2 + (a-c)\sqrt{(a-c)^2 - 4(1+\theta)F}\right)/(2(1+\theta)) - F + V_1 + V_2 . \quad \text{(A28)}$$

If $SS^M\big|_{r=0}$ is greater than $SS^D\big|_{r=\underline{r}}$, monopoly can attain greater social welfare than duopoly as illustrated in Fig. 5. Rearranging $SS^M\big|_{r=0} > SS^D\big|_{r=\underline{r}}$ yields $F > 3(5-3\theta)(a-c)^2/64$ and $\theta \geq 1/3$. When $\theta < 1/3$, one may confirm that $SS^M\big|_{r=0} > SS^D\big|_{r=\underline{r}}$ is never satisfied irrespective of r. In this case, if $F > (a-c)^2/(4(1+\theta))$, the regulator maximizes SS^M by setting r

= 0 because the entrant does not enter the market. If $\bar{r} \le 0$, rearranging this inequality gives $F \le (1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right)$. In this case, SS^D is maximized at $r = 0$ as $SS^D|_{r=0} = (3-2\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right) - 2F + V_1 + V_2$, which is always greater than $SS^M|_{r=0}$. Hence, the regulator sets $r = 0$ if $F \le (1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right)$.

To summarize the above results, if $F > 3(5-3\theta)(a-c)^2/64$ and $\theta \ge 1/3$, or $F \ge (a-c)^2/(4(1+\theta))$ and $\theta < 1/3$, the regulator approves zero overhead allocation, allowing the incumbent to install the direct costing system as shown in case (i). Secondly, the regulator approves only the absorption costing at $r = \bar{r}$ in the SPNE if $(1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right) < F < 3(5-3\theta)(a-c)^2/64$ and $\theta \ge 1/3$, or $(1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right) < F < (a-c)^2/(4(1+\theta))$ and $\theta < 1/3$, which is case (ii). Lastly, if $F \le (1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right)$, the regulator approves only the direct costing that leads to duopoly, which is case (iii). □

Proof of Corollary 1.

The first-order derivative of the upper limit of F, $M_2^{(A,A)}$, on θ is:

$$\frac{\partial M_2^{(A,A)}}{\partial \theta} = -\frac{(a-c-r)\left(2\left(1-\theta+\theta^2\right)(a-c)-3\theta r\right)}{(2-\theta)^3(1+\theta)^2}. \tag{A29}$$

Observe that Equation (A29) is concave with respect to r and thus takes the unique extremal value at $r = \left(2+\theta+2\theta^2\right)(a-c)/(6\theta)$ if r varies. Because $r < \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right) < \left(2+\theta+2\theta^2\right)(a-c)/(6\theta)$ is met, Equation (A29) is maximized at $r = \theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)$. Moreover, because $\frac{\partial M_2^{(A,A)}}{\partial \theta}\Big|_{r=\theta^2(1-\theta)(2+\theta)(a-c)/\left(2\left(2-\theta^2\right)\right)} < 0$ holds, $\frac{\partial M_2^{(A,A)}}{\partial \theta}$ is negative irrespective of r, proving that $M_2^{(A,A)}$ decreases according to θ. Next, we calculate the first-order derivative of the lower limit of $M_2^{(D,A)}$ on θ, which yields a complex concave function with respect to r. Because of the concavity of $\partial M_2^{(D,A)}/\partial\theta$ on r, this first-order derivative takes the maximum value when $r = (1-\theta)^2(2+\theta)\left(8+6\theta+3\theta^2+2\theta^3\right)(a-c)/\left(8\left(8-7\theta^2+2\theta^4\right)\right)$ if r varies. Reevaluation of the derivative at this value yields a negative value, suggesting that $M_2^{(D,A)}$ also decreases

according to θ. Moreover, we may easily confirm that both the upper limit ($M_2^{(A,\ A)}$) and the lower limit ($M_2^{(D,\ A)}$) of F increase with a–c. □

Proof of Corollary 2.

Both the lower limits of F when $\theta \geq 1/3$ (i.e., $3(5-3\theta)(a-c)^2/64$) and when $\theta < 1/3$ (i.e., $(a–c)^2/(4(1+\theta))$) obviously decrease with θ and increase with a–c. □

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Table 1

Notations.

p	retail price
q	quantity
F_U	fixed manufacturing cost incurred by the upstream division
F_D	fixed retailing cost incurred by the downstream division
F	$F_U + F_D$
r	overhead allocation to the marketing division
c	direct manufacturing cost per unit
a	positive constant greater than c
θ	substitutability of products supplied by the two firms ($0 < \theta < 1$)
	($1–\theta$ is the degree of product differentiation.)
i	subscript that indexes the firm
j	subscript that indexes the firm that is different from firm i
Π	total profit for a firm
M	total revenue for a firm from the product considered
π	profit for the downstream marketing division in a firm
V	profit for a firm from another product
$\Delta\Pi$	difference in profit for Firm 1 for strategies (D, NE) and (A, A) ($\Pi_1^{(D,NE)} - \Pi_1^{(A,A)}$)
CS	consumer surplus
SS	social surplus
S	strategy
D	strategy of the adoption of the direct costing system
A	strategy of the adoption of the absorption costing system
NE	strategy of not entering the market

Table 2

Revenue values.

$M_1^{(D,D)}$	$(1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right)$
$M_2^{(D,D)}$	$(1-\theta)(a-c)^2/\left((2-\theta)^2(1+\theta)\right)$
$M_1^{(A,D)}$	$\left((1-\theta)(2+\theta)(a-c)+2r\right)\left((1-\theta)(2+\theta)(a-c)-(2-\theta^2)r\right)/\left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right)$
$M_2^{(A,D)}$	$\left((1-\theta)(2+\theta)(a-c)+\theta r\right)^2/\left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right)$
$M_1^{(D,A)}$	$\left((1-\theta)(2+\theta)(a-c)+\theta r\right)^2/\left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right)$
$M_2^{(D,A)}$	$\left((1-\theta)(2+\theta)(a-c)+2r\right)\left((1-\theta)(2+\theta)(a-c)-(2-\theta^2)r\right)/\left((2-\theta)^2(1-\theta)(1+\theta)(2+\theta)^2\right)$
$M_1^{(A,A)}$	$(a-c-r)\left((1-\theta)(a-c)+r\right)/\left((2-\theta)^2(1+\theta)\right)$
$M_2^{(A,A)}$	$(a-c-r)\left((1-\theta)(a-c)+r\right)/\left((2-\theta)^2(1+\theta)\right)$
$M_1^{(D,NE)}$	$(a-c)^2/4$
$M_1^{(A,NE)}$	$(a-c-r)(a-c+r)/4$

Note: All values derived in the calculation of the payoffs for Tables 3 and 4 are shown in the Appendix.

Table 3

Payoff matrix of the game with two incumbents.

		Firm 2	
	Accounting strategy	Direct costing	Absorption costing
Firm 1	Direct costing	$\begin{pmatrix} M_1^{(D,D)} - F + V_1 \\ M_2^{(D,D)} - F + V_2 \end{pmatrix}$	$\begin{pmatrix} M_1^{(D,A)} - F + V_1 \\ M_2^{(D,A)} - F + V_2 \end{pmatrix}$
	Absorption costing	$\begin{pmatrix} M_1^{(A,D)} - F + V_1 \\ M_2^{(A,D)} - F + V_2 \end{pmatrix}$	$\begin{pmatrix} M_1^{(A,A)} - F + V_1 \\ M_2^{(A,A)} - F + V_2 \end{pmatrix}$

Note: The first and second rows in parentheses represent the total profit for Firms 1 and 2, respectively. See Table 2 for the revenue values denoted by *M*.

Table 4

Payoff matrix of the game with one incumbent and one entrant.

		Firm 2		
	Accounting strategy	Direct costing	Absorption costing	No Entry
Firm 1	Direct costing	$\begin{pmatrix} M_1^{(D,D)} - F + V_1 \\ M_2^{(D,D)} - F + V_2 \end{pmatrix}$	$\begin{pmatrix} M_1^{(D,A)} - F + V_1 \\ M_2^{(D,A)} - F + V_2 \end{pmatrix}$	$\begin{pmatrix} M_1^{(D,NE)} - F + V_1 \\ V_2 \end{pmatrix}$
	Absorption costing	$\begin{pmatrix} M_1^{(A,D)} - F + V_1 \\ M_2^{(A,D)} - F + V_2 \end{pmatrix}$	$\begin{pmatrix} M_1^{(A,A)} - F + V_1 \\ M_2^{(A,A)} - F + V_2 \end{pmatrix}$	$\begin{pmatrix} M_1^{(A,NE)} - F + V_1 \\ V_2 \end{pmatrix}$

Note: The first and second rows in parentheses represent the total profit for Firms 1 and 2, respectively. See Table 2 for the revenue values denoted by *M*.

Fig. 1. Timeline of events in the game with two incumbents.

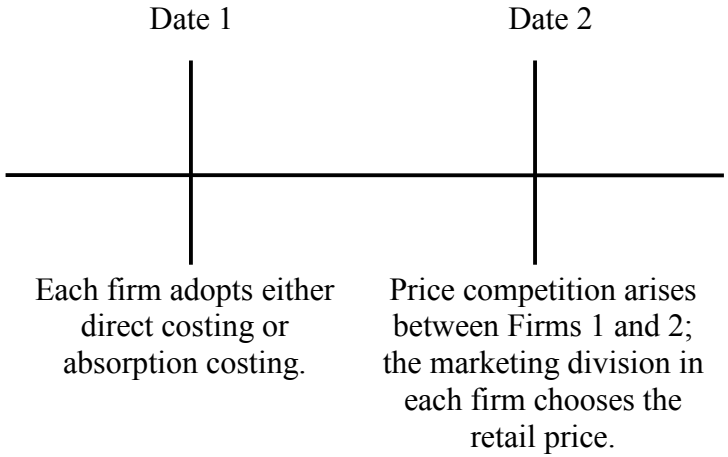

Fig. 2. Timeline of events in the game with one incumbent and one entrant.

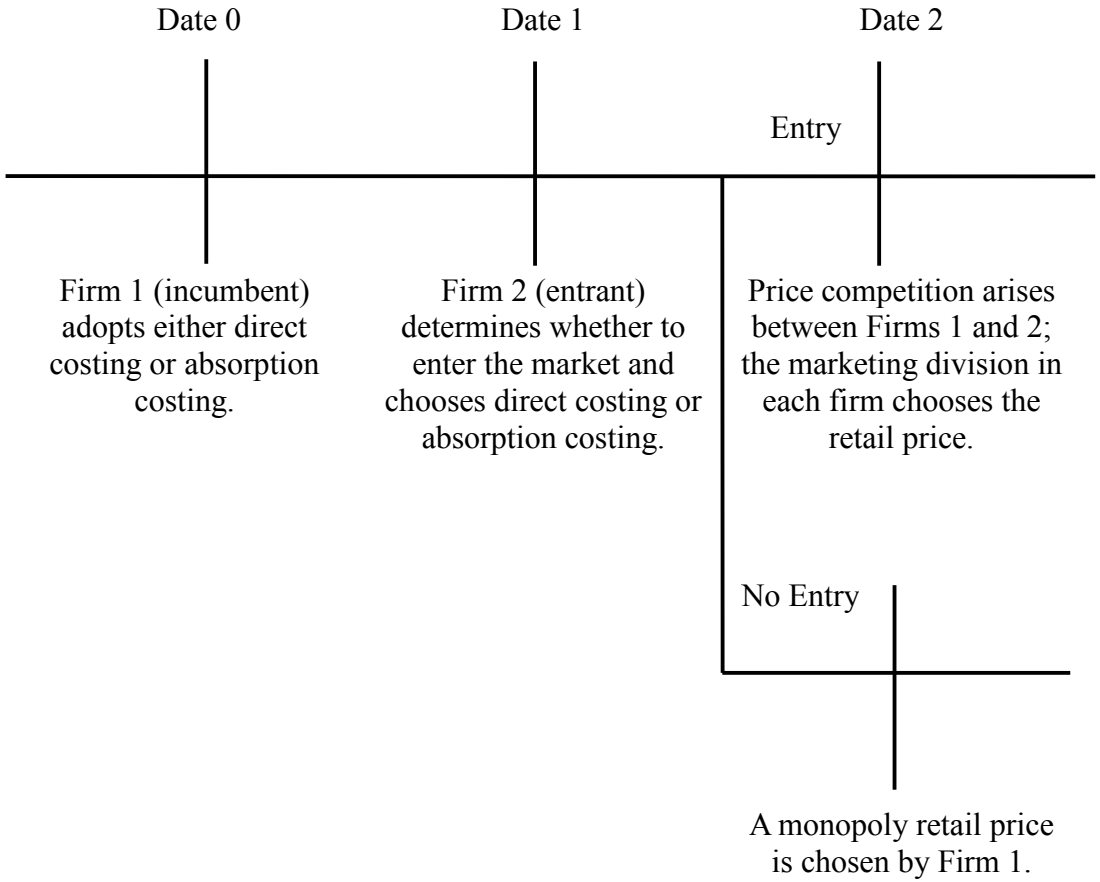

Fig. 3. Timeline of events in the game with two incumbents and the regulator.

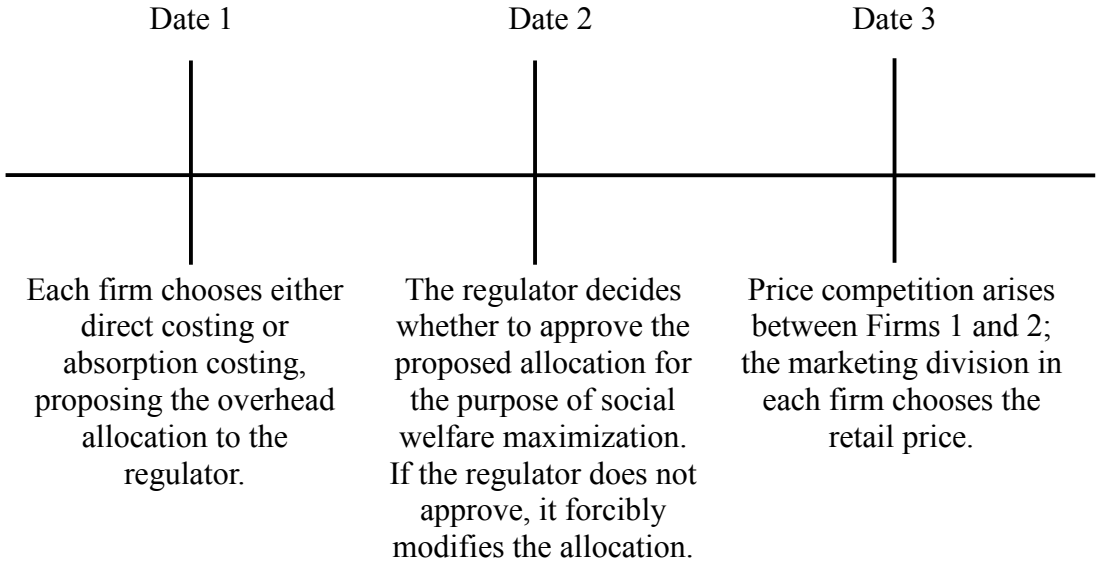

Fig. 4. Timeline of events in the game with one incumbent, one entrant, and the regulator.

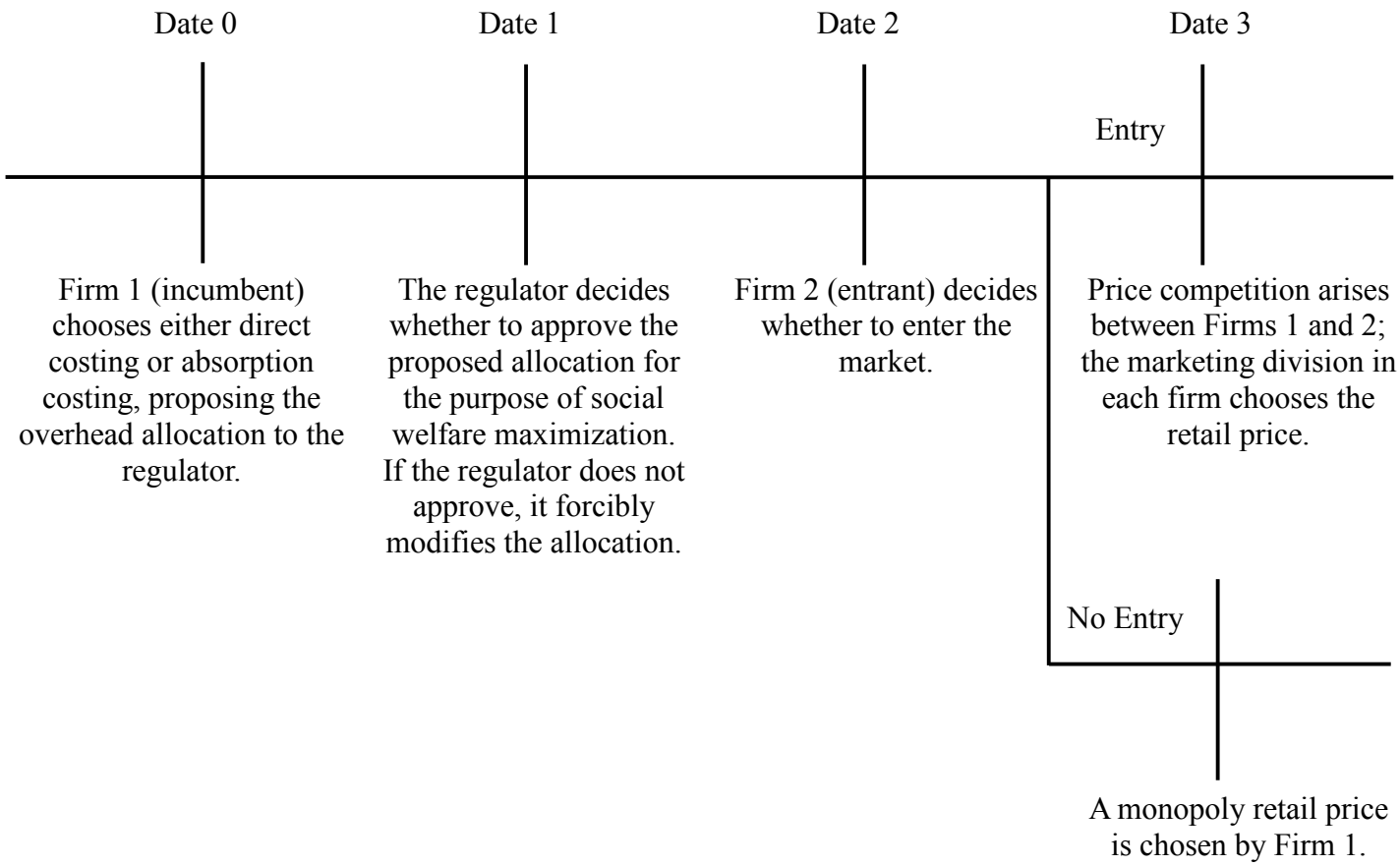
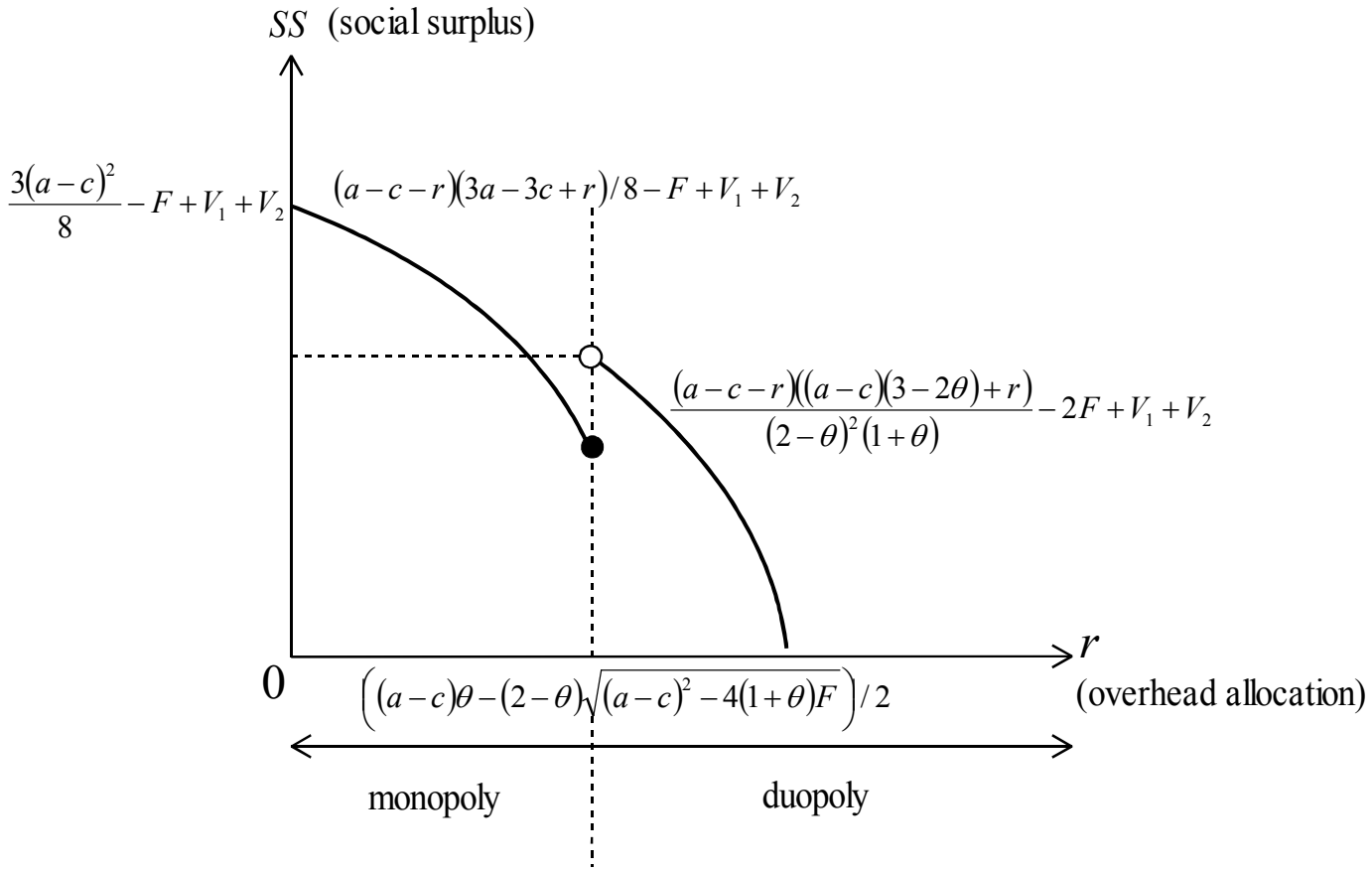
Fig. 5. Social welfare when overhead allocation varies.