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Abstract: This study demonstrates that, in two periods, the total profit of a firm in product market competition decreases with a leading indicator that emphasizes consumers. While previous studies in the management accounting literature have suggested that leading indicators are useful for predicting firms' future profits, few studies have theoretically investigated this topic. Therefore, we explore the usefulness of leading indicators to improve firms' long-term profit using a game theoretical approach. Consistent with empirical evidences, our model analysis demonstrates that a leading indicator improves firms' profits in the second period, while it harms first-period profit and total profit due to excessive supply in a specific economic environment.

Keywords: performance evaluation; delegation game; leading indicator; non-financial indicator; duopoly competition

1. Introduction

The choice of performance indicators is an important problem when designing performance evaluation systems in companies. In management accounting, the performance evaluations of internal employees are important, and furthermore, the managers of the company are recognized in the proxy statement. Recently, stakeholders can easily access information about performance evaluation systems of a company's managers via the disclosure of the integrated report. This report does not reveal the performance indicators or their weights but discloses information about goal achievement and managerial compensation. For example, Coca Cola Ltd. uses short-term performance indicators (net operating revenue and operating income) and long-term incentive plans (net operating revenue, earnings per share, free cash flow, and total shareowner return modifier) to evaluate managers.[1]

From the example of Coca Cola Ltd., it is evident that company owners attempt to control managers' behavior by using performance indicators in practice. Decisions about performance indicators and the weights placed on them are important as these decisions affect the behavior of managers through compensation contracts. For example, when a manager is evaluated only in periods of corporate social responsibility (CSR) activities, the manager will not focus on the firm's profit and perform in such a way as to enhance CSR via social activities. Additionally, when managers are evaluated only by financial performance, they will not focus on customers and instead pursue short-term profits.

In management accounting, considering the balance between short-term and long-term decisions, it is important to manage the firm-wide performance. A Balanced Score

[1] We obtained this information from Coca Cola's Proxy Statement for 2019, p. 11 (Last accessed, November 5, 2021) https://www.sec.gov/Archives/edgar/data/21344/000120677419000735/ko_courtesy-pdf.pdf

Card (BSC) with multi-level performance indicators is a typical way that companies incorporate short-term and long-term decisions into company strategy. Additionally, manager performance evaluations based on multi-indicators (except for BSCs) are used in many companies to maintain a balance between short-term and long-term decisions, as an example of a proxy statement. When a company improves the stability of long-term profits, the value and reputation of the company will also improve in the long-term, which promotes company sustainability.

Thus, leading indicators are frequently adopted as long-term performance indicators in practice. For example, customer satisfaction or complaints affect the retention rates of products or services and are important for improving companies' future financial performance. Empirical management accounting research has emphasized on the importance of these non-financial, consumer-oriented performance indicators. For example, Ittner and Larcker (1998) finds that customer satisfaction does not only predict future profits at the business-unit level, but it also leads to the future performance at the firm level. Banker et al. (2000) demonstrates similar evidence in hospitality firms by analyzing archival time-series data. In Banker et al. (2000), customer complaints provide meaningful information about a company's future profits. This empirical evidence suggests that non-financial customer-oriented indicators can predict firms' future profits.

Ittner and Larcker's (1998) findings have important implications about the choice of managers' performance indicators. If performance indicators related to customers or consumers can predict future profits at the firm level, establishing customer-oriented performance indicators for managers can lead firms' future profits and help managers avoid myopic behavior. Therefore, indicators related to customers are effective for controlling the behavior of firm managers by encouraging them to take a longer-term approach.

In prior management accounting research, Ittner and Larcker (1998) and Banker et al. (2000) empirically indicate improvements in future short-term profits by considering indicators related to customers. Therefore, prior literature has found that indicators related to customers lead firms' short-term future profits rather than long-term total profits. Certainly, one may infer that improvements in a firm's profits enhances future firm value and the firm can then return this profit to shareholders. However, when a shareholder elects to hold onto stocks, they are interested in the firm's long-term total profit. A shareholder would prefer that a firm maintains stable profits to maximize the total profit in holding stocks, and therefore, this study focuses on firms' total profit in the long-term and analyzes the usefulness of the leading indicator. Based on the above discussion, this study considers the following research question (RQ):

RQ: Does a non-financial leading indicator related to a customer theoretically improve the total profit of a firm with product market competition?

This study considers the RQ using a game theoretical approach, which assumes product market competition. In this case, one can infer that contract theory provides useful insights to study performance evaluation, as it considers internal control by assuming a principal-agent problem. Dutta and Reichelstein (2003) employes contract theory to analyze the effectiveness of non-financial indicators as leading indicators, assuming a two-term contract. However, many firms face product market competition in practice, and this factor tends to be overlooked in the management accounting research. For example, assuming a BSC approach, when a firm incorporates multi-indicator performance evaluation into its strategy, a game theoretical approach that assumes product market competition is compatible, as strategies are affected by competitor

decisions in a product market. To reinforce this fact, prior studies have analyzed managers' performance evaluations, assuming product market competition. For example, Vickers (1985) and Fershtman and Judd (1987) used a delegation game in their analyses from a managerial viewpoint. Furthermore, some studies examined managers' optimal performance indicators under product market competition (e.g., Hino and Zennyo 2017; Hirose et al. 2020; Matsumura and Ogawa 2014; Miller and Pazgal 2005; Ritz 2008). Additionally, based on a delegation game, several studies have analyzed relative performance evaluation, which is a significant performance evaluation topic in management accounting studies (e.g., Aggarwal and Samwick 1999; Fumas 1992; Hamamura 2021, 2022, 2024; Hamamura and Ramani 2023; Jansen et al. 2009; Miller and Pazgal 2001, 2002). The above studies have explored the optimal performance evaluation system to include competitor profit in managers' objective functions. The improvement of competitor profit directly affects managerial performance in these studies. However, this study assumes a customer indicator as the performance indicator, which is different from their approach.

In accounting studies, Hamamura (2019) considers competitor's profit as an additional performance indicator. When a positive weight is placed on a competitor's profit, it is related to firms tacitly cooperating to enhance the product market by considering overall industry profits. Hamamura (2019) interprets a case in which a manager is evaluated using a BSC and can affect the future profits of an industry and their own firm by considering industry profits. It is obvious that enhancing industry profits will have a positive effect on the future profit of the industry and on one's own firm. Increased industry profits lead to increased market size, and firms can obtain higher profits in a larger market. Hence, Hamamura (2019) explores the long-term behavior of managers.

Moreover, several studies have analyzed objective functions, including consumer surplus; these studies are different from the relative performance evaluation research. Arya et al. (2019) conducts pioneering research in accounting, exploring disclosure decisions in cases where managers emphasized consumer surplus. Considering consumer surplus means emphasizing performance indicators related to the customer. Therefore, this study examines manager contracts with owners who use consumer surplus as a leading indicator and compares those cases to non-leading indicator cases, assuming the same performance indicators as in Arya et al. (2019).[2] When the profit in the consumer surplus case is less than the profit in another case, the adoption of a leading indicator does not improve the total profit of a firm in this model.

We assess the usefulness of including consumer surplus in the objective functions, assuming quantity competition and a two-period game. Consequently, in equilibrium, the main model demonstrates that each firm includes consumer surplus in the objective functions as a leading indicator in a specific economic environment. However, this equilibrium is not Pareto efficient in the specific economic condition. As the adoption of a leading indicator enhances demand-enhancing investment in the first period and remains in effect in the second period, the profit in the second period will improve. However, the profit in the first period will decline because the manager has an incentive to exceed supply and investment by emphasizing consumer surplus in a specific economic environment. As the balance of these trade-off effects is altered by exogenous variables, the total profits of firms in two periods decline in a specific economic environment.

A crucial factor in this outcome is excessive supply, which arises from product market competition because firms attempt to obtain large market shares by a credible

[2] This objective function, which is considered by Arya et al. (2019), has been analyzed in the economic research as a delegation game (e.g., Chen et al. 2016; Hino and Zennyo 2017; Kim et al. 2019).

threat. Certainly, while excessive supply increases the total cost of production and investment, the reduction in price from excessive supply has a serious effect on firm profit in our model. Hence, the adoption of a leading indicator has an impact on product market competition and an owner chooses a performance indicator by considering competition. While managers ordinarily exercise customer-friendly management techniques to improve customer-oriented performance indicators through costly investments, our result is obtained from the impact of excessive supply. This study considers that investments that continue to have demand-enhancing effects in the next period represent long-term benefits from the investment. When the investment does not have an impact on future demand functions, we can demonstrate our important result. Without an investment that continues to have this demand-enhancing effect, the model of this study is the choice of performance indicator, which is not related to long-term benefits. Hence, this study considers investment that continues its demand-enhancing effect in the next period.

This result has some implications for the choice of performance evaluation in management accounting research. Obviously, future profit is improved by a leading indicator, as shown by Ittner and Larcker (1998) and Banker et al. (2000). However, excessive competition may arise if a leading indicator is adopted in the first period. Consequently, the profit in the first period with the leading indicator will decline, and therefore, owners should carefully adopt a leading indicator depending on the economic environment.

2. Basic model

We consider a two-period model. There are two firms, Firms 1 and 2, in a final product market, and they engage in quantity competition. In the first period, both firms decide on

costly investments, which have the effect of enhancing demand (e.g., advertising). The demand function of firm i in the first period is as follows:

$$p_{i1} = a + I_i + \gamma I_j - q_{i1} - q_{j1}, \quad (1)$$

where p_{it} is the market price of firm i in period $t \in \{1, 2\}$, q is quantity, I is demand-enhancing investment, and a is positive constant. Hereafter, we represent $(i, j) = (1,2), (2,1)$. Additionally, $\gamma \in (0,1]$ represents the spillover effect, which is the competitor's demand-enhancing investment. Advertising does not have a perfect spillover effect on the competitor's product. Hence, this study assumes imperfect spillover.

In the second period, investments in the first period remain at the discount rate $r \in (0,1]$, as follows:

$$p_{i2} = a + r\left(I_i + \gamma I_j\right) - q_{i2} - q_{j2}. \quad (2)$$

It is important that the investment effects of the first period remain in the second period because the demand-enhancing effect of advertising remains even after the investment. Hence, we assume the demand-enhancing effect imperfectly remains in the next period. If this study does not assume a remaining effect, decision-making in the second period does not involve a relationship between periods. Without the remaining effect, it does not make sense to analyze the long-term model; this study assumes this effect.

Both firms produce and sell the final product with marginal cost c. This study assumes marginal cost c to be 0 for simplicity. The profit function of firm i in the first period is as follows:

$$\pi_{i1} = p_{i1}q_{i1} - \frac{1}{2}kI_i^2, \quad (3)$$

where $kI_i^2/2$ is the investment cost and $k > 0$ is efficiency of the investment. In the second period, both firms do not invest to enhance demand. Hence, the profit function of firm i in the second period is as follows:

$$\pi_{i2} = p_{i2}q_{i2}. \quad (4)$$

This study assumes that owners delegate decision rights of the quantity in the product market to managers.

While the owners aim to maximize total profit $\Pi_i = \pi_{i1} + \pi_{i2}$, manager performance is evaluated by owners using other performance indicators. Based on previous delegation game studies, the manager is evaluated by the objective function O_{it}, which is chosen by the owner. This study assumes that the contract between the owner and manager is renewed in every period. Hence, the manager is a short-run player who maximizes objective functions in every period to obtain high compensation. Here, we assume the objective function of firm i's manager in the first period is as follows:

$$O_{i1} = \pi_{i1} + \alpha_i CS_t, \quad (5)$$

where CS_t is the consumer surplus in period t and the weight placed on the consumer surplus, $\alpha \in (0,1]$, is the exogenous variable. This study assumes $CS_t = ((q_{1t})^2 + 2q_{1t}q_{2t} + (q_{2t})^2)/2$ in period t, based on Dixit (1979) and Singh and Vives (1984). Therefore, the owner evaluates the manager considering consumer surplus in the first period. The weight placed on the consumer surplus is an exogenous variable as it is not important to choose the level of α, while it is important whether $\alpha \neq 0$ in this study. Hence, this study assumes the level of α to be an exogenous variable and chosen by $\alpha \neq 0$ or $\alpha = 0$.

Prior literature proposed that when the emphasis is on the consumer or customer, it enhances firms' future profits (e.g., Ittner and Larcker 1998). This study analyzes

whether the profit of the second period and the total profit are improved by emphasizing consumer surplus ($\alpha > 0$) in the first period. In the second period, the owner would want to maximize the profit after adoption of the leading indicator and prior literature considers only financial performance as an independent variable (Banker et al. 2000; Ittner and Larcker 1998), this study assumes that the manager is evaluated only by profit in the second period. Hence, the manager of firm i in the second period is evaluated by the following objective function:

$$O_{i2} = p_{i2}q_{i2}. \tag{6}$$

The timeline of this model is as follows: in the first period, the owners decide whether $\alpha \neq 0$ or $\alpha > 0$ on date 1. Next, on date 2 in the first period, managers decide on the demand-enhancing investment and quantity in a product market. On date 3 in the first period, managers are rewarded by the owner. In the second period, managers decide on the quantity of the product on date 1. On date 2 in the second period, managers are rewarded by the owner. This study assumes all the endogenous variables are observable after the decision. The notations are presented in Table 1.

Here, with exception of the analysis in the monopoly case, this study specifies $\alpha, k, a,$ as $\alpha_1 = \alpha_2 = \alpha$, $k = 1$, and $a = 1$ for simplicity in our main analysis. These specifications do not seriously impact the outcome of this study, and it is difficult to analyze and interpret the outcome without these specifications. Additionally, when $\alpha_1 = \alpha_2 = \alpha$, $k = 1$, $a = 1$, $0 < \alpha < 1/4$, and $0 < \alpha < \gamma$ are satisfied, all outcomes are positive in our model. In this study, we consider our model under the following assumptions.

Table 1. Notations

π	Short-term profit
Π	Total profit for a firm in two periods
O	Objective function of managers
i	Subscript that indexes a player
j	Subscript that indexes a firm other than player i
t	Subscript that indexes period ($t \in \{1,2\}$)
p	Retail price
q	Quantity
I	Demand-enhancing investment
CS	Consumer surplus
α	Weight placed on consumer surplus ($\alpha \in (0,1]$)
k	Efficiency of investment greater than 0
r	Discount rate of investment in the second period ($r \in (0,1]$)
a	Positive constant greater than 0
γ	Spillover effect, which is the competitor's demand-enhancing investment ($\gamma \in (0,1]$)
L	Leading indicator case
NL	No leading indicator case
PI	Performance indicator chosen by the owner ($PI \in \{L, NL\}$)

Parametric Assumption. This study specifies $\alpha, k, a,$ as $\alpha_1 = \alpha_2 = \alpha$, $k = 1$, and $a = 1$. In addition, we assume that $0 < \alpha < 1/4$, and $\alpha < \gamma$ to ensure positive outcomes in our model.

We present the reason for this assumption in the Online Appendix.

The leading indicator in this study may not correspond to that in prior studies because prior empirical studies do not analyze consumer surplus as a leading indicator (e.g., Ittenr and Larcker 1998; Banker et al. 2000). However, we consider the consumer-related indicator (one of the leading indicators) as prior studies considered it, and consumer surplus is a consumer indicator because improving consumer surplus increases the utility for consumers. Prior studies have interpreted a firm that emphasizes consumer

surplus as a customer-friendly firm (e.g., Ying, Li, and Xuemei 2015). Therefore, this study assumes that consumer surplus is an indicator related to customers.

3. Monopoly case

First, before analyzing the basic model, we explore the impact of the leading indicator on total profit in the monopoly case. It is important to analyze the monopoly case, because it is one of the benchmark cases of our model. In this case, we consider the demand function in the first period as follows:

$$p_1 = a + I - q_1. \tag{7}$$

In addition, the demand function of the second period is as follows:

$$p_2 = a + rI - q_2. \tag{8}$$

In this case, consumer surplus that is included varies as $CS = (q_1)^2/2$, because this firm does not have competitors and the quantities of this firm directly impact consumer surplus. In the monopoly case, we consider the endogenous decision of α before the decision of I.

By backward induction, we obtain the following outcomes:

$$\begin{aligned} I^M &= \frac{1}{1-\alpha}, \\ q_1^M &= \frac{1}{1-\alpha}, \\ q_2^M &= \frac{1+r-\alpha}{2(1-\alpha)}, \\ p_1^M &= 1, \\ p_2^M &= \frac{1+r-\alpha}{2(1-\alpha)}, \end{aligned} \tag{9}$$

$$\pi_1^M = \frac{1-2\alpha}{2\,(\alpha-1)^2},$$

$$\pi_2^M = \frac{(1+r-\alpha)^2}{4\,(1-\alpha)^2}.$$

Because when $\alpha < 1/2$ is satisfied, all outcomes are positive, the Parametric Assumption ensures the positive outcome in this case.

In this case, we consider $\Pi^M = \pi_1^M + \pi_2^M$ and analyze $\Pi^M - \Pi^M|_{\alpha=0}$. From the analysis, $\Pi^M > \Pi^M|_{\alpha=0}$ is satisfied under $0 < \alpha < 1/2$ and $-(1-\alpha)/(2-\alpha) + \sqrt{(1+2\alpha-\alpha^2)/(2-\alpha)^2} < r < 1$. This outcome implies that the monopoly firm adopts the leading indicator when the remain effect of the investment is large. We summarize this outcome as a following lemma.

Lemma 1. In the monopoly case, under $0 < \alpha < 1/2$ and $-(1-\alpha)/(2-\alpha) + \sqrt{(1+2\alpha-\alpha^2)/(2-\alpha)^2} < r < 1$ the leading indicator is adopted by the owner.

This section confirms that the positive effect of the leading indicator is important and the usefulness of the long-term behavior coincides with prior management accounting studies (e.g., Banker et al. 2000; Ittner and Larcker 1998). The next section considers the impact of competition on a firm's total profit in two periods with the leading indicator.

4. Leading indicator harms total profit under duopoly competition

In this section, we analyze the basic model that was constructed in Section 2. First, we consider the case in which both firms choose $\alpha = 0$ case as Case 1 and $\alpha > 0$ case as Case 2. After that, we compare the total profit of Case 1 to that of Case 2 and demonstrate

the combinations of payoff in these cases. In addition, endogenously chosen α ($\alpha > 0$ or $\alpha = 0$) is analyzed in the next section.

4.1. Case 1: Each firm is evaluated only by profit

First, by backward induction, we identify the equilibrium strategies and profit as follows.

$$
\begin{aligned}
I_i^{(NL,NL)} &= \frac{1}{2-\gamma}, \\
q_{i1}^{(NL,NL)} &= \frac{1}{2-\gamma}, \\
q_{i2}^{(NL,NL)} &= \frac{2-\gamma+r(1+\gamma)}{3(2-\gamma)}, \\
p_{i1}^{(NL,NL)} &= \frac{1}{2-\gamma}, \\
p_{i2}^{(NL,NL)} &= \frac{2-\gamma+r(1+\gamma)}{3(2-\gamma)}. \\
\pi_{i1}^{(NL,NL)} &= \frac{1}{2(2-\gamma)^2}, \\
\pi_{i2}^{(NL,NL)} &= \frac{\left(2-\gamma+r(1+\gamma)\right)^2}{9(2-\gamma)^2},
\end{aligned}
\tag{10}
$$

where superscript (NL, NL) represent the case in which both firms do not use the leading indicator in the performance evaluation of managers. Hereafter, combinations of the performance indicator, PI, of firm i and j are denoted as (PI_i, PI_j). Representing the case with the leading indicator as $PI = L$ and without the leading indicator as $PI = NL$. Additionally, $\Pi_i^{(NL,NL)}$ is defined as $\Pi_i^{(NL,NL)} = \pi_{i1}^{(NL,NL)} + \pi_{i2}^{(NL,NL)}$. Here, when the Parametric Assumption is satisfied, all outcomes in this section are positive.

4.2. Case 2: Both firms are evaluated by the leading indicator

We solve the model with the $\alpha \in (0,1]$ case. By backward induction, we consider the quantity decision in the second period. Differentiating the objective function of firm i in the second period, we obtain the first order condition as follows:

$$q_{i2}(q_{j2}) = \frac{1 - q_{j2} + r(I_i + \gamma I_j)}{2}. \tag{11}$$

From this outcome, we obtain the optimal strategy of firm i in the second period.

$$q_{i2} = \frac{1 + r\left((2-\gamma)I_i - (1-2\gamma)I_j\right)}{3}. \tag{12}$$

From Eq. (12), when γ satisfies $0 < \gamma < 1/2$, the quantity of firm i decreases as the competitor's investment increases.

Next, firms decide the level of investment and sales quantities in a product market. Hence, considering the quantity and investment decision in the first period and obtaining the best response function of firm i toward the competitor's strategy is as follows.

$$\begin{aligned} &q_{i1}(q_{j1}, I_i, I_j) = \frac{1 - (1-\alpha)q_{j2} + I_i + \gamma I_j}{2 - \alpha}, \\ &I_i(q_{i1}) = q_{i1}. \end{aligned} \tag{13}$$

From this outcome, we obtain

$$q_{i1}^{(L,L)} = \frac{1}{2 - 2\alpha - \gamma},$$

$$q_{i2}^{(L,L)} = \frac{2 - 2\alpha - \gamma + r(1+\gamma)}{3(2 - 2\alpha - \gamma)},$$

$$
\begin{aligned}
I_i^{(L,L)} &= \frac{1}{2-2\alpha-\gamma}, \\
p_{i1}^{(L,L)} &= \frac{1-2\alpha}{2-2\alpha-\gamma}, \\
p_{i2}^{(L,L)} &= \frac{2-2\alpha-\gamma+r(1+\gamma)}{3(2-2\alpha-\gamma)}, \\
\pi_{i1}^{(L,L)} &= \frac{1-4\alpha}{2(2-2\alpha-\gamma)^2}, \\
\pi_{i2}^{(L,L)} &= \frac{\left(2-2\alpha-\gamma+r(1+\gamma)\right)^2}{9(2-2\alpha-\gamma)^2},
\end{aligned}
\tag{14}
$$

where superscript (L,L) represents that both firms adopt the leading indicator. Because when α satisfies $0<\alpha<1/4$, all outcomes of this model are positive, under the Parametric Assumption, we obtain the positive outcomes. Additionally, we define $\Pi_i^{(L,L)} \equiv \pi_{i1}^{(L,L)} + \pi_{i2}^{(L,L)}$.

4.3. Comparing Case 2 with Case 1

Here, we compare the total profits of Cases 1 and 2. First, consider $\pi_{i,2}^{(NL,NL)} - \pi_{i,2}^{(L,L)}$.

$$
\begin{aligned}
&\pi_{i,2}^{(NL,NL)} - \pi_{i,2}^{(L,L)} \\
&= -\frac{4r\alpha(1+\gamma)\big(r(1+\gamma)(2-\alpha-\gamma)+(2-\gamma)(2-2\alpha-\gamma)\big)}{9(2-\gamma)^2(2-2\alpha-\gamma)^2} < 0.
\end{aligned}
\tag{15}
$$

From Eq. (15), $\pi_{i,2}^{(NL,NL)} < \pi_{i,2}^{(L,L)}$ is obtained. Therefore, the leading indicator improves the future profit of firms in our model and we obtain the following lemma:

Lemma 2. In product market competition, the profit of the second period improves from the leading indicator in the first period.

Additionally, under the Parametric Assumption, we consider $\pi_{i,1}^{(NL,NL)} - \pi_{i,1}^{(L,L)}$ as follows.

$$\pi_{i,1}^{(NL,NL)} - \pi_{i,1}^{(L,L)} = \frac{2\alpha(2+\alpha-3\gamma+\gamma^2)}{(2-\gamma)^2(2-2\alpha-\gamma)^2} > 0. \tag{16}$$

We obtain the following lemma from this outcome.

Lemma 3. In product market competition, the profit of the first period decreases from the leading indicator in the first period.

The economic intuition behind this outcome is as follows. First, Lemma 3 is obtained by excessive supply from the leading indicator related to the customer for the same reason as in the monopoly case. In the competitive case, the effect of a decreasing price is larger than that in the monopoly case because the market price also decreases from the competitor's excessive supply. With this negative effect, the profit intensity of the first period decreases. In addition, the difference between $\alpha > 0$ and $\alpha = 0$ is represented as the level of investment. When the level of investment in the first period is large, firms can enhance the demand in the next period, thereby improving the profit in the second period. Therefore, the comparison of levels of investment in the first period is as follows:

$$I_i^{(NL,NL)} - I_i^{(L,L)} = -\frac{2\alpha}{(2-\gamma)(2-2\alpha-\gamma)}. \tag{17}$$

Under the Parametric Assumption, $I_i^{(NL,NL)} < I_i^{(L,L)}$ is obtained in this outcome.

Next, we consider $\Pi_i^{(NL,NL)} - \Pi_i^{(L,L)}$ and obtain the following outcome.

$$\Pi_i^{(NL,NL)} - \Pi_i^{(L,L)} = \frac{2\alpha\Phi}{9(2-\gamma)^2(2-2\alpha-\gamma)^2}, \quad (18)$$

where $\Phi \equiv 9(2+\alpha-3\gamma+\gamma^2) - 2r(2-2\alpha-\gamma)(2+\gamma-\gamma^2) - 2r^2(1+\gamma)^2(2-\alpha-\gamma)$. From $\Phi > 0$, when

$$\alpha > \frac{9\gamma(3-\gamma) + 2r(2-\gamma)(2+\gamma-\gamma^2) + 2r^2(2-\gamma)(1+\gamma)^2 - 18}{9 + 4r(2+\gamma-\gamma^2) + 2r^2(1+\gamma)^2} \equiv \dot{\alpha}, \quad (19)$$

is satisfied, we obtain $\Pi_i^{(NL,NL)} > \Pi_i^{(L,L)}$ straightforwardly. Depending on γ and r, we obtain $\dot{\alpha} < 1/4$. For example, under $r = 0.1$ and $\gamma = 0.2$, $\dot{\alpha} \simeq -1.23$ (in this case, because we assume $\alpha > 0$, $\alpha = 0$ is obtained). This implies that, under $r = 0.1$ and $\gamma = 0.2$, we can ensure the existence of $\alpha \in (\dot{\alpha}, 1/4)$. Therefore, the leading indicator does not improve firms' total profit under the specific condition. Based on this outcome, we propose the following proposition.

Proposition 1. Under the Parametric Assumption, there exists the case in which $\Pi_i^{(NL,NL)} > \Pi_i^{(L,L)}$ is obtained.

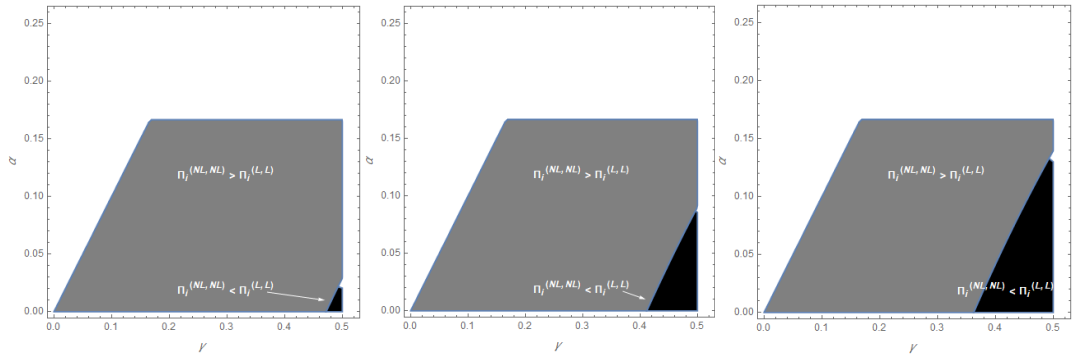
Note that one can obtain the case in which $0 < \dot{\alpha} < 1/4$ is satisfied, depending on the combinations of r and γ. In this case, for $0 < \alpha < \dot{\alpha}$, $\Pi_i^{(NL,NL)} < \Pi_i^{(L,L)}$ is obtained.

This proposition implies that the leading indicator harms the total profits in a specific case. This outcome is obtained from the trade-off between the positive and negative effects of the leading indicator. The leading indicator improves the profit in the second period by increasing the level of demand-enhancing investments but decreases the profit in the first period as a result of excessive supply. The balance between effects is decided by the combination of parameters. When the spillover effect is small, the positive

effect is weakened because the competitor's investment does not impact demand seriously. This weakened spillover effect does not enhance the positive effect of the costly investment. For this reason, when γ is small, the positive effect of enhancing profit in the second period cannot exceed the negative effect of decreasing profit in the first period. Consequently, the total profit will decline.

Regarding the numerical example, this study considers the impact of exogenous variables. In this analysis, we fix $r = 0.65, 0.72, 0.78$ and draw a region of $\Pi_i^{(NL,NL)} > \Pi_i^{(L,L)}$ in Figure 1.

Figure 1. Plot region $\Pi_i^{(NL,NL)} > \Pi_i^{(L,L)}$ as r chenges.



$\boldsymbol{r = 0.65}$ $\boldsymbol{r = 0.72}$ $\boldsymbol{r = 0.78}$

From this figure, the region of $\Pi_i^{(NL,NL)} > \Pi_i^{(L,L)}$ decreases as r increases because the impact of the positive effect in the second period increases by the remaining effect of investment. In addition, when γ is large, the spillover effect, which has a positive impact on each firm's demand, improves. Therefore, a large γ improves the positive effect of the leading indicator.

We demonstrate the case in which the total profit of the firm in the delegation game suffers as a result of the leading indicator. However, this outcome is not the

equilibrium case of endogenous α. Therefore, we consider the choice of $\alpha > 0$ or $\alpha = 0$ in the next section.

4.4. Endogenous choice of whether firms use the leading indicator

We demonstrate that both firms choose the adoption of the leading indicator and it negatively affects firms' profit. Consider the asymmetric case where one of the firms adopts the leading indicator as the equilibrium strategy and the other firm does not. In this subsection, we analyze the case where $(PI_i, PI_j) = (NL, L)$ and obtain the following outcome.

$$
\begin{aligned}
q_{i1}^{(NL,L)} &= \frac{\gamma - \alpha}{\gamma(2 - \alpha - \gamma)}, \\
q_{j1}^{(NL,L)} &= \frac{\gamma + \alpha}{\gamma(2 - \alpha - \gamma)}, \\
q_{i2}^{(NL,L)} &= \frac{1}{3} + \frac{r\big(\gamma(1+\gamma) - 3\alpha(1-\gamma)\big)}{3\gamma(2 - \alpha - \gamma)}, \\
q_{j2}^{(NL,L)} &= \frac{3r\alpha(1-\gamma) + r\gamma(1+\gamma) + \gamma(2 - \alpha - \gamma)}{3\gamma(2 - \alpha - \gamma)}, \\
I_i^{(NL,L)} &= \frac{\gamma - \alpha}{\gamma(2 - \alpha - \gamma)}, \\
I_j^{(NL,L)} &= \frac{\gamma + \alpha}{\gamma(2 - \alpha - \gamma)}, \\
p_{i1}^{(NL,L)} &= \frac{\gamma - \alpha}{\gamma(2 - \alpha - \gamma)}, \\
p_{j1}^{(NL,L)} &= \frac{\gamma(1 - 2\alpha) + \alpha}{\gamma(2 - \alpha - \gamma)},
\end{aligned}
\tag{20}
$$

$$p_{i2}^{(NL,L)} = \frac{1}{3} + \frac{r\big(\gamma(1+\gamma) - 3\alpha(1-\gamma)\big)}{3\gamma(2-\alpha-\gamma)},$$

$$p_{j2}^{(NL,L)} = \frac{3r\alpha(1-\gamma) + r\gamma(1+\gamma) + \gamma(2-\alpha-\gamma)}{3\gamma(2-\alpha-\gamma)},$$

$$\pi_{i1}^{(NL,L)} = \frac{(\gamma-\alpha)^2}{2\gamma^2(2-\alpha-\gamma)^2},$$

$$\pi_{j1}^{(NL,L)} = \frac{(\gamma+\alpha)(\gamma(1-4\alpha)+\alpha)}{2\gamma^2(2-\alpha-\gamma)^2},$$

$$\pi_{i2}^{(NL,L)} = \frac{\big(3r\alpha(1-\gamma) - r\gamma(1+\gamma) - \gamma(2-\alpha-\gamma)\big)^2}{9\gamma^2(2-\alpha-\gamma)^2},$$

$$\pi_{j2}^{(NL,L)} = \frac{\big(3r\alpha(1-\gamma) + r\gamma(1+\gamma) + \gamma(2-\alpha-\gamma)\big)^2}{9\gamma^2(2-\alpha-\gamma)^2}.$$

All outcomes are positive under the Parametric Assumption. From this outcome, we obtain the Parametric Assumption.

From this outcome, $\Pi_i^{(NL,NL)} - \Pi_i^{(L,NL)}$ is

$$\Pi_i^{(NL,NL)} - \Pi_i^{(L,NL)} = -\frac{2\alpha\Psi}{9(2-\gamma)^2\gamma^2(2-\alpha-\gamma)^2}, \tag{21}$$

where $\Psi \equiv (2-\gamma)\gamma(9(1-\gamma)^2 + 2r(6-11\gamma+8\gamma^2-2\gamma^3) + r^2(6-2\gamma-4\gamma^2+4\gamma^3)) + \alpha(9(1-5\gamma+4\gamma^2-\gamma^3) - 2r\gamma(6-11\gamma+8\gamma^2-2\gamma^3) + 2r^2(9-27\gamma+29\gamma^2-14\gamma^3+2\gamma^4))$. When $\Psi > 0$ is satisfied, we obtain $\Pi_i^{(NL,NL)} < \Pi_i^{(L,NL)}$. In other words, when $\alpha > -(2-\gamma)\gamma\big(9(1-\gamma)^2 + 2r(6-11\gamma+8\gamma^2-2\gamma^3) + r^2(6-2\gamma-4\gamma^2+4\gamma^3)\big)/\big(9(1-5\gamma+4\gamma^2-\gamma^3) - 2r\gamma(6-11\gamma+8\gamma^2-2\gamma^3) + 2r^2(9-27\gamma+29\gamma^2-14\gamma^3+2\gamma^4)\big)$ is satisfied under $\alpha < 1/4$, we obtain $\Pi_i^{(NL,NL)} < \Pi_i^{(L,NL)}$. Hence, when the competitor adopts the leading indicator, $PI_i = L$ is the best-response strategy.

In addition, $\Pi_i^{(NL,L)} - \Pi_i^{(L,L)}$ is

$$\Pi_i^{(L,L)} - \Pi_i^{(NL,L)} = -\frac{2\alpha \mathrm{X}}{9\gamma^2(2-\alpha-\gamma)^2(2-2\alpha-\gamma)^2}, \tag{22}$$

where $\mathrm{X} \equiv 3\alpha^3(3+6r^2(1-\gamma)^2+4r(1-\gamma)\gamma)-(2-\gamma)\gamma\big(9(1-\gamma)^2+2r(6-11\gamma+8\gamma^2-2\gamma^3)+r^2(6-2\gamma-4\gamma^2+4\gamma^3)\big)-\alpha^2(9(2+\gamma-\gamma^2)+2r\gamma(24-35\gamma+13\gamma^2)+6r^2(6-13\gamma+12\gamma^2-5\gamma^3))+3\alpha(3+9\gamma-15\gamma^2+6\gamma^3+2r\gamma(10-19\gamma+13\gamma^2-3\gamma^3)+2r^2(3-5\gamma+8\gamma^2-8\gamma^3+3\gamma^4))$. When $\mathrm{X}<0$ is satisfied, we obtain $\Pi_i^{(L,L)} > \Pi_i^{(NL,L)}$, and $PI_i = LI$ is the best response strategy. We can demonstrate the existence of the case in which $\mathrm{X}<0$ is satisfied.

Based on the above discussion, under the Parametric Assumption, when $\Psi > 0$ and $\mathrm{X} > 0$ are satisfied, $(PI_i, PI_j) = (L, L)$ is chosen in equilibrium. However, because it is difficult to obtain the explicit outcome about the comparison among profits, we numerically highlight the case in which leading indicators harm the firm's profit under the specific economic environment.

We consider the condition of $\Psi \equiv (2-\gamma)\gamma(9(1-\gamma)^2+2r(6-11\gamma+8\gamma^2-2\gamma^3)+r^2(6-2\gamma-4\gamma^2+4\gamma^3))+\alpha(9(1-5\gamma+4\gamma^2-\gamma^3)-2r\gamma(6-11\gamma+8\gamma^2-2\gamma^3)+2r^2(9-27\gamma+29\gamma^2-14\gamma^3+2\gamma^4))>0$ under $\alpha < 1/4$.

$$\begin{aligned}\alpha > &-(2-\gamma)\gamma\big(9(1-\gamma)^2+2r(6-11\gamma+8\gamma^2-2\gamma^3)\\ &+r^2(6-2\gamma-4\gamma^2+4\gamma^3)\big)\\ &/\big(9(1-5\gamma+4\gamma^2-\gamma^3)-2r\gamma(6-11\gamma+8\gamma^2-2\gamma^3)\\ &+2r^2(9-27\gamma+29\gamma^2-14\gamma^3+2\gamma^4)\big) \equiv \alpha^{A1}.\end{aligned} \tag{23}$$

In this case, showing $\alpha^{A1} < 1/4$, we can confirm that there exists the case in which $\Pi_i^{(NL,NL)} < \Pi_i^{(L,NL)}$. To demonstrate the case wherein $\alpha^{A1} < 0$, we specify the numerical

example as $r = 0.1$ and $\gamma = 0.2$. In this case, we obtain $\alpha^{A1} \simeq -1.84197$. This outcome satisfies $\alpha^{A1} < \gamma$; therefore, there exists the case in which $\Psi > 0$. Additionally, from the coefficient of γ, when γ is sufficiently large, we obtain a positive α^{A1}, which may exceed $1/4$. Even if we organize by γ, we can obtain $\alpha^{A1} < 1/4$. We do not specify the condition of γ because it leads to complex conditions. However, we can obtain important outcomes numerically. Under $r = 0.1$ and $\gamma = 0.2$, we obtain $\Psi = -(1.71468\alpha(2.388787 + 1.29686\alpha))/(1.8 - \alpha)^2$, and $\Psi|_{r=0.1,\gamma=0.2} > 0$ is satisfied in $\alpha < 1/6$.

Next, we demonstrate the existence of the case in which $\mathrm{X} > 0$, specifying the variables as $r = 0.1$ and $\gamma = 0.2$. In this case, we obtain $\mathrm{X}|_{r=0.1,\gamma=0.2} \simeq -2.388787 + 13.683168\alpha - 20.3712\alpha^2 + 9.3072\alpha^3$, and this outcome is always negative under $\alpha < 1/4$.

From above discussions, when we specify r and γ as $r = 0.1$ and $\gamma = 0.2$, we obtain $\Pi_i^{(L,NL)} > \Pi_i^{(NL,NL)}$ and $\Pi_i^{(L,L)} > \Pi_i^{(NL,L)}$. This outcome implies that an equilibrium exists in which both firms adopt leading indicators under the specific economic environment. We summarize our analysis as a following observation.

Observation 1. Under the specific economic environment, there exists a case in which both firms adopt the leading indicator in equilibrium.

Additionally, in the $(PI_i, PI_j) = (L, L)$ case, we can obtain the specific economic environment of $\Pi_i^{(NL,NL)} > \Pi_i^{(L,L)}$. Therefore, the combination of payoffs in equilibrium is the same as in the prisoner's dilemma and is not a Pareto-efficient outcome. We focus on this case based on the numerical analysis.

Using Eq. (19), we demonstrate that both firms adopting the leading indicator leads to a Pareto-optimal outcome. Considering the same specification of the variables in Observation 1 ($r = 0.1$ and $\gamma = 0.2$), we obtain that $\Pi_i^{(L,L)} < \Pi_i^{(NL,NL)}$ under the following case.

$$\Pi_i^{(NL,NL)} - \Pi_i^{(L,L)} \simeq \frac{\alpha(0.208 + 0.1696\alpha)}{(0.9 - \alpha)^2} > 0 \tag{24}$$

This outcome implies that $\Pi_i^{(L,L)} < \Pi_i^{(NL,NL)}$ is obtained in a specific economic environment. Consequently, we obtain the following observation.

Observation 2. Under the specific economic environment, there exists a case in which both firms are not a Pareto-efficient combination of payoffs in equilibrium.

This study demonstrates that when the owner can decide whether to adopt the leading indicator and both firms adopt it, it does not improve the long-term profit of the firm in specific economic environments. The driving force of this outcome is that the leading indicator can act as a commitment device. When the firm emphasizes consumer surplus by the leading indicator, the firm will supply excessively in a product market. Because this study considers quantity competition, the same as in Arya et al. (2019), each firm wants to obtain the first mover advantage. In this case, emphasizing consumer surplus is a commitment device to choose an aggressive strategy in a quantity competition because it enhances quantity in a market. As a result, each firm chooses adoption of the leading indicator to threaten the competitor by excessive competition.

Ittner and Larcker (1998) and Banker et al. (2000) empirically demonstrated that non-financial indicators as leading indicators improve the future profit of firms. In management accounting, firms use leading indicators to achieve financial performance

(e.g., BSC). However, the main result of this study suggests that while short-term profit improves, long-term profit does not improve from the leading indicator when the firm faces competition in a product market. The main result of this study implies that adoption of the leading indicator does not always improve the long-term total profit of the firm, which is important for firms interested in long-term sustainability and in returning profits to shareholders. The implication of this is that the owner must heed the economic environment and choose the appropriate performance indicator.

In addition, it is interesting that while the adoption of the leading indicator is explained as a long-term concern, this study demonstrates the case in which the long-term profit decreases from the leading indicator. Therefore, the leading indicator is not always linked to future financial performance. Obviously, the firm loses profit from excessively emphasizing long-term decisions and the firm's profit will suffer in the long-term from this negative effect.

Additionally, our results explain the decline in profit for Japanese companies. In the 1990s, management accounting research explored long-term incentives in Japanese companies (e.g., Cooper and Slugmulder 1999; Gietzmann 1996). However, in the 2010s, Japanese companies did not symbolize good business because they did not sustain high profits due to market competition from foreign companies. Our model captures the relationship between time for patience and benefit of success, which is emphasized by Japanese firms that provide long-term profits.

Nowadays, these managerial performance indicators are disclosed in proxy statements, indicating that many managers are evaluated by non-financial indicators as leading indicators. The adoption of these leading indicators is an area of keen interest in management accounting practice and management accounting research should examine this topic further in future research.

5. Additional analysis: Managers also emphasize consumer surplus in the second period under leading indicator

In this analysis, we assume $O_{i2} = \pi_{i2} + \alpha_{i2} CS_t$ under the leading indicator case. In this subsection, we assume Parametric Assumption to solve our model explicitly. We can use the outcome in Section 4.1 to consider the non-leading indicator case. Therefore, in this section, we analyze the cases of (L, L) and (NL, L) for the symmetry of objective functions. Thus, using Parametric Assumption, we obtain following observations based on the numerical analysis.

Observation 3. When the Parametric Assumption is satisfied, firms adopt the leading indicator in equilibrium in a specific economic environment.

Observation 4. When both firms adopt a leading indicator, there exists the case in which the combined payoff is not Pareto optimal in this equilibrium.

Proof. See Online Appendix.

This additional analysis indicates that our outcome is robust when managers emphasize consumer surplus in the second period under the leading indicator. Compared to previous outcomes, this observation implies that the additional leading indicator leads to more excessive surplus and investment in the second period. Therefore, assuming the leading indicator in the first period, we can analyze its impact. In particular, in this case, the case where the leading indicator harms firms' total profit is expanded. The profit of the second

period decreases as α increases, because firms commit to aggressive strategies in the second period as a result of the leading indicator. Therefore, our main result is robust.

6. Discussion and conclusion

Assuming the effect of demand-enhancing investment in the first period remains in the second period in the context of product market competition, this study considers whether leading indicators contribute to total profit. The results of the model demonstrate that the leading indicator does not improve total profit in a specific economic environment. While the leading indicator improves profit in the second period, it lowers profit in the first period because of excessive supply. The balance of this trade-off affects total profit.

This result has important implications in management accounting research. For example, Ittner and Larcker (1998) and Banker et al. (2000) find empirical evidence that the leading indicator has an important impact on the future profit of a firm. Our result theoretically supports this empirical evidence using a game theoretical approach, assuming product market competition. Hence, this study contributes theoretical evidence to the empirical findings in leading indicator investigations. In addition, this study considers total profit in the long period, discussing the usefulness of the leading indicator in product market competition.

This study has several limitations. First, we identify some exogenous variables to the numerical variables in the equilibrium strategy. While these variables should be generalized in future studies, this study demonstrates an important specific case. Second, this study assumes that the competitor's performance indicators are observable. While it is generally difficult to observe a competitor's internal strategies, this study refers to proxy statements in the United States, which affect the observability of performance

indicators. Hence, it may be reasonable to assume that in the presence of proxy statements, firms would know their competitor's performance indicators. It would be promising, however, to identify strategic alternatives for when performance indicators are not common knowledge, as establishing leading indicators would be beneficial for both firms. Third, we consider the exogenous weight placed on the leading indicator. Therefore, future research should consider endogenous weight. In particular, uncommon weight in both firms and during two periods needs to be considered. This analysis will be useful in understanding the leading indicator. Lastly, one may infer that while we refer to consumer surplus as a leading indicator, it does not correspond to the definition in empirical studies. Therefore, we need to consider other performance indicators in future research.

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