Cross-firm real earnings management*

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Abstract: There is ample empirical evidence documenting that stockholders can learn about the fundamental value of any particular firm from observing the earnings announcements of other firms that operate in the same industry. We argue that such intra-industry information transfers may motivate managers to mislead stockholders about the value of their firm not only by manipulating their own earnings report but also by influencing the earnings reports of rival firms. Managers obviously do not have access to the accounting system of peer firms, but they can nevertheless influence the earnings reports of rival firms by distorting real transactions that relate to the product market competition. We demonstrate such managerial behavior, which we refer to as cross-firm real earnings management, and explore its potential consequences and its interrelation with the traditional practice of earnings management within an industry setting with imperfect (non-proprietary) accounting information.

Keywords: accounting; financial reporting; earnings management; real earnings management; non-proprietary information; product market competition; managerial myopia.

JEL classification: D82, M41, M43.

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1. **Introduction**

Our study is rooted in the observation that stockholders can learn about the fundamental value of any particular firm from observing the earnings announcements of other firms that operate in the same industry. For instance, favorable earnings announcement of a certain firm may allude to a reduction in the market share of its rivals or may alternatively reflect some industry-wide shock, such as an increase in the consumer demand or a decrease in the input prices, which is likely to affect favorably all firms in the industry. There is ample empirical evidence documenting that stock prices indeed reflect such intra-industry information transfers (e.g., Foster, 1981; Han, Wild, and Ramesh, 1989; Han and Wild, 1990; Freeman and Tse, 1992; Lang and Lundholm, 1996; Ramnath, 2002; Thomas and Zhang, 2007; Kim, Lacina and Park, 2008). Therefore, capital markets concerns of managers may induce them to mislead stockholders about the value of their firm not only by managing their own earnings report but also by influencing the earnings reports of rival firms. Managers obviously do not have access to the accounting system of peer firms, but they can nevertheless influence the economic profits of rival firms, and thereby also their earnings reports, by distorting real transactions that relate to the product market competition. So, while the target of earnings management is conventionally perceived in the literature as being the accounting report of the managers’ own firm (e.g., Dye, 1988; Stein, 1989; Arya, Glover and Sunder, 1998; Fischer and Verrecchia, 2000; Kirschenheiter and Melumad, 2002; Fischer and Stocken, 2004; Demski, 2004; Ewert and Wagenhofer, 2005; Guttman, Kadan, and Kandel, 2006; Einhorn and Ziv, 2012; Amir, Einhorn and Kama, 2014), we draw attention to another practice of earnings management, which aims to influence the reported earnings of other firms.\(^1\) We refer to this practice as cross-firm real earnings management.

We demonstrate the potential for the practice of cross-firm real earnings management to exist and study its consequences within a Cournot competition game between two firms that operate in the same product market and their stocks are publicly traded in the same capital market. For simplicity, we model the

\(^1\) See Ewert and Wagenhofer (2012) for a recent survey of the earnings management literature.
two firms in a symmetric way. Managers in this game are myopic in the sense that they care not only about the long-term fundamental value of their firm but also about the short-term market price of its stocks, as determined by the capital market investors based on the content of noisy accounting earnings reports that the two firms release after their profits are set in the product market. The production decisions serve in our setting as the vehicle through which the two managers carry out their real activities of cross-firm earnings management. Consistent with the conventional perception that real earnings management requires incomplete information about the underlying real action (e.g., Stein, 1989), the production decisions of the managers are assumed unobservable to the capital market investors. In equilibrium, both managers bias their own earnings report by implementing accounting manipulations, but they nevertheless also distort the production levels relative to the benchmark set by the classical setting of Cournot competition. Such real distortions in production emerge in equilibrium even though information in our model is non-proprietary in nature, as it is released to the markets after profits have already been determined. They are thus not triggered by product market considerations of the managers, but rather stem from their capital market concerns.

To understand our results, it should be noted that, although the capital market investors can rationally form expectations for the production quantities of the two firms and the implied retail price of their products in equilibrium, they cannot perfectly deduce the resulting profits of the firms, as those are additionally subject to various business shocks. The accounting reports of the two firms serve investors to imperfectly resolve their uncertainties about these business shocks and thereby allow them to more accurately evaluate the firms and price their stocks. As the two competing firms are likely to face correlated business shocks, and since the accounting report of each firm only noisily reflects its true profit, the investors price the stocks of each firm based not only on its own accounting report but also on the basis of

\footnote{For studies that demonstrate direct consequences of proprietary accounting information on the competition between firms in the product market see, for example, Dontoh (1989), Darrough and Stoughton (1990), Wagenhofer (1990), Feltham and Xie (1992), Darrough (1993), Arya, Frimor and Mittendorf (2010), Bagnoli and Watts (2010). More broadly, for studies that consider real effects of accounting information (not necessarily in the context of product market competition) see, for instance, Kanodia (1980), Kanodia, Mukherji, Sapra and Venugopalan (2000), Dye and Sridhar (2002), Kanodia (2006).}
the accounting report of the rival firm. This motivates the two managers to distort their production decisions in order to affect the accounting earnings report of the rival firm (via the effect on its economic profit) and thereby mislead the capital market investors about the value of their own firm.\textsuperscript{3} Taking the conjectures of the investors as fixed, the managers in our model end up in distorting production even though they know that they cannot fool the capital market in equilibrium. This result is consistent with Stein (1989). Here, however, despite the fact that, from the narrow perspective of the firm’s value, the myopic managers choose sub-optimal production levels, we show that the equilibrium values of the firms might nevertheless increase.

When the profits of the two firms are subject to positively correlated business shocks (e.g., fluctuations in downstream consumer demand or in upstream input prices), the market price of each firm positively responds to the earnings report of the rival firm. The manager of each firm thus obtains an added cross benefit from a high profit of the rival firm, which induces him/her to compete less aggressively, cutting back on his/her production level. Interestingly, despite the seemingly altruist willingness of the managers to cut the profit of their own firm in order to increase the profit of the rival firm, the two firms nevertheless end up with higher profits in equilibrium as a result of the reduction in the aggressiveness of the product market competition. This suggests that myopic preferences of managers, which bring capital market considerations into their production choice, may serve as an effective commitment device to create collaboration between competing firms, which eventually results in lower quantities of production and higher profits.\textsuperscript{4} In extreme cases where the two firms confront highly correlated business shocks and their managers are very myopic, the collaboration may be so profound that the two firms essentially behave like a monopoly and divide the monopolist profit between them. Opposite

\textsuperscript{3} Our model therefore points to the role of capital market concerns of managers in implicitly causing them to be concerned not only about their own reported performance but also about the reported performance of their rivals, even when relative performance measures are not explicitly employed in the managerial compensation contract. These inherent relative-performance concerns of managers, which naturally arise from their capital market concerns, should be thus taken into consideration when designing relative-performance compensation contracts of managers.

\textsuperscript{4} The literature points to several other commitment devices employed by firms to shape their aggressiveness in the product market competition, such as capital investment (e.g., Dixit, 1980), financial leverage (e.g., Brander and Lewis, 1986) and managerial compensation contracts (e.g., Aggarwal and Samwick, 1999; Miller and Pazgal, 2001).
equilibrium outcomes arise from the model in circumstances where the firms face negatively correlated business shocks (e.g., fluctuations in the market share of the two firms). Here, the market price of each firm responds negatively to the earnings report of the rival firm. So, the manager of each firm obtains added cross benefit from a low profit of the rival firm, which urges him/her to compete more aggressively and increase the production level above the otherwise optimal level. This works to lower the profits of the firms. At the extreme, when the two firms face business shocks with extremely negative correlation and their managers are highly myopic, the competition between them becomes so aggressive that their profits converge to zero. While the direction of the distortion in the product market equilibrium outcomes from those of the classical Cournot competition depends on whether the two firms face positively or negatively correlated business shocks, the magnitude of the distortion is determined by the absolute value of the correlation between the business shocks. The greater is the correlation between the business shocks that the two firms confront, in absolute terms, the stronger is the response of the stock price of each firm to the accounting report of the rival firm, and consequently the more salient is the managerial motivation to engage in cross-firm earnings management and the more significant is the resulting distortion in the product market outcomes.

In order to delve into the relationships between the practice of cross-firm earnings management introduced in our work and the well-established traditional practice of earnings management, we follow the conventional approach in the literature (e.g., Fischer and Verrecchia, 2000) and allow the managers in our setting to exercise discretion in the accounting measurement and reporting process. The two managers can thus use their judgment in determining the real production quantity of their firm in order to alter the earnings report of the rival firm, but they can additionally utilize their discretion in financial reporting to bias their own earnings report. We show that both these kinds of earnings management activities co-exist in equilibrium and explore how their relative magnitude depends on both the business environment and the accounting environment. Consistent with prior literature, the managerial incentive for traditional
accounting-based earnings management is increasing in both the level of business uncertainty and the precision of the accounting system. This is because the accounting report of each firm becomes more useful to investors in pricing the stocks of that particular firm when the business uncertainty escalates or the accuracy of the accounting system improves. Obviously, such changes make the accounting report of the rival firm by itself more useful too in evaluating the firm, but they also have the opposite effect of augmenting the extent to which this report is already subsumed by the firm’s own accounting report. We show that, as a result of the two countervailing forces at work, the managerial motivation for cross-firm earnings management responds in a non-monotonic manner to changes in the business uncertainty conditions and in the accounting regulation. We also show that an increase in the extent to which the business uncertainties of the two firms are correlated, by amplifying the intra-industry information transfers, works to decrease the managerial motivation to engage in accounting-based earnings management while increasing the managerial drive to carry out real activities of cross-firm earnings management. We thus conclude that the involvement of managers with accounting-based earnings management activities and their involvement with real activities of cross-firm earnings management may respond either in the same direction or in opposite directions to changes in the business uncertainty conditions or in the accounting regulation, depending on the specific circumstances.

The paper proceeds as follows. The next section describes the model underlying the analysis. Section 3 presents the equilibrium outcomes that the model yields and discusses their implications. The final section summarizes and offers concluding remarks. Proofs appear in the appendix.

2. Model

Our model is designed to demonstrate the effect of capital market concerns of managers on the competition between firms in the product market. It thus depicts a game between two firms, denoted $A$ and $B$, which operate in the same product market and their stocks are publicly traded in the same capital market.
The managers of the two firms compete in the product market on the quantity of their production, making their production decision in light of the wish to maximize both the fundamental value of their firm and the price at which its stocks are traded in the capital market following earnings announcements. For simplicity, we model the two firms in a symmetric way. The rest of this section details the parameters and assumptions of the model, which are all assumed to be common knowledge unless otherwise indicated.

The two firms in our model produce and sell the same product. The firms compete a la Cournot on the quantity of units they produce and sell, which they decide on simultaneously and independently of each other.5 Denoting the number of units produced and sold by each firm \( i \ (i = A, B) \) by \( q_i \) and assuming a standard linear demand function for the products, we represent the retail price for each unit of product that the firms sell by \( p(q_A, q_B) = a - q_A - q_B \), where \( a > 0 \).6 In this formulation, the parameter \( a \) is the familiar demand intercept that reflects the overall level of demand for the product. The marginal cost of production is assumed to be fixed and identical across firm \( s \) and is given by the parameter \( c \), where \( a > c \geq 0 \). To introduce a role for an accounting system, we allow for uncertainty regarding the realized profits of the firms. Thus, given the production quantities \( q_A \) and \( q_B \) of the firms, we represent the profit of each firm \( i \ (i = A, B) \) by the random variable \( \pi_i(q_A, q_B) \), which follows the structure \( q_i(p(q_A, q_B) - c) + \eta_i \). The random variable \( \eta_i \) depicts a business shock and is assumed to be normally distributed with zero mean and variance \( \sigma^2_{\eta} \in (0, \infty) \), where \( \sigma^2_{\eta} \) captures the extent to which the business environment is uncertain.7 The business shock \( \eta_i \) that each firm \( i \ (i = A, B) \) faces represents uncertainties

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5 The Cournot competition is used in our model only as a demonstration of instances where cross-firm earnings management might occur. We note, however, that cross-firm earnings management also arises under other competition structures, like Stackelberg competition or Bertrand competition.

6 Our results hold qualitatively in a setting with substitute products, in which the retail prices of the products of firms \( A \) and \( B \) are given by \( a - q_A - \gamma q_B \) and \( a - \gamma q_A - q_B \), respectively, where \( 0 < \gamma \leq 1 \) is the substitutability coefficient that reflects the degree of competitive intensity between the two products.

7 Our results hold qualitatively when the business shock stems from uncertainty regarding the demand intercept \( a \) or the production cost \( c \). This alternative modeling choice, however, makes the analysis less tractable and introduces more complexity into the exposition of the results.
about firm-specific prospects, as well as industry-wide uncertainties.

We allow the random variables $\eta_A$ and $\eta_B$ to be correlated and denote their covariance by $\rho \sigma^2$, where $-1 < \rho < 1$ and $\rho \neq 0$. The correlation $\rho$ between $\eta_A$ and $\eta_B$, which plays a crucial role in our analysis, is allowed to be either positive or negative. We preclude from the model the case of $\rho = 0$, where the profits of the two firms are subject to uncorrelated business uncertainties, which is clearly a less likely case for firms operating in the same industry. Positive values of $\rho$ capture situations where the two firms face common shocks in upstream input prices or in downstream consumer taste, such as the increase in consumer demand for smart-phones, the fall in consumer demand for non-digital cameras at the turn of the century, or the sharp rise in internet backbone capacity in the late 1990s. Negative values of $\rho$, on the other hand, might arise from fluctuations in the market share of the two firms due to firm-specific shocks attributable to the effectiveness of marketing campaigns, deficiencies in production processes, quality of management teams and so forth. Since it is reasonable to assume that in reality business uncertainties arise both from industry-wide shocks that are common to all firms in a given industry and from firm-specific shocks that alter the competition for market share between firms in the industry, the correlation $\rho$ can be seen as reflecting the net effect of these uncertainties.

After the production quantities are determined in the product market, but before the profits are realized and distributed as a liquidating dividend to stockholders, both firms mandatorily provide the capital market with their accounting earnings report. The earnings report of each firm $i$ ($i = A, B$), denoted $r_i$, is modeled as the realization of a noisy estimator of the profit variable $\tilde{\pi}_i(q_A, q_B)$, which takes the form $\tilde{\pi}_i(q_A, q_B) + \tilde{\epsilon}_i + b_i$, where $\tilde{\epsilon}_i$ depicts a noise inherent in the accounting system and $b_i$ is an opportunistic bias implemented by the manager of the firm, who exercises discretion in the process of accounting measurement and reporting. The random variable $\tilde{\epsilon}_i$ is assumed to be an independent normally
distributed random variable with zero mean and variance \( \sigma^2_\varepsilon \in (0, \infty) \), where \( \sigma^2_\varepsilon \) captures the extent to which the accounting system is noisy.\(^8\) In common with the earnings management literature (e.g., Stein, 1989; Fischer and Verrecchia, 2000; Guttman, Kadan and Kandel, 2006; Einhorn and Ziv, 2012; Amir, Einhorn and Kama, 2012), we assume that the opportunistic bias \( b_i \) of each firm \( i \) (\( i = A, B \)) is associated with a quadratic cost of \( kb_i^2 \), where the positive scalar \( k > 0 \) represents the marginal biasing cost. Accounting information in our model is non-proprietary, because it is reported after the two firms have already chosen their production level. The only role that the accounting reports of the two firms serve in our model is in assisting the capital market investors to better evaluate and price the firms’ equity.

Even though the production quantity of each firm is observable only to its manager, in equilibrium the investors rationally infer the production quantities of the two firms and the implied retail price of their products. They are, nevertheless, incapable of perfectly deducing the profits of the firms, as those are additionally subject to the business shocks \( \tilde{\eta}_A \) and \( \tilde{\eta}_B \). The earnings reports thus help them to imperfectly estimate the extent to which the business shocks have affected the profits of the two firms. The investors are assumed to be risk neutral. Accordingly, they set the market equity price of each firm equal to their expectations regarding the firm’s profit conditional on all the publicly available information. Since the profits of the two firms are subject to correlated business shocks (i.e., \( \rho \neq 0 \)) and the accounting earnings report of each firm only noisily reflects its profit (i.e., \( \sigma^2_\varepsilon > 0 \)), the set of information relevant to the investors in pricing each firm includes both the earnings report provided by the firm itself and the earnings report provided by its rival. We accordingly use the functions \( P_A, P_B : \mathbb{R}^2 \rightarrow \mathbb{R} \) to represent the pricing rule of the capital market investors, where \( P_i (r_A, r_B) \) is the market price of the equity of firm \( i \) (\( i = A, B \)), given that \( r_A \) and \( r_B \) are the earnings reports provided by firm \( A \) and firm \( B \), respectively.

\(^8\) The sole source of accounting noise in our setting is \( \tilde{\varepsilon}_i \), as the opportunistic bias \( b_i \) is perfectly detectable in equilibrium.
While perfect information about the true level of performance normally becomes available to the market in the long run, performance is noisily reported in the financial statement and embedded in equity prices much earlier. We thus allow the managers to be myopic in the sense that, in addition to their interest in the fundamental value of their firm that will become commonly known only in the long run, they also care about the firm’s current stock price as determined by the level of performance reported in the accounting system.\(^9\) This assumption, which has been previously employed by other models (e.g., Einhorn and Ziv, 2007; Langberg and Sivaramakrishnan, 2010), is reasonable in a variety of prevalent situations. This is the case, for example, when managers are compensated based on the stock market price and at the same time are concerned about their future professional reputation. It is also the case when there are different types of shareholders, some needing to sell their holdings quickly and others intending to hold their shares for the long run. Accordingly, we assume that the payoff of the manager of firm \(i\) (\(i = A, B\)) is given by

\[ \lambda P_i(r_A, r_B) + (1 - \lambda)\pi_i - kb_i^2, \]

and thus consists of a weighted average that assigns a weight \(1 - \lambda\) to the firm’s true profit \(\pi_i\) and a weight \(\lambda\) to the firm’s stock price \(P_i(r_A, r_B)\) as determined by the reported earnings of the firm and its rival, where \(0 < \lambda \leq 1\), and a subtraction of the cost \(kb_i^2\) associated with the accounting bias \(b_i\).\(^10\) The parameter \(\lambda\) represents the level of managerial myopia. The assumption that managers are myopic to some extent (i.e., \(\lambda > 0\)) is critical to our analysis as it brings capital market considerations into managers’ production choice.

[Figure 1]

Figure 1 provides a timeline depicting the sequence of events in the model. It follows from the timeline that equilibrium in the model consists of the two production decisions \(q_A\) and \(q_B\) simultaneously

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\(^9\) Studies that analyze product market competition under managerial myopia conventionally assume that managers are myopic in the sense that they promote current profits at the expense of future profits. In our model, similar to Stein (1989), the myopia of managers stems from their capital market concerns, which induce them to sacrifice the economic value of their firm in order to promote the market perception of this value in the short run.

\(^{10}\) To simplify the presentation, we assume that the biasing cost is incurred by the manager, but all of our results qualitatively hold when these costs are (partially or entirely) incurred by the firm.
made in the product market by the managers of the two firms, the two accounting biases \( b_A \) and \( b_B \) implemented by the two managers, and the two subsequent pricing rules \( P_A, P_B : \mathbb{R}^2 \to \mathbb{R} \) applied by the investors in the capital market with respect to the equity of the two firms. We look for a perfect Bayesian equilibrium, in which all players make optimal decisions that maximize their utility on the basis of all their available information, as well as their rational expectations about the strategic behavior of all other players, utilizing Bayes’ rule to make inferences and update their beliefs. Denoting by \( \hat{q}_A, \hat{q}_B, \hat{b}_A, \hat{b}_B \) and \( \hat{P}_A, \hat{P}_B : \mathbb{R}^2 \to \mathbb{R} \) the conjectures of the players about \( q_A, q_B, b_A, b_B \) and \( P_A, P_B : \mathbb{R}^2 \to \mathbb{R} \), respectively, any perfect Bayesian equilibrium \( (q_A, q_B, b_A, b_B, P_A, P_B : \mathbb{R}^2 \to \mathbb{R}) \) must satisfy the following five conditions for any levels of reported earnings \( r_A, r_B \in \mathbb{R} \):

(i) \[
(q_A, b_A) \in \arg\max_{(q_A, b_A) \in \mathbb{R}^2} E \left[ \lambda \hat{P}_A \left( \pi_A(q_A, \hat{q}_B) + \hat{e}_A + b_A, \pi_B(q_A, \hat{q}_B) + \hat{e}_B + b_B \right) + (1 - \lambda) \pi_A(q_A, \hat{q}_B) - k b_A^2 \right]
\]

(ii) \[
(q_B, b_B) \in \arg\max_{(q_B, b_B) \in \mathbb{R}^2} E \left[ \lambda \hat{P}_B \left( \pi_A(q_A, q_B) + \hat{e}_A + \hat{b}_A, \pi_B(q_A, q_B) + \hat{e}_B + b_B \right) + (1 - \lambda) \pi_B(q_A, q_B) - k b_B^2 \right]
\]

(iii) \[
P_A(r_A, r_B) = E \left[ \pi_A(q_A, \hat{q}_B) \mid \pi_A(q_A, \hat{q}_B) + \hat{e}_A + \hat{b}_A = r_A, \pi_B(q_A, \hat{q}_B) + \hat{e}_B + \hat{b}_B = r_B \right]
\]

(iv) \[
P_B(r_A, r_B) = E \left[ \pi_B(q_A, \hat{q}_B) \mid \pi_A(q_A, \hat{q}_B) + \hat{e}_A + \hat{b}_A = r_A, \pi_B(q_A, \hat{q}_B) + \hat{e}_B + \hat{b}_B = r_B \right]
\]

(v) \[
\hat{q}_A = q_A, \hat{q}_B = q_B, \hat{b}_A = b_A, \hat{b}_B = b_B, \hat{P}_A(r_A, r_B) = P_A(r_A, r_B) \text{ and } \hat{P}_B(r_A, r_B) = P_B(r_A, r_B).
\]

Conditions (i) and (ii) pertain to the simultaneous production and reporting decisions of the two managers.\(^{11}\) According to these two conditions, each manager chooses the production quantity and the accounting bias that maximize his/her expected utility, utilizing his/her rational expectations about the simultaneously chosen production quantity and accounting bias of the rival manager and about the

\(^{11}\) In order to simplify the presentation, we formulate conditions (i) and (ii) on the basis of the assumption that the manager of each firm \( i \ (i = A, B) \) does not observe the realizations of the business shock \( \eta_i \) and the accounting noise \( \varepsilon_i \) when making his/her reporting decision. The model, however, yields the same results under an alternative assumption that the manager of each firm \( i \ (i = A, B) \) does observe the realization of \( \eta_i \) or the realization of \( \varepsilon_i \) or both of them.
forthcoming pricing rule applied by the capital market investors. Conditions (iii) and (iv) describe the pricing rule applied by the capital market investors subsequent to the earnings announcements of the firms. They require the risk-neutral investors to set the market equity price of each firm to be equal to their expectations about the firm’s profit based on all the publicly available information, which includes the earnings announcements of the two firms, and utilizing their rational conjectures about the managers’ production quantities and accounting biases. The fifth, and last, equilibrium condition is that all players have rational expectations regarding each other’s behavior.

3. **Equilibrium Analysis**

We derive the interrelated equilibrium outcomes in the product market, the accounting system and the capital market using backward induction. We start with the capital market and derive the pricing functions applied by the investors for given beliefs about the production levels and the accounting biases of the two firms. We then move backward and derive the managers’ optimal production quantities and accounting biases. Along this tack, Lemma 1 presents the pricing functions $P_A, P_B : \mathbb{R}^2 \to \mathbb{R}$ applied by the capital market investors in a sub-game given their conjectures about the production quantities, $q_A$ and $q_B$, of the two firms and about their accounting biases, $b_A$ and $b_B$.

**Lemma 1.** In the sub-game subsequent production and accounting reporting, with conjectured production quantities $\hat{q}_A$ and $\hat{q}_B$ and conjectured accounting biases $\hat{b}_A$ and $\hat{b}_B$, for any $i, j \in \{A, B\}$ such that $i \neq j$, the pricing function $P_i : \mathbb{R}^2 \to \mathbb{R}$ applied by the capital market investors takes the following form:

$$P_i(r_A, r_B) = \mu_i + \alpha \left( r_i - \mu_i - \hat{b}_i \right) + \beta \left( r_j - \mu_j - \hat{b}_j \right), \quad \text{where} \quad \mu_i = \hat{q}_i(a - \hat{q}_A - \hat{q}_B - c), \quad \alpha = \frac{\varphi + (1 - \rho^2)\varphi^2}{1 + 2\varphi + (1 - \rho^2)\varphi^2},$$

$$\beta = \frac{\rho\varphi}{1 + 2\varphi + (1 - \rho^2)\varphi^2} \quad \text{and} \quad \varphi = \frac{\sigma_y^2}{\sigma_c^2}.$$

In the presence of business uncertainties (as captured by our assumption that $\sigma_y^2 > 0$), the capital
market investors cannot precisely infer the firms’ profits, \( \tilde{\pi}_A(q_A, q_B) = q_A(a - q_A - q_B - c) + \tilde{\eta}_A \) and \( \tilde{\pi}_B(q_A, q_B) = q_B(a - q_A - q_B - c) + \tilde{\eta}_B \), despite their rational expectations about the firms’ optimal production quantities, \( q_A \) and \( q_B \). They thus find the accounting system useful. However, due to the imprecision of the accounting system (as captured by our assumption that \( \sigma^2_\varepsilon > 0 \)), the investors consider the accounting report of each firm only as a noisy estimator of its underlying true profit. The accounting report of the rival firm may serve them as an additional noisy estimator, provided that the profits of the two firms are subject to correlated business uncertainties (as captured by the assumption \( \rho \neq 0 \)). Therefore, as formally stated by Lemma 1, not only does the market price of each firm respond to its own reported earnings, it also responds to the reported earnings of its rival. The pricing coefficient \( \alpha \) captures the extent to which the stock price of each firm relies on its own earnings report, and is therefore henceforth referred to as the direct earnings response coefficient (or, in short, the direct ERC).\(^\text{12}\) The pricing coefficient \( \beta \) captures the extent to which the stock price of each firm relies on the earnings report of the rival firm, and is therefore henceforth referred to as the cross earnings response coefficient (or, in short, the cross ERC). The properties of the two pricing coefficients, the direct ERC \( \alpha \) and the cross ERC \( \beta \), are summarized in the following lemma.

**Lemma 2.** The direct ERC \( \alpha \) is positive, decreasing in \(|\rho|\) and increasing in \( \phi \). The sign of the cross ERC \( \beta \) is identical to that of \( \rho \), whereas its absolute value is increasing in \(|\rho|\) and non-monotonic in \( \phi = \sigma^2_\varepsilon / \sigma^2_\eta \) - initially increasing in \( \phi \), reaching its maximum at \( \phi = \frac{1}{\sqrt{1 - \rho^2}} \), and then decreasing in \( \phi \).

Lemma 2 indicates that, while the market price of each firm always positively responds to its own earnings report (i.e., \( \alpha > 0 \)), it might either positively (i.e., \( \beta > 0 \)) or negatively (i.e., \( \beta < 0 \)) respond to

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\(^{12}\) It should be noted that the direct ERC \( \alpha \) does not coincide with the classical earnings response coefficient commonly used in empirical studies. This is because most empirical studies estimate the earnings response coefficient using regression models that ignore intra-industry information transfers.
the earnings report of the rival firm, depending on whether \( \rho > 0 \) or \( \rho < 0 \). The magnitude of the correlation \( \rho \) is also an important determinant underlying the pricing rule of investors. It follows from Lemma 2 that, the higher the correlation between the business uncertainties of the two firms, in absolute terms, the higher is the absolute value of the cross ERC \( \beta \), the lower is the value of the direct ERC \( \alpha \), implying that the stock prices reflect stronger intra-industry information transfers. Lemma 2 further sheds light on the sensitivity of the pricing coefficients \( \alpha \) and \( \beta \) to the ratio \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 \) of the business uncertainty \( \sigma_\eta^2 \) to the accounting noisiness \( \sigma_\varepsilon^2 \), which reflects the usefulness of the accounting report of each firm (when standing alone) in estimating the profit of that particular firm. When the ratio \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 \) converges to zero, both coefficients \( \alpha \) and \( \beta \) converge to zero too, because the accounting reports of the firms are either not necessary to investors due to the absence of business uncertainties (i.e., \( \sigma_\eta^2 \) approaches zero) or extremely noisy and thus not at all informative to investors (i.e., \( \sigma_\varepsilon^2 \) approaches infinity). Once the business environment becomes uncertain and the accounting system becomes informative (i.e., \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 > 0 \)), capital market prices turn to be dependent on the accounting reports of the two firms, and both coefficients \( \alpha \) and \( \beta \) diverge from zero and grow larger in absolute terms as the ratio \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 \) further increases due to either an escalation in the business uncertainty or an improvement in the accounting quality. However, when the ratio \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 \) is already relatively high, any additional increase in this ratio, albeit further increases the direct ERC \( \alpha \) and thus enhances the reliance of the stock price of each firm on its own earnings report, has now the opposite effect of decreasing the cross ERC \( \beta \) and thus weakening the dependence of the stock price on the earnings report of the rival firm, which becomes largely subsumed by the other report and eventually becomes redundant as the ratio \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 \) approaches to infinity. Only at this hypothetical extreme of an infinite ratio \( \varphi = \sigma_\eta^2 / \sigma_\varepsilon^2 \).
where the business uncertainty is infinitely huge (i.e., $\sigma^2_q$ approaches infinity) or the accounting system is perfectly precise (i.e., $\sigma^2_\epsilon$ approaches zero), the cross ERC $\beta$ converges again to zero and the stock price of each firm turns to be solely dependent on its own accounting report.

The structure of the pricing functions $P_\lambda$ and $P_\beta$, as given in Lemma 1 and Lemma 2, is consistent with extant empirical evidence. Many empirical studies document the response of stock prices to earnings announcements of peer firms (e.g., Foster, 1981; Han, Wild, and Ramesh, 1989; Han and Wild, 1990; Freeman and Tse, 1992; Lang and Lundholm, 1996; Ramnath, 2002; Thomas and Zhang, 2007; Kim, Lacina and Park, 2008). The empirical findings suggest that, not only that such intra-industry information transfers indeed exist, they may even be substantial, as the empirically observable cross ERC is of a similar order of magnitude as the empirically observed direct ERC (see, for instance, Lang and Lundholm, 1996, Table 3). Some studies further shed light on the determinants of the direction of the price response to intra-industry information transfers. In particular, Lang and Lundholm (1996) find that in industries in which industry-wide shocks constitute the primary source of business uncertainty (about 30%-60% of the industries in their different tests), as captured in our model by a positive $\rho$, the relation between a firm’s stock price and the reported earnings of other firms in the same industry tends to be positive. On the other hand, in industries where the primary source of uncertainty is firm-specific competitive advantage (about 40%-70% of the industries of their different tests), as captured in our model by a negative $\rho$, they find that the relation between a firm’s stock price and the reported earnings of other firms in the industry tends to be negative. Relatedly, Kim, Lacina and Park (2008) find a negative (positive) relation between a firm’s stock price and managerial earnings and revenue forecasts of other rival (non-rival) firms in the same industry.

Utilizing our results about the pricing functions applied by the investors in the capital market, as presented in Lemma 1 and Lemma 2, we now move backward and derive the managers’ optimal reporting strategy and their optimal production strategy. Focusing first on the managers’ optimal reporting strategy,
it appears that the managers bias their earnings report upward by a constant amount that is independent of their production decision. The accounting bias of each firm appears to be increasing in the importance that the manager attaches to the market price of the firm (as captured by the level \( \lambda \) of managerial myopia), increasing in the weight that investors assigned in their pricing rule to the accounting report of the priced firm (as captured by the direct ERC \( \alpha \)), and decreasing in the marginal biasing cost \( k \). This shape of the managers’ reporting strategy is consistent with the prior earnings management literature (e.g., Fischer and Verrecchia, 2000) and is formally stated in Lemma 3.

**LEMMA 3.** The optimal accounting bias \( b_i \) of each firm \( i \) \((i = A, B)\) equals \( b_i = \frac{\lambda \alpha}{2k} \), where \( \alpha \) is the direct ERC given in Lemma 1.

Capital market concerns of managers may induce them to engage not only in accounting-based activities of earnings management, as a mean to inflate the earnings report of their own firm, but also in real activities of cross-firm earnings management that are directed to influence the earnings report of the rival firm. However, while the propensity of the managers to engage in traditional accounting-based earnings management is increasing in the direct ERC \( \alpha \) but independent of the cross ERC \( \beta \), as indicated in Lemma 3, their drive to carry out real activities that influence the report of the rival firm would naturally depend not only on the direct ERC \( \alpha \) but also on the cross ERC \( \beta \). Knowing that the stock price responds to the reported earnings of the rival firm, as indicated by Lemma 1, the myopic managers are interested not only in the effect of their production choice on the expected profit of their own firm, but also take into consideration the effect of their production choice on the expected profit of the rival firm. In particular, it follows from Lemma 1 that each manager \( i \) \((i = A, B)\) makes the production decision that maximizes a linear combination, \((\lambda \alpha + 1 - \lambda)\pi_i + \lambda \beta \pi_j\), which assigns a weight \( \lambda \alpha + 1 - \lambda \) to the profit \( \pi_i \) of his/her own firm and a weight \( \lambda \beta \) to the profit \( \pi_j \) of the rival firm \( j \) \((j \neq i)\).
Equivalently, each manager $i$ chooses the production quantity that maximizes $\pi_i + \delta \pi_j$, where

$$\delta = \frac{\lambda \beta}{\lambda \alpha + 1 - \lambda}$$

is his/her marginal rate of substitution of the profit $\pi_j$ of the rival firm for the profit $\pi_i$ of his/her own firm. The measure $\delta$ serves in our analysis as a summary measure that condenses all the relevant information embedded in the modeling parameters $\rho$, $\lambda$, $\sigma^2_\eta$, and $\sigma^2_\epsilon$ with respect to the manager’s preferences over the profit of his/her own firm and that of the rival firm. We thus henceforth refer to the measure $\delta$ as the cross-firm substitution rate.

Based on Lemma 1, it is easy to see that the cross-firm substitution rate $\delta$ may vary from $-1$ to $+1$. When $\delta$ is positive (negative), the manager is willing to sacrifice $|\delta| < 1$ dollars of his/her own profit in order to increase (decrease) the profit of the rival by one dollar. So, while the sign of the cross-firm substitution rate $\delta$ reflects the direction of the managerial incentives for cross-firm real earnings management, its absolute value captures the magnitude of these incentives. The presentation of the cross-firm substitution rate $\delta$ in terms of the equilibrium pricing coefficients $\alpha$ and $\beta$ is useful in designing an empirical proxy that indicates circumstances where the practice of cross-firm real earnings management is more likely to occur. We, however, additionally provide in Lemma 4 the presentation of $\delta$ in terms of the primitive modeling parameters in order to explore the fundamental determinants underlying the practice of cross-firm real earnings management.

**LEMMA 4.** The cross-firm substitution rate $\delta = \frac{\lambda \beta}{\lambda \alpha + 1 - \lambda}$, where $\alpha$ and $\beta$ are the pricing coefficients given in Lemma 1, equals $\frac{\lambda \rho \varphi}{1 - \lambda + (2 - \lambda)\varphi + (1 - \rho^2)\varphi^2}$, where $\varphi = \sigma^2_\eta / \sigma^2_\epsilon$. The rate $\delta$ varies between $-1$ and $+1$. The sign of $\delta$ is identical to that of $\rho$. The absolute value of $\delta$ is increasing in $|\rho|$, increasing in $\lambda$, and non-monotonic in $\varphi = \sigma^2_\eta / \sigma^2_\epsilon$ - initially increasing in $\varphi$, reaching its maximum at
Lemma 4 indicates that the sign of the cross-firm substitution rate $\delta$ is identical to that of the parameter $\rho$. Intuitively, when the two firms are subject to positively (negatively) correlated business shocks, the stock price of each firm positively (negatively) relies on the earnings report of the rival firm, implying that the goal of the cross-firm earnings management activities of each manager is inflating (deflating) the profit of the rival firm. Not only does the sign of the correlation $\rho$ play a major role in shaping the managerial incentives for cross-firm earnings management, as reflected by the cross-firm substitution rate $\delta$. Its absolute value does so too. The more correlated are the business shocks that the two firms face, in absolute terms, the more significantly does the stock price of each firm reflect the earnings report of the rival firm, and the more eager are the managers to engage in cross-firm earnings management. Therefore, as formally stated in Lemma 4, the absolute value of the substitution rate $\delta$, which depicts the magnitude of the managerial motivation to engage in cross-firm earnings management, is increasing in the absolute value of $\rho$. Since the myopic preferences of the managers trigger their interest in the profit of their rival, the absolute value of the substitution rate $\delta$ is obviously also increasing in the level $\lambda$ of managerial myopia, as indicated by Lemma 4. Lemma 4 further points to the non-monotonic reliance of the absolute value of the substitution rate $\delta$ on the ratio $\varphi = \sigma_{\eta}^2 / \sigma_{\varepsilon}^2$ of the business uncertainty $\sigma_{\eta}^2$ to the accounting noisiness $\sigma_{\varepsilon}^2$, which stems from the non-monotonicity of the cross ERC $\beta$ in $\varphi$, as described in Lemma 2.

Managerial incentives for cross-firm real earnings management are absent only when the substitution rate $\delta$ is zero. The case of $\delta = 0$ therefore provides a natural point of reference to the analysis and serves as our benchmark. In this context, it should be noted that the substitution rate $\delta$ is always different from zero under our modeling assumptions, but it does converge to zero under some

$$\varphi = \sqrt{\frac{1 - \lambda}{1 - \rho^2}}$$

and then decreasing in $\varphi$. Also, $\lim_{\rho \to 0} \lim_{\lambda \to 0} \lim_{\varphi \to 0} \lim_{\varphi \to \infty} \delta = 0$. 


extreme circumstances. Lemma 4 implies that such circumstances occur in the model when the two firms face business shocks that are nearly uncorrelated (i.e., \( \rho \) converges to zero), or when the managers are not at all myopic (i.e., \( \lambda \) converges to zero), or in the absence of any business uncertainties (i.e., \( \sigma^2 q \) converges to zero), or in the presence of infinitely huge business uncertainties (i.e., \( \sigma^2 q \) converges to infinity), or under a perfect accounting system (i.e., \( \sigma^2 e \) converges to zero), or under totally uninformative accounting system (i.e., \( \sigma^2 e \) converges to infinity). Lemma 5 indicates that, in the benchmark case of \( \delta = 0 \), where managerial incentives for cross-firm earnings management do not exist, each firm responds to the production level of the rival firm with a level of production that maximizes its own profit, as in the classical Cournot competition. Lemma 5 further explores the deviation of the managers from the profit maximizing production decisions when \( \delta \neq 0 \) and states the direction and magnitude of their deviation in the concise terms of the cross-firm substitution rate \( \delta \).

**Lemma 5.** The best production level response \( q_i \) of firm \( i \) \((i = A, B)\) to a given production level \( q_j \) of the rival firm \( j \) \((j \neq i)\) is

\[
q_i = \frac{a - q_j - c}{2} - \frac{\delta q_j}{2},
\]

where \( \delta \) is the cross-firm substitution rate, as defined in Lemma 4.

In the benchmark case of \( \delta = 0 \), each manager \( i \) \((i = A, B)\) responds to the production level \( q_i \) of the rival firm \( j \) \((j \neq i)\) with a level of production \( \frac{a - q_j - c}{2} \) that maximizes its own profit, as in the classical Cournot competition. When \( \delta \neq 0 \), however, the two managers distort production in the direction that promotes capital market prices at the expense of economic profits. Specifically, for \( \delta > 0 \) \((\delta < 0)\), each manager \( i \) responds to the production level \( q_j \) of the rival firm \( j \) with a level that is lower (higher) than the benchmark optimal response of \( \frac{a - q_j - c}{2} \) by an amount that is equal to \( \frac{|\delta| q_j}{2} \). This
distortion in the unobservable real production level from the profit-maximizing level, which reflects the cross-firm earnings management activities of the managers, becomes stronger in its magnitude as the absolute value of the substitution rate \( \delta \) increases. Its direction is determined by the sign of the substitution rate \( \delta \). A positive rate of substitution \( \delta \) induces the two managers to compete less aggressively and cut back on production due to the cross-benefit from increasing the profit of the rival firm. On the other hand, a negative rate of substitution \( \delta \) urges the managers to compete more aggressively and increase the production level due to the added cross-benefit from a low profit of the rival firm. The resulting equilibrium outcomes are given in Proposition 6.

**PROPOSITION 6.** The model yields a unique perfect Bayesian equilibrium \((q_A, q_B, b_A, b_B, P_A, P_B : \mathbb{R}^2 \to \mathbb{R})\). In the product market, the equilibrium production quantity of each firm \( i \) \((i = A, B)\) equals \( q_i = \frac {a - c}{3 + \delta} \) and is decreasing in the cross-firm substitution rate \( \delta \) given by Lemma 4. The implied expected profit of each firm \( i \) \((i = A, B)\) equals \( E[\tilde{\pi}_i(q_A, q_B)] = (1 + \delta) \left( \frac {a - c}{3 + \delta} \right)^2 \) and is increasing in the cross-firm substitution rate \( \delta \). The equilibrium accounting biases, \( b_A \) and \( b_B \), of the firms are as given in Lemma 3. In the capital market, the equilibrium pricing functions \( P_A, P_B : \mathbb{R}^2 \to \mathbb{R} \) are as given by Lemma 1, where the above equilibrium production levels and accounting biases are conjectured by investors.

The product market equilibrium outcomes, as formally given in Proposition 6, are graphically illustrated in Figure 2, where the left plot pertains to the case of \( \delta > 0 \) and the right plot pertains to the case of \( \delta < 0 \). In both plots, the production quantity of firm \( A \) is illustrated on the vertical axis, while the production quantity of firm \( B \) is illustrated on the horizontal axis. The blue solid line in both plots is the production level response of manager \( A \) to any given production level of the rival firm \( B \). The orange solid line in both plots is the production level response of manager \( B \) to any given production
level of the rival firm $A$. The blue and orange dotted lines are the response functions of managers $A$ and $B$, respectively, in the benchmark of $\delta = 0$, which coincides with the classical Cournot competition. In the left plot, the positive substitution rate $\delta$ leads the two managers to compete less aggressively and thus their response lines are below the benchmark dotted lines. On the other hand, in the right plot, the negative substitution rate $\delta$ causes the two managers to compete more aggressively and thus their response lines are above the benchmark dotted lines. The equilibrium production quantities are captured by the intersection point of the blue and the orange solid lines. The equilibrium point reflects lower (higher) production quantities for $\delta > 0$ ($\delta < 0$) relative to the benchmark production level of $\frac{a-c}{3}$ captured by the intersection point of the blue and orange dotted lines. Capital market concerns therefore work to shift the equilibrium production quantities in the direction of the monopolist quantities (as captured in the plots by the green point) when $\delta > 0$. However, they have the opposite effect of shifting the equilibrium production quantities in the direction of the competitive quantities of zero profits (as captured in the plots by the pink point) when $\delta < 0$. In both cases, the higher is the absolute value of the substitution rate $\delta$, the larger is the distance of the equilibrium point from the benchmark point. The equilibrium point converges to the monopolist green point in the extreme case where $\delta$ approaches $+1$, and it coincides with the competitive pink point in the extreme case of $\delta$ approaching $-1$.

[Figure 2]

In spite of the myopic preferences of the two managers, which motivate them to distort production in the direction that promotes capital market prices at the expense of economic profits, the resulting profits of the two firms increase beyond the benchmark level of $\left(\frac{a-c}{3}\right)^2$ for positive values of $\delta$. This is because, when $\delta$ is positive, each firm benefits from the cross-firm earnings management activities of the
rival manager, which compensate for the cost imposed by the cross-firm earnings management activities of its own manager. A positive substitution rate $\delta$ has the interesting effect of spurring firms to collaborate with their rivals. Even though such collaboration is driven by capital market considerations, and not by the motivation of managers to maximize the economic profits of their own firms, it eventually results in higher profits for both firms in equilibrium.\(^{13}\) As $\delta$ increases from zero toward $+1$, the managers become more concerned about the profit of the rival and care less about the profit of their own firm, and therefore the collaboration between them is enhanced and their resulting profits further increase. At the extreme, when $\delta$ approaches $+1$, the collaboration is so profound that the two firms essentially behave like a monopoly and divide the monopolist profit between them.\(^{14}\) A negative substitution rate $\delta$ has the opposite effect of escalating the aggressiveness of the product market competition and consequently decreasing the profits of both firms below the benchmark level of $\left(\frac{a-c}{3}\right)^2$.\(^{15}\) As $\delta$ decreases from zero toward $-1$, the managers become more concerned about the profit of the rival and care less about the profit of their own firm, making the product market competition even more aggressive, so that the resulting decline in the profits of the firms becomes even steeper. At the extreme, when $\delta$ approaches $-1$, the competition between the two

\(^{13}\) When extending the model to allow the two managers to have asymmetric substitution rates (due to heterogeneity in either their level of myopia, the business characteristics of their firms, or the accounting system of their firms), cross-firm earnings management in an industry with a positive $\rho$ (which implies positive substitution rates for both managers) increases the aggregate profit in the industry, but this increment in the aggregate profit is not necessarily equally divided between the individual firms. If the substitution rates of the two managers do not differ a lot, the two firms share the increment in their aggregate profit, though the firm with the lower rate of substitution takes a larger share. Otherwise, only the profit of the firm with the lower rate of substitution increases while the profit of the other firm decreases.

\(^{14}\) When $\delta$ approaches $+1$ (i.e., both $\rho$ and $\lambda$ converge to $+1$), the total quantity $q_A + q_B$ produced by the two firms converges to the monopolist production quantity $\frac{a-c}{2}$ and the sum $E[\tilde{\pi}_A(q_A, q_B)] + E[\tilde{\pi}_B(q_A, q_B)]$ of their expected profits accordingly converges to the monopolist profit $\left(\frac{a-c}{2}\right)^2$, which is equally divided between them.

\(^{15}\) When extending the model to allow the two managers to have asymmetric substitution rates, cross-firm earnings management in an industry with a negative $\rho$ (which implies negative substitution rates for both managers) decreases the aggregate profit in the industry, but this decline in the aggregate profit does not necessarily apply equally to both firms. If the difference in the substitution rates of the two managers is relatively low, the two firms suffer from the decline in their aggregate profit, though the firm with the lower rate of substitution incurs a larger cost. Otherwise, only the profit of the firm with the lower rate of substitution decreases while the profit of the other firm increases.
rival firms becomes so aggressive that it results in zero profits for the firms, as in the case of a competitive market with an infinite number of firms.\[16\]

Figure 3 graphically illustrates how the deviations of the equilibrium production outcomes from the benchmark outcomes vary with the rate of substitution $\delta$. The blue curve in the left plot describes the equilibrium production quantity $q_i$ of firm $i$ ($i = A, B$) as a decreasing function of the parameter $\delta$. This decreasing curve goes through the benchmark production level $\frac{a-c}{3}$ at $\delta = 0$. It is above the benchmark production level when $\delta$ is negative and below it when $\delta$ is positive. The blue curve in the right plot similarly describes the expected equilibrium profit $E[\pi_i(q_A, q_B)]$ of firm $i$ ($i = A, B$) as an increasing function of the parameter $\delta$. This increasing curve goes through the benchmark expected profit $\left(\frac{a-c}{3}\right)^2$ at $\delta = 0$, and it is below (above) this benchmark when $\delta$ is negative (positive). Both plots demonstrate that the higher is the absolute value of $\delta$, the more significant is the deviation from the benchmark production outcomes.

[Figure 3]

Having established how the equilibrium profits of the two firms vary with the cross-firm substitution rate $\delta$ (Proposition 6) and how the cross-firm substitution rate $\delta$ varies with the modeling parameters (Lemma 4), it is now easy to obtain the relationships between the equilibrium profits of the firms and the primitive parameters $\rho$, $\lambda$, $\sigma_q^2$ and $\sigma_\varepsilon^2$. These relationships, which result immediately from Proposition 6 and Lemma 4, are formally stated in Corollary 7.

\[16\] When $\delta$ approaches $-1$ (i.e., $\rho$ converges to $-1$ and $\lambda$ converges to $+1$), the total quantity $q_A + q_B$ produced by the two firms converges to the competitive production quantity $a-c$ and the expected profits $E[\pi_A(q_A, q_B)]$ and $E[\pi_B(q_A, q_B)]$ of both firms converge to zero.
COROLLARY 7. In equilibrium, the expected profit $E[\pi_i(q_A, q_B)]$ of each firm $i$ ($i = A, B$) is increasing in $\rho$. When $\rho > 0$ ($\rho < 0$), $E[\pi_i(q_A, q_B)]$ is above (below) the benchmark profit of $\left(\frac{a-c}{3}\right)^2$, it is increasing (decreasing) in $\lambda$, and it is non-monotonic in $\phi = \frac{\sigma^2}{\Omega^2}$ - initially increasing (decreasing) in $\phi$, reaching its maximum (minimum) at $\phi = \sqrt{\frac{1-\lambda}{1-\rho^2}}$, and then decreasing (increasing) in $\phi$.

The comparative statics results, as presented in Corollary 7, are graphically illustrated in Figure 4. The left plot describes how the expected equilibrium profit $E[\pi_i(q_A, q_B)]$ of firm $i$ ($i = A, B$) varies with the parameters $\rho$ and $\lambda$. The blue curve in the left plot describes the expected equilibrium profit $E[\pi_i(q_A, q_B)]$ of firm $i$ as an increasing function of the parameter $\rho$. This increasing curve goes through the benchmark expected profit of $\left(\frac{a-c}{3}\right)^2$, as obtained from the classical Cournot competition, at $\rho = 0$. It is below (above) the benchmark level when $\rho$ is negative (positive). The higher is the absolute value of $\rho$, the more significant is the deviation of the equilibrium profit from the benchmark level. The equilibrium expected profit moves from the blue curve toward the orange curve as the managerial myopia $\lambda$ increases. So, while the direction of the deviation of the equilibrium profit from the benchmark profit is determined by the sign of $\rho$, its magnitude is increasing in the absolute value of $\rho$ and in $\lambda$. The right plot illustrates the sensitivity of the equilibrium expected profit $E[\pi_i(q_A, q_B)]$ of firm $i$ ($i = A, B$) to the ratio $\phi = \frac{\sigma^2}{\Omega^2}$. The blue and the orange curves in the right plot describe the expected profit as a function of $\phi$ for positive and negative values of $\rho$, respectively. Both curves intersect with the benchmark expected profit at $\phi = 0$. As $\phi$ increases, the blue (orange) curve initially increases (decreases), reaching a maximum (minimum) at $\phi = \sqrt{(1-\lambda)/(1-\rho^2)}$, and afterwards decreases (increases). The two curves converge again to the
benchmark level as $\phi$ converges to infinity.

[Figure 4]

Proposition 6 demonstrates the co-existence of cross-firm earnings management alongside the traditional earnings management. In equilibrium, the two managers utilize their discretion in the financial reporting process in order to shift upward their own earnings report. In addition, they also use their judgment in determining the real production quantity of their firm in order to alter the earnings report of the rival firm. The capital market investors rationally infer both the accounting-based manipulation of the two managers and the real distortion in their production decisions, and therefore perfectly adjust for the resulting biases in the earnings reports of the two firms when pricing their equity. Even though the managers know that they cannot fool the capital market, they still choose to engage in costly accounting-based earnings management activities, as well as in real activities of cross-firm earnings management that distort their production decisions. They are trapped into such behavior because they take the conjectures of the capital market investors as fixed, knowing that the investors would ascribe to them the accounting manipulation and the real production distortion in any case. This result is consistent with Stein (1989). Here, however, despite the fact that, from the narrow perspective of the firm’s value, the myopic managers choose sub-optimal production levels, it appears that the equilibrium expected values of the firms might nevertheless increase. Our analysis further suggests that cross-firm earnings management and traditional earnings management may apparently behave as either complement or substitute practices. This is because the involvement of managers with the two practices of earnings management may react to changes in the business conditions or in the accounting regulation either in the same direction or in opposite directions, depending on the specific circumstances. To understand the insights that the analysis yields in this context, it should be noted that, while the rate $\frac{\lambda \alpha}{2k}$ captures the magnitude of the managerial motivation to engage in traditional accounting-based earnings management, it is the absolute value of the cross-firm substitution rate $\delta$ that captures the
magnitude of the managerial motivation to engage in cross-firm real earnings management. It now follows immediately from the comparative statics results presented in Lemma 2 and Lemma 4 that an increase in the level $\lambda$ of managerial myopia works to enhance the managerial incentives to engage in both practices of earnings management, but an increase in the absolute value of the correlation $\rho$ between the business uncertainties of the two firms decreases the managerial motivation to engage in traditional accounting-based earnings management while increasing the managerial drive to carry out real activities of cross-firm earnings management. It also follows that, an increase in the ratio $\varphi = \sigma_\eta^2 / \sigma_\varepsilon^2$, due to either an escalation in the business uncertainty or an improvement in the accounting quality, works to amplify both practices of earnings management in environments with relatively low $\varphi$, but in environments with sufficiently high $\varphi$ it rather works to encourage traditional earnings management while diminishing cross-firm earnings management.

4. **Summary and Conclusions**

It is conventionally perceived in the literature that opportunistic earnings management occurs when managers use judgment in financial reporting and in structuring transactions to alter financial reports to either mislead some stockholders about the underlying economic performance of the company or to influence contractual outcomes that depend on the reported accounting numbers. In this classical definition of earnings management, originally provided by Healy and Wahlen (1999, page 368), as well as in other definitions that appear in the literature, the target of earnings management is the accounting report of the managers’ own firm. We draw attention to another practice of earnings management, previously unexplored in the literature, which aims to influence the reported earnings of other firms. We refer to this practice as cross-firm earnings management. Such a practice can only exist if managers have both the incentives and the tools to affect the reported earnings of peer firms. We argue that managerial incentives for cross-firm earnings management can stem from capital market concerns of managers. In particular, knowing that stockholders
can learn about the fundamental value of any particular firm from observing the earnings announcements of
other firms that operate in the same industry, managers may have incentives to influence the earnings reports
of rival firms in order to mislead the stockholders about the value of their own firm. Managers obviously do
not have access to the accounting system of peer firms, but they can nevertheless influence the economic
profits of rival firms, and thereby also their earnings reports, by distorting real transactions that relate to the
product market competition. Hence, while the linkage between peer firms in the capital market provides their
managers with the incentives to engage in cross-firm earnings management, the linkage between the firms in
the product market equips their managers with the tools to do so.

We demonstrate such managerial behavior and study its consequences and its interrelation with
traditional earnings management activities within a setting that depicts a game between two competing firms
that operate in the same product market and their stocks are publicly traded in the same capital market. An
analysis of our game suggests that capital market concerns of managers not only induce them to engage in
traditional accounting manipulations. They may additionally evoke incentives for real activities of cross-firm
earnings management that affect the aggressiveness of the competition in the product market. This implies
that the practice of cross-firm earnings management may co-exist in equilibrium alongside the traditional
practice of earnings management. It appears, however, that the extent to which managers are involved with
these two practices of earnings management may react to changes in the business conditions or in the
accounting regulation either in the same direction or in opposite directions, depending on the specific
circumstances. Hence, cross-firm earnings management and traditional earnings management may
apparently behave as either complement or substitute practices.

The analysis interestingly suggests that the practice of cross-firm earnings management is not
necessarily costly to firms, even though it involves the distortion of real production decisions. Our analysis
yields the prediction that in industries where competing firms face positively correlated business shocks (e.g.,
fluctuations in downstream consumer tastes and in upstream input prices), real activities of cross-firm
earnings management are expected to increase the profits of the firms, because they work to diminish the aggressiveness of their product market competition and allow for collaboration between them. On the other hand, in industries where competing firms face negatively correlated business shocks (e.g., fluctuations in the market share of the competing firms), real activities of cross-firm earnings management are likely to result in lower profits for the firms, as they work to accelerate the aggressiveness of their competition in the product market. Our analysis further alludes to the sensitivity of the product market competition to the ownership structure of the competing firms, and in particular to whether they are privately held or publicly traded. In particular, it follows from our analysis that the competitive behavior of firms might significantly alter when peer firms in the industry go public or alternatively go private.

The analysis given in this study suggests several possibilities for future research. While it sheds light on the incentives of managers to affect the reported earnings of rival firms and explores some of the real activities that managers might employ in their attempt to do so, we believe that there is considerable potential for further investigating the consequences of such activities, as well as their underlying determinants, and in exploring other kinds of real activities of cross-firm earnings management. Extensions of our analysis could involve settings with different competitive structures (e.g., Stackelberg competition, Bertrand competition, or a repeated Cournot game instead of the single shot Cournot game), settings with asymmetries between firms (e.g., asymmetry in managerial myopia, production cost, business uncertainty or accounting noise), or settings with an endogenous choice of some of the firms’ characteristics (e.g., endogenous choice of managerial myopia or endogenous accounting noise that stems from opportunistic accounting manipulations that the capital market is incapable of perfectly adjusting for).
APPENDIX – PROOFS

Proof of Lemma 1.

The third and fourth conditions of the equilibrium imply

\[ P_A(r_A, r_B) = E\left[ \tilde{\pi}_A(q_A, q_B) | r_A, r_B \right] = E\left[ \mu_A + \tilde{\eta}_A | \mu_A + \tilde{\eta}_A + \tilde{\sigma}_A + \tilde{b}_A = r_A, \mu_B + \tilde{\eta}_B + \tilde{\sigma}_B + \tilde{b}_B = r_B \right] \]

and

\[ P_B(r_A, r_B) = E\left[ \tilde{\pi}_B(q_A, q_B) | r_A, r_B \right] = E\left[ \mu_B + \tilde{\eta}_B | \mu_B + \tilde{\eta}_B + \tilde{\sigma}_B + \tilde{b}_B = r_A, \mu_A + \tilde{\eta}_A + \tilde{\sigma}_A + \tilde{b}_A = r_B \right] , \]

where

\[ \mu_A = \hat{q}_A(a - \hat{q}_A - \hat{q}_B - c) , \text{ and } \mu_B = \hat{q}_B(a - \hat{q}_B - \hat{q}_A - c) . \]

Employing our distributional assumptions we get

\[ P_A(r_A, r_B) = \mu_A + \alpha \left( r_A - \mu_A - \tilde{\sigma}_A \right) + \beta \left( r_B - \mu_B - \tilde{\sigma}_B \right) \]

\[ \text{and } P_B(r_A, r_B) = \mu_B + \alpha \left( r_B - \mu_B - \tilde{\sigma}_B \right) + \beta \left( r_A - \mu_A - \tilde{\sigma}_A \right) , \]

where

\[ \alpha = \frac{\varphi + (1 - \rho^2)\varphi^2}{1 + 2\varphi + (1 - \rho^2)\varphi^2} , \beta = \frac{\rho\varphi}{1 + 2\varphi + (1 - \rho^2)\varphi^2} , \text{ and } \varphi = \frac{\sigma_q^2}{\sigma_e^2} . \] \( \square \)

Proof of Lemma 2.

Given that \( \varphi > 0 \), the direct ERC \( \alpha = \frac{\varphi + (1 - \rho^2)\varphi^2}{1 + 2\varphi + (1 - \rho^2)\varphi^2} \) is positive and the cross ERC

\[ \beta = \frac{\rho\varphi}{1 + 2\varphi + (1 - \rho^2)\varphi^2} \] has the same sign as \( \rho \). The direct ERC \( \alpha \) is decreasing in \( |\rho| \) because

\[ \frac{d\alpha}{d\rho} = -\frac{2\rho\varphi^2(1 + \varphi)}{(1 + \varphi(2\varphi - \rho^2)\varphi^2)} \] has the same sign as \( -\rho \), and it is increasing in \( \varphi \) because

\[ \frac{d\alpha}{d\varphi} = \frac{1 + (1 - \rho^2)(2 + \varphi)}{(1 + \varphi(2\varphi - \rho^2)\varphi^2)} > 0 \] Also, \( |\beta| \) is increasing in \( |\rho| \) because

\[ \frac{d\beta}{d\rho} = \varphi - \frac{1 + 2\varphi + (1 - \rho^2)\varphi^2}{(1 + 2\varphi + (1 - \rho^2)\varphi^2)^2} > 0 \]

and \( \text{sign}(\beta) = \text{sign}(\rho) \). Lastly, \( |\beta| \) can be written as \( |\beta| = \frac{|\rho|}{F(\varphi)} \), where

\[ F(\varphi) = \frac{1}{\varphi} + 2 + (1 - \rho^2)\varphi \] is a convex function that attains its minimum at \( \varphi = \sqrt{\frac{1}{1 - \rho^2}} \). \( \square \)
Proof of Lemma 4.

Using the expressions for $\alpha$ and $\beta$ from Lemma 1 we have that

$$\delta = \frac{\lambda \beta}{\lambda \alpha + 1 - \lambda} = \frac{\lambda \rho \varphi}{1 - \lambda + (2 - \lambda) \varphi + (1 - \rho^2) \varphi^2},$$

where $\varphi = \frac{\sigma^2}{\sigma^2}$.

It follows from $-1 < \rho < 1$, $0 < \lambda \leq 1$, and $0 < \varphi < \infty$ that $-1 < \delta < 1$ and $\text{sign}(\delta) = \text{sign}(\rho)$. Also, $|\delta|$ is increasing in $|\rho|$ because

$$\frac{d\delta}{d\rho} = \frac{\lambda \rho \varphi (1 - \lambda + (2 - \lambda) \varphi + (1 - \rho^2) \varphi^2)}{[1 - \lambda + (2 - \lambda) \varphi + (1 - \rho^2) \varphi^2]^2} > 0 \quad \text{and} \quad \text{sign}(\delta) = \text{sign}(\rho),$$

and it is increasing in $\lambda$ because

$$\frac{d\delta}{d\lambda} = \frac{\rho \varphi (1 + \varphi (2 + \varphi \rho^2))}{[1 - \lambda + (2 - \lambda) \varphi + (1 - \rho^2) \varphi^2]^2} \quad \text{has the same sign as} \quad \rho.$$

Lastly, $|\delta|$ can be written as $|\delta| = \frac{\lambda |\rho|}{2 - \lambda + G(\varphi)},$

where $G(\varphi) = \frac{1}{\varphi}(1 - \lambda) + (1 - \rho^2) \varphi$ is a convex function that attains its minimum at $\varphi = \frac{1 - \lambda}{\sqrt{1 - \rho^2}}$. □

Proof of Lemma 3 and Lemma 5.

The manager of firm $i$ takes his/her conjectures for the production level $q_j$ and the accounting bias $b_j$ of firm $j$, as well as his/her conjectures for the pricing rules applied by the capital market investors, and chooses a pair of production quantity $q_i$ and accounting bias $b_i$ such as to maximize

$$E \left[ \lambda P_i \left( \tilde{r}_i, \tilde{r}_j \right) + (1 - \lambda) \tilde{x}_i \left( q_i, q_j \right) - kb_i^2 \right].$$

Using Lemma 1, the decision problem of manager $i$ can be reduced to choosing a pair of $q_i$ and $b_i$ to maximize the function

$$H_i(q_i, b_i) = (\lambda \alpha + 1 - \lambda) q_i (a - q_i - q_j - c) + \lambda \beta q_j a - q_j - q_j - c + \lambda \alpha b_i - kb_i^2.$$  This yields the following first-order conditions:

$$\frac{\partial H_i}{\partial q_i} = (\lambda \alpha + 1 - \lambda) (a - 2q_i - q_j - c) - \lambda \beta q_j = 0$$  and  $$\frac{\partial H_i}{\partial b_i} = \lambda \alpha - 2kb_i = 0,$$

which imply $q_i = \frac{a - q_j - c}{2} - \frac{\delta q_j}{2}$ and $b_i = \frac{\lambda \alpha}{2k}$, where $\delta = \frac{\lambda \beta}{\lambda \alpha + 1 - \lambda}$. The second-order conditions are
\[
\frac{\partial^2 H_i}{\partial q_i^2} = -2(\lambda \alpha + 1 - \lambda) < 0, \quad \frac{\partial^3 H_i}{\partial q_i^2 \partial b_i} = -2k < 0 \quad \text{and} \quad \frac{\partial^2 H_i}{\partial q_i^2}, \frac{\partial^3 H_i}{\partial q_i^2 \partial b_i} - \left( \frac{\partial^3 H_i}{\partial q_i \partial b_i} \right)^2 = (-2(\lambda \alpha + 1 - \lambda))(-2k) - 0 > 0. \]

**Proof of Proposition 6.**

Lemma 5 establishes that the best production level response of firm A is \( q_A = \frac{a - \hat{q}_b - c}{2} - \frac{\delta \hat{q}_b}{2} \), and that of firm B is \( q_B = \frac{a - \hat{q}_b - c}{2} - \frac{\delta \hat{q}_b}{2} \), where \( \delta = \frac{\lambda \beta}{\lambda \alpha + 1 - \lambda} \), and where \( \hat{q}_i \) is the conjecture of firm \( j \) about the quantity chosen by firm \( i, i = A, B, i \neq j \). Using the fifth equilibrium condition, \( \hat{q}_A = q_A, \hat{q}_B = q_B \), the solution for the two production response equations is \( q_A = q_B = \frac{a - c}{2 + \delta} \). These quantities yield expected profits of \( E[\tilde{\pi}_A(q_A, q_B)] = E[\tilde{\pi}_B(q_A, q_B)] = \left(1 + \delta\right)\left(\frac{a - c}{3 + \delta}\right)^2 \). We have that

\[
\frac{\partial E[\tilde{\pi}_i(q_A, q_B)]}{\partial \delta} = \frac{(a - c)^2 (1 - \delta)}{(3 + \delta)^3} \geq 0, \quad i = A, B, \quad \text{with equality only at} \quad \delta = 1. \]

**Proof of Corollary 7.**

The proof follows immediately from Lemma 4 and Proposition 6. \( \square \)
REFERENCES


Figure 1 provides a timeline depicting the sequence of events in the model.

**PRODUCT MARKET**
Managers simultaneously choose production quantities $q_A$ and $q_B$

**ACCOUNTING SYSTEM**
Managers simultaneously choose accounting biases $b_A$ and $b_B$

Earnings reports $r_A$ and $r_B$ are produced by the accounting system

**CAPITAL MARKET**
Investors set equity prices $P_A$ and $P_B$ in the capital market

**LIQUIDATION**
Profits $\pi_A$ and $\pi_B$ are realized and distributed as a liquidation dividend
Figure 2 illustrates the response functions of the two managers, where the left plot pertains to the case of $\delta > 0$ and the right plot pertains to the case of $\delta < 0$. In both plots, the production quantity of firm $A$ is illustrated on the vertical axis, while the production quantity of firm $B$ is illustrated on the horizontal axis. The blue solid line in both plots is the production level response of manager $A$ to any given production level of the rival firm $B$. Similarly, the orange solid line in both plots is the production level response of manager $B$ to any given production level of the rival firm $A$. The blue and orange dotted lines are the response functions of managers $A$ and $B$, respectively, in the benchmark of $\delta = 0$. The equilibrium production quantities are captured by the intersection point of the blue and the orange solid lines. The benchmark production quantities are captured by the intersection point of the blue and the orange dotted lines. The green point depicts the monopolist production quantities, while the pink point depicts the competitive production quantities that lead to zero profits.
Figure 3 is based on parameter values $a = 100$ and $c = 10$. The left plot illustrates the firms’ equilibrium production quantities as a function of the cross-firm substitution rate $\delta$. The horizontal axis presents all the possible values of the cross-firm substitution rate $\delta$, which may vary from $-1$ to $+1$. The dotted horizontal line illustrates the benchmark production quantity $\left(\frac{a-c}{3}\right)^2$ of firm $i$ ($i = A, B$) under $\delta = 0$. The decreasing blue curve describes the equilibrium production quantity $q_i$ of firm $i$ as a function of $\delta$. The right plot illustrates the firms’ equilibrium expected profits as a function of the substitution rate $\delta$. The horizontal axis again presents all the possible values of the substitution rate $\delta$, which may vary from $-1$ to $+1$. The dotted horizontal line illustrates the benchmark expected profit $\left(\frac{a-c}{3}\right)^2$ of firm $i$ ($i = A, B$) under $\delta = 0$. The increasing blue curve describes the equilibrium expected profit $E[\pi_i(q_A, q_B)]$ of firm $i$ as a function of $\delta$. 


Figure 4 is based on parameter values $a = 100$ and $c = 10$, as in Figure 3. The left plot illustrates the firms’ equilibrium expected profits as a function of the parameters $\rho$ and $\lambda$, where $\varphi = \frac{\sigma_\eta^2}{\sigma_\varepsilon^2} = 1$. The horizontal axis describes all the possible values of the parameter $\rho$, which may vary from $-1$ to $+1$. The blue curve describes the equilibrium expected profit $E[\tilde{\pi}_i(q_A, q_B)]$ of firm $i$ ($i = A, B$) as a function of the parameter $\rho$. As the parameter $\lambda$ increases from $0.5$ to $0.8$, the curve of $E[\tilde{\pi}_i(q_A, q_B)]$ moves toward the orange curve. The right plot illustrates the firms’ equilibrium expected profit as a function of the parameter $\varphi = \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}$, where $\lambda = 0.5$ and $\rho = \pm 0.5$. The horizontal axis describes all the possible values of the parameter $\varphi = \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}$, which may vary from zero to infinity. The blue (orange) curve describes the equilibrium expected profit $E[\tilde{\pi}_i(q_A, q_B)]$ of firm $i$ ($i = A, B$) as a function of the parameter $\varphi = \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}$ for a positive (negative) value of $\rho$. 