Product Market Competition and Real Activities Manipulation: Theory and Implications

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We investigate how a firm manipulates its real activities in production to meet the earnings target in product market competition rather than provides a rational response triggered by product market considerations. We show that the equilibratory way to reach the earnings target is to set a higher first-period output, as this can reach a higher short-term profit level. This also reflects the myopic concern for a firm engaging in real activities manipulation and may undermine its long-term competitiveness. Moreover, the tendency for firms to meet the earnings target is motivated by marketwide demand conditions, where once the expected level of demand uncertainty is high, a firm will exploit the effect of high level of expected demand uncertainty on its output choice by taking mixed strategy and raising its short-term output level. Thus, we show that abnormal output may occur in equilibrium even when opportunistic real activities manipulation is absent. This suggests that one should take into account longer-horizon paths of variables in attempting to detect opportunistic real activities manipulation.

Keywords: Earnings Target; Real Activities Manipulation; Cournot Competition; One-sided Incomplete Information.

JEL: D82; L13; M41

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Abstract

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1 Introduction

It is well-acknowledged that accounting earnings play an important role in the financial markets. Recent literature incorporates the role that the financial market plays in non-financial market settings such as firm internal compensation[1] and investment[2]. This paper, among others, incorporates the desire to meet earnings target, a particular financial market phenomenon, into firms' operating decision making vis-a-vis product market competition against its product-market rivals. We investigate how a firm manipulates its real activities in production to meet the earnings target in product market competition rather than provides a rational response triggered by product market considerations. Economic shocks have an effect on a firm's performance and its real decision, which may create an uncertainty. When a firm responds by engaging in abnormal real activities, it could mask the effect of the shocks on reported earnings in an attempt to continue reporting high earnings[3] or alter its real decisions as part of a rational response to the shocks so that the firm's reported earnings will reflect the shocks' effect on firm value. The former (opportunistic real activities manipulation) can be mixed with the latter (rational real activities) and, hence, is difficult for an auditor, regulator or

[1]For example, Andergassen (2016) considered an agency model in which managers can exert unobservable cost-cutting efforts and have private information about firm profits in which they may use fraudulent reporting to inflate their stock and stock option-based compensation packages.

[2]For example, Yang et al. (2016) showed that in order to satisfy its investment demands, financially constrained firms overstate their earnings around seasoned equity offerings (SEOs) and perform well after SEOs.

[3]Recent studies provide evidence that management may use real earnings manipulation for meeting or beating some earnings target. Graham et al. (2005) indicated that 80 percent of respondents (chief financial officers and financial executives) would decrease discretionary spending on research and development (R&D), advertising, or maintenance to meet an earnings target, and 60 percent would avoid initiating a positive net present value project if it meant falling short of analysts' consensual earnings forecasts. If earnings targets remain high, but accounting standards become increasingly stringent, there is a negative consequence for managers seeking to meet short-term earnings goals, which may increasingly substitute accounting earnings management with more substantive and potentially damaging changes in strategic decisions (Roychowdhury 2006; Mizik and Jacobson 2007; Cohen and Zarowin 2010; Badertscher 2011; Zang 2012; Chan et al. 2015; Kothari et al. 2016).

even product market competitors to detect.

Opportunistic real activities manipulation will not only have competitive, but also informational impacts in product market competition. For product market competitors, the suspicion that a firm might manipulate its real activities for a higher profit will create additional uncertainty. For example, the firm might engage in abnormal real activities on either a myopic intention or a profit-maximization intention. This uncertainty can influence competitors' real activities. If opportunistic real activities manipulation is fully anticipated by its competitors, it can induce competitive interaction and retaliation from the competitors in the long-term and can have an impact on the firm's long-term competitiveness as well.

Zhang and Gimeno (2010) examined the effect of earnings pressure felt by management to meet an earnings target on a firm's behavior in oligopolistic output competition in which the production decisions serve as the vehicle through which the firm carries out its real activities manipulation. Zhang and Gimeno (2010) found that firms facing an earnings target tended to restrict output in markets in which market structure and competitor characteristics were favorable for the exercise of market power, while their competitors tended to increase output in those markets. However, if a firm has a myopic incentive, how does this change the firm intertemporal operating activities for higher short-term earnings in equilibrium? Moreover, when opportunistic real activities manipulation creates an uncertainty such that abnormal real activities may result from diverse objectives, how does the firm take advantage of this uncertainty to meet an earnings target and boost short-term earnings? Could the rival firm identify the informed firm's identity effectively (i.e., identifying opportunistic real activities manipulation or not)? How does this uncertainty influence the rival firm's response?

We examine the competitive and informational impact of one firm's abnormal output levels (either opportunistically use abnormal output to mask the firm's reported earnings or rationally respond to competition pressure) on its rival's responses within a Cournot game between two firms operating in the same product market. Output decisions in oligopolistic competition are highly interactive, since firms' output decisions affect market-clearing prices and competitors' output decisions. This mutual adjustment of output decisions and equilibrium outcomes are captured in a simplified form in the Cournot oligopoly model (Cournot, 1838), whereby firms make simultaneous interdependent output decisions that determine market-clearings prices and profits. We consider a two-period Cournot competition model with one-sided incomplete information and demand shocks. The one-sided incomplete information refers to one of two competing firms that has private information on its identity, for example whether it prefers to maximize profits or attempts to meet two-period earnings target. The other (rival) firm maximizes profits and does not know the first firm's type (i.e., whether it is profit-maximization-type or earnings-target-type). The profit-maximization-type firm pursues profits maximization within two periods, while the earnings-target-type firm attempts to meet earnings target within two periods and smooth over the annual earnings, but pursues increasing short-term profit, which reflects this type of firm's myopic objective. Moreover, the demand shock reflects that the informed firm (either profit-maximization-type or earnings-target-type) may mask the effect of demand shock on its first-period profit with an expectation on demand shock and thus boost its first-period output level in an attempt to increase short-term profit.

By this setting, the rival (uninformed) firm can revise its assessments of the informed firm's identity depending on the informed firm's first-period output decisions and the realization of demand shock at the end of the first period, i.e., the informed firm's output level could be used for both competitive and informational intentions in the product market competition. In addition, the rival's first-period responses affect the informed firm's first-period output decisions in two ways. First, the informed firm may engage in real activities manipulation by opportunistically altering its first-period output decisions to take advantage of the rival's uncertainty about the informed firm's identity and obtain higher short-term earnings (i.e., the informed firm is the earnings-target-type). Alternatively, the informed firm may alter its first-period decisions as a rational response to the rival's first-period decision (i.e., the informed firm is the profit-maximization-type). One informed firm may mimick another's behavior and thus create its rival uncertainty about the informed firm's objective, in which the informed firm can take advantage of this uncertainty and change its intertemporal operating activities for a higher short-term profit level. Specifically, the informed firm could change its first-period output decisions before the realization of demand uncertainty in order to maintain its rival's uncertainty about the informed firm's objective.

In what follows, we briefly summarize the major results. For a higher first-period profit level, the earnings-target firm raises its first-period output level to achieve a higher short-term profit and lowers the second-period output to reach the earnings target, even though such behaviors may undermine its competitiveness; the profit-maximization type firm makes an output decision as a rational response to the rival's output decision in each period. This is a separating equilibrium because the equilibrium strategy separates the profit-maximization type from the earnings-target type. Although the informed firm can enhance its first-period profit through boosting its output levels, this will induce the rival firm to respond aggressively in the second period. However, this does not violate the empirical results that a firm distorts its abnormal real decision intertemporally in order to meet earnings target, even though such behavior may undermine its long-term competitiveness.

Moreover, we show that the tendency for firms to meet earnings target is motivated by marketwide demand conditions. Specifically, once the expected level of demand uncertainty in the first period is high, the profit-maximization-type firm is motivated to conceal its identity by taking advantage of the effect of the high level of expected demand shock on its first-period output choice and then taking a mixed strategy. This type of firm raises its first-period output level in an attempt to enhance its profit level. This is a hybrid equilibrium in which with some probability the profit-maximization-type firm pretends to be the earnings-target-type firm by mimicking its aggressiveness in product market competition, and the rival firm cannot perfectly identify the opportunistic abnormal output activities. We further illustrates that the tendency for firms to meet earnings target is positively related to the marketwide business condition. As the expected level of demand shock further increases, there will be a higher likelihood that the profit-maximization-type firm pools with the earnings-target-type firm. This further confounds the rival firm's ability to identify opportunistic abnormal output activities and thus the profit-maximization-type firm's absolute amount of real activities manipulation gain is higher. Accordingly, the rival firm will respond less aggressively in the second period.

The main contribution of this paper is to show that observing abnormal production is not sufficient for identifying opportunistic real activities manipulation. The analysis suggests that reversals in production may indicate that opportunistic real activities manipulation happens previously. Specifically, a reversal of an abnormal decision in the second period after the decision takes place could be indicative of the degree to which the decision is opportunistic or rational and predicts that both current abnormal operating activity with a higher profit level and future sub-optimal operating activity with a lower operating performance are relevant to identify opportunistic real activities manipulation. In addition, our paper implies that the effect of economic shocks on a firm's performance also confounds a rival's ability to accurately identify opportunistic real activities manipulation through observing only the realization of short-term output activity and economic shocks. This is consistent with Cohen et al. (2019) who argued that economic shocks to a firm's performance could confound a researcher's ability to accurately estimate abnormal real activities. Owens et al. (2017) also analyzed how shocks to firms' business models confound estimation of discretionary accrual.

Our paper also suggests that a market-leader firm facing earnings targets may exploit its available market power to generate a higher short-term profit level through real distortions in production and will induce a rival to respond aggressively later, thus reducing the market-leader firm's long-term product market competitiveness. This is consistent with Zhang and Gimeno (2010), who provided evidence of the negative impact of short-term earnings pressure on long-term product market competition, where a firm will restrict output so as to increase prices and current earnings, even though such behavior may encourage output expansion by competitors and undermine competitiveness. Chapman (2011) also presented evidence that firms use quarter-end price promotions to accelerate profit intertemporally in order to meet earnings targets they otherwise would have missed. Chapman showed that price promotion to boost short-term earnings at the end of the fiscal quarter may persuade competitors within an industry to follow.

Finally, our paper is related to recent studies which have examined the relation between the kinky earnings phenomenon and (accruals) earnings manipulation and proposed different conclusions. On the one hand, some studies raise doubts about whether earnings manipulation explains the observed discontinuities in the distribution. Dechow et al. (2003) showed that small profit firms have high discretionary accruals relative to other firms. However, the earnings kink does not disappear or decline when they focus on the distribution of firms with income decreasing discretionary accruals. They point out that the boosting of discretionary accruals partially explains earnings kinky. Durtschi et al. (2005) found that earnings kinky may be driven by other factors including: scaling, sample selection, and the effects of special items and taxes. Beaver et al. (2007) showed that the asymmetric effects of income taxes and special items rather than discretionary accrual behavior on the earnings of profit and loss firms contribute to the discontinuity at zero in the earnings distribution. Other studies present evidence that firms engage in earnings management only to meet or beat earnings target. Gore et al. (2007), for the U.K., and Daske et al. (2006), for the EU, presented evidence that discretionary accruals have the effect of increasing the frequency of achieving positive earnings levels, earnings changes, and earnings surprises. Our analysis shows that when a market is less transparent (on the producer side), there is a higher probability that the profit-maximization-type firm pools with the earnings-target-type firm and then this further confounds a rival firm's ability to identify opportunistic real activities manipulation. This further creates a chance for the market-leader firm to distort its production quantities and have kinky earnings surrounding the current earnings threshold. Thus, this kinky earnings phenomenon can reflect either opportunistic real activities manipulation or prudent business decisions (non-opportunistic real activities manipulation).

The remainder of this paper is organized as follows. Section 2 summarizes the related literature and discusses the contribution of this paper relative to the existing literature. Section 3 describes a two-period Cournot competition model with one-sided incomplete information. The objective function of each firm is also provided. Section 4 characterizes the equilibrium properties in a two-period Cournot competition with one-sided incomplete information and discusses our equilibrium results as well. Section 5 presents the conclusion. For ease of presentation, long proofs are relegated to the appendix.

2 Related Literature

Bagnoli and Watts (2010) investigated how misreporting in production cost affects product market competition and how rivalry impacts both production decisions and misreporting decisions. They showed that Cournot competitors bias their reports to create the impression that their costs are lower than they actually are. This bias leads to lower total production and a higher product price, even though each firm fully understands its rival's incentives to bias its financial reports. Our study addresses the impact of real distortion in production on product market competition. Specifically,, in our model, opportunistic real activities manipulation in production emerges in equilibrium even though each firm's production cost information is nonproprietary in which firms will not engage in accounting-based earnings manipulation in product market competition. Thus, opportunistic real activities manipulation in production is distinct from accounting-based earnings manipulation. Moreover, in our model, a rival firm's uncertainty about a signaling firm's real type provides another rationale of withholding of information (preventing full disclosure in equilibrium). We show that real activities manipulation in production will provide a noisy signal about the signaling firm's strategic and informational incentives. Such complexity will further impact the rival firm's response later and the signaling firm's long-term product market competitiveness. Markarian and Santalo (2014) examined the impact of product market competition on a firm's incentive to engage in real (accruals) earnings manipulation for capital market valuation. Our study investigates the trade-off between the informational and strategic impact of real activities manipulation in production and the long-term consequences of this, which makes our paper different from Markarian and Santalo (2014).

Our study is also related to the literature on real smoothing. Acharya and Lambrecht (2015) considered an environment where a manager fears intervention by investors, when their earnings expectations are not met and as a result manages earnings downward and underproduces so as to lower investors' expectation about future income. Acharya and Lambrecht (2015) showed that based on sales information, the capital market may or may not infer the correct value of the firm's income, and the manager will reduce the production level to downplay the firm's fundamentals and lower outsiders' income expectation. Thus, the earnings expectation is not raised in the future. Moreover, the firm may smooth and adjust output and payout process over time in response to economic shocks. In our paper, to motivate the earnings-target-type firm myopia, we focus on the case in which this type of firm prefers a higher first-period profit and a lower second-period profit in which real smoothing is real activities manipulation in production for a higher short-term profit in terms of expansion of short-term output at the risk of reducing long-term product market position for a myopic firm. Due to this type of firm myopic concern, it will not further beat the earnings target and attempting to achieve a mark at least as large as the target. It will attempt to hit the earnings target.

One study examines the economic consequences of earnings management and fraudulent accounting on aggregate economic activity. Kedia and Philippon (2009) studied a problem of managers who privately observe the true productivity of their firms and who make employment and investment decisions. They show that firms with low true productivity boost their reporting earnings (in terms of discretionary accruals earnings management) and mimick efficient firms' investment and employment to maintain consistency between reporting earnings and actions. These will distort the allocation of resources in the economy, and hiring and investment are lower after the misreporting period. Our study varies from Kedia and Philippon (2009) because we examine the long-term consequence of real activities manipulation in an intertemporal Cournot competition setting. In particular, we investigate how opportunistic real activities manipulation distorts a firm's intertemporal output decisions by taking advantage of its rivals' uncertainty about its truthfulness in its identity and the consequences of real distortions in intertemporal productions on long-term product market competition.

3 The Model

To examine the impact of opportunistic real activities manipulation to meet earnings targets on a firm's intertemporal real decisions and how this affects real operating decisions of other firms in the same industry, we consider a two-period Cournot competition model with one-sided incomplete information in which one firm is uncertain about the other firm's type. The uncertainty about the informed firm type reflects doubts concerning its operating activity and its related strategic intentions. To give a conjecture on the plausibility of this setting, we consider the U.S. electricity generation industry. A few large generators dominate this industry and there are more for-profit competitors and few not-for-profit competitors. Moreover, some of the dominant firms are profit-maximizers or face earnings benchmark felt by management to avoid reporting losses and focus around the zero earnings level[4].

As argued in the introduction, the informed firm's real activities manipulation in production can be mixed with a rational response to a rival's output decision in Cournot competition and is difficult for the rival to detect. With this uncertainty, the uninformed firm (the rival) will not fully anticipate the real intention in an abnormal production level, which can reflect either opportunistic real activities manipulation or prudent business decisions (non-opportunistic real activities manipulation). We will investigate whether the informed firm can take advantage of its rival's uncertainties regarding its truthfulness in its identity and then arrange its outputs level for a higher first-period earnings level.

The Environment

We consider two firms which provide differentiated products in the industry with demand uncertainty. Following Dixit (1979) and Singh and Vives (1984), we assume the following inverse demand function for each period:

$$p_i(q_i, q_j, \varepsilon) = a - q_i - bq_j + \varepsilon,$$

[4] In addition, Carvajal et al. (2017) provided empirical evidence to suggest that Australian managers attempt to avoid making losses and earnings decreases, which implies that managers consider these earnings benchmarks as important.

where market demand is determined by a constant term (a) and a random shock term (ε). The random term ε represents the demand shock, which is assumed to be an uniformed distribution over $[-\bar{\varepsilon}, \bar{\varepsilon}]$ and identical independent distribution for each period. Moreover, two firms determine industry output ($q_i + q_j$) where q_i and q_j, for i, $j = 1, 2$, denote firm i and firm $j's$ arbitrary output, respectively. b represents the extent of differentiation between the two firms' products, $0 < b < 1$. When b approaches 1, the two firms' products are perfect substitutes, and when b approaches 0, the two firms' products are isolated. This inverse demand function implies that high outputs ($q_i + q_j$) could reduce market price, and high demand ($a + \varepsilon$) could induce a high market price. We assume a linear cost function for the two firms: $c_i q_i$, $i = 1, 2$, within two periods.

The Timeline

At the beginning of period 1, firm 1 is privately informed of its type, which can be either profit-maximization-type (m) or earnings-target-type (r). The profit-maximization-type firm maximizes the sum of profits within two periods, while the earnings-target-type firm attempts to reach earnings targets within two periods and smooth over the annual earnings, but prefers a higher short-term earnings level. Firm 1 could be a market-leader firm and may likely engage in real activities manipulation strategy, because the erosion to its competitive advantage is relatively small (e.g., Zhang and Gimeno, 2010; Zang, 2012). Firm 1 and firm 2 engage in Cournot competition in the first period with demand uncertainty. We investigate how firm 1 engages in real activities manipulation through production in the first period and transfers part of its profit from one period to the other period.

At the end of the first period, both firms' first-period payoffs and first-period random shock are realized and firm 2 updates its belief about firm 1's type after observing these. Based on the realized profits of the first period, the earnings-target-type of firm 1 will determine the required extent of profit for meeting the earnings target in the second period. Then, the two firms compete in Cournot again, and the second-period profits are realized in the end. We assume that there is no demand shock in the second period and that this avoids failure to reach the earnings target for the earnings-target-type firm.

Information

We use the following settings to describe the uncertainty about firm 1's type. ρ^t, $t = 1, 2$, represents firm 2's belief (ex-ante and ex-post) that firm 1 is a profit-maximization-type, while $1 - \rho^t$ represents the belief that it is an earnings-target-type.

Before competition, the first-period belief ρ^1 with $0 < \rho^1 < 1$ is exogenously given as a prior belief. The second-period belief ρ^2 will be endogenously determined by the prior belief ρ^1, firm 1's first-period output levels, and the realization of first-period demand uncertainty. We will discuss the on- and off-equilibrium path beliefs in a subsequent section on characterizing the equilibrium.

To distinguish the output choices for each type of firm 1, let $q_1^t(k)$ denote the quantity set by type k $(k = m, r)$ of firm 1 in period t. Let π_i^t and Π_i represent firm $i\prime s$ profit in period t and total profit, respectively, where

$$\begin{aligned}
\Pi_1 &= (a - q_1^1(k) - bq_2^1 + \varepsilon - c_1)q_1^1(k) + (a - q_1^2(k) - qp_2^2 - c_1)q_1^2(k) \\
&= \pi_1^1(q_1^1(k), q_2^1, \varepsilon) + \pi_1^2(q_1^2(k), q_2^2), \\
\Pi_2 &= \rho^1(a - q_2^1 - bq_1^1(m) + \varepsilon - c_2)q_2^1 + (1 - \rho^1)(a - q_2^1 - qp_1^1(r) + \varepsilon - c_2)q_2^1 \\
&\quad + \rho^2(a - q_2^2 - bq_1^2(m) - c_2)q_2^2 + (1 - \rho^2)(a - q_2^2 - bq_1^2(r) - c_2)q_2^2 \\
&= \pi_2^1(\rho^1, q_2^1, q_1^1(m), q_1^1(r), \varepsilon) + \pi_2^2(\rho^2, q_2^2, q_1^2(m), q_1^2(r)).
\end{aligned}$$

Next, the objective function for each type of firm 1 and firm 2 is described.

Objective Function If firm 1 is a profit-maximizer, the two firms' objective function at the first period is

$$\max_{q_i^1} E\left(\pi_i^1 + \pi_i^2\right), \text{ for } i = 1, 2, \tag{1}$$

where $E(\cdot)$ denotes the expectation over the demand uncertainty. Notice that throughout this paper, we have assumed that the discount factor is 1 for simplification. Given the equilibrium during the first period, the objective function during the second period is

$$\max_{q_i^2} \pi_i^2, \text{ for } i = 1, 2, \tag{2}$$

Alternatively, if firm 1 is of earnings-target-type, the first-period objective function of firm 2 remains the same as equation (1), but the first-period objective function of firm 1 is to find a q_1^1 to meet some earnings target $\overline{\Pi}$. That is

$$E\left(\pi_i^1 + \pi_i^2\right) \geq \overline{\Pi} \tag{3}$$

In this objective function, $\overline{\Pi}$ represents some earnings target for full-year earnings which consists of two half-year earnings. The earning target describes the firm who wishes to avoid reporting losses and focuses on firms around the zero earnings level. Moreover, the earnings target $\overline{\Pi}$ can be used to link firm 1's intertemporal output decisions such that firm 1's intertemporal profits exactly hit the target and be taken as pre-commitment to pursue a higher first-period profit (thus a higher first-period earnings target) and bring forward a part of the second-period profit to the first period (thus a lower second-period target). Thus, under output competition this type of firm prefers a higher output in the first period that allows it to pursue a higher first-period profit. With this setting, if the earnings target is met, the output will be different from the profit-maximizer's output. To motivate the earnings-target-type firm myopia, we focus on the case in which this type of firm will prefer a higher first-period profit and a lower second-period profit.

Two interpretations of the role of earnings target for a myopic firm are provided. From the view of strategic competition, earnings targets affect firms' strategic behavior: market-leader firms facing earnings targets exercise their available market power to generate a high short-term profit. Thus, earnings targets tip the balance toward milking market position and could contribute to the decline of market-leader firms. This provides a view of the long-term consequences of meeting earnings targets. From the view of agency theory, earnings target could curtails managers' empire-building tendencies for an excessive taste for running large firms, as opposed to simply profitable ones (Stein, 2003, p. 119). This may lead to excessive investment and excessive focus on revenues and market share. Earnings target could be used to discipline managers to generate current profit by de-escalating the pursuit of market position. Both interpretations illustrate that earnings target induce the earnings-target type firm to have a higher preference on short-term profit than on long-term profit. This does not violate the empirical results that earnings target encourages dominant firms to exercise their available market power to generate current earnings, even though such behavior may encourage output expansion by competitors and undermine competitiveness.

In our model, some firms might not know whether their competitors are maximizing profits or trying to meet an earnings target. Thus, the informed firm's short-term output strategy can be interpreted as a result of opportunistic real activities manipulation or of a purely strategic concern. Under Cournot competition where firms are strategic substitutes, if boosting short-term output is recognized as an opportunistic real activities manipulation, this can induce retaliation from the rival and thus encourage the rival's output expansion in the long-term. Based on this argument, the earnings-target-type firm will not beat the earnings target and earn more than the earnings target. It will just meet the earnings target.

In the second period, the first period demand uncertainty has realized, the earnings-target-type of firm 1 will calculate the extent of profit manipulation in the second period. Let $\pi_1^1(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$ represent the first-period realized profit of firm 1. The extent of profit manipulation is $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon) = \overline{\Pi} - \pi_1^1(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$. Firm 1 will pursue to reach this profit level $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$ by manipulating the output level in the oligopoly market and choosing a q_1^2 such that

$$\pi_1^2 \geq \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon). \tag{4}$$

where $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$ could be considered an earnings target in the second period for the earnings-target-type firm. Notice that for a myopic firm, it will not further pursue a higher possible profit. Thus, any production plan that delivers a profit at least as high as the target $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$ is equally desirable. The second-period objective function of firm 2 remains the same as equation (2).

As a benchmark of comparison, we consider a complete information case where firm 2 can perfectly infer firm 1's objective type. Then, the first-period output decision of firm 1 has no informational effect and the two-period Cournot competition model with one-sided incomplete information reduces to a one-shot Cournot competition over two periods. Since the output level in each period can be adjusted without cost, the optimal first-period output levels of profit-maximization-type of firm 1 and firm 2 depend only on a contemporaneous level of a and ε. Let (q_1^*, q_2^*) denote the output level which maximizes firm $i\prime s$, $i = 1, 2$, one-shot profit

$$q_i^* \in \arg\max_{q_1^t} E\pi_i^1(a, q_i^1, q_j^1, \varepsilon), \ i, j = 1, 2, \ i \neq j,$$

and π_1^* denote the obtained profit.

4 Equilibrium Analysis

In this section, we solve for the perfect Bayesian equilibrium in the two-period Cournot competition. Using backward induction, we first characterize the second-period market equilibrium $(q_1^2(m), q_1^2(r), q_2^2(\rho^2))$, for a given level of the posterior belief ρ^2 and the first-period random shock. We then consider the first-period market equilibrium $(q_1^1(m), q_1^1(r), q_2^1)$, and interpret the setting of on- and off-equilibrium path beliefs ρ^2. We especially consider firm 2's reaction to firm 1's real activities manipulation in production for a higher first-period profit level, when firm 1 might take advantage of its private information.

As mentioned earlier, since the earnings-target type firm has a myopic preference, it attempts to reach some earnings target and pursues a higher first-period profit level and a higher first-period output level than the profit-maximization-type's first-period output level. Moreover, once the first-period earnings target is reached, it is not necessary for this type to pursue a higher second-period profit and thus has an incentive to signal itself out from profit-maximization-type firm in period 1.

4.1 Market Equilibrium Strategies in Period 2

The second-period market equilibrium is different from the first-period market equilibrium in three aspects. First, firm 1's second-period market strategy has no signaling indication. Second, firm 2 uses the ex-post belief, ρ^2, instead of the ex-ante belief, to calculate the expected profit. Third, the earnings-target-type firm needs to meet a second-period earnings target depending on the first-period market equilibrium and the first-period demand uncertainty. At the beginning of the second period, both firm 1 and firm 2 can observe their first-period output levels, the realization of first-period demand uncertainty, and the realization of their first-period payoffs. The second-period belief ρ^2 (on- and off-equilibrium path) will be discussed in more detail when we characterize the first-period outputs in the next subsection. For the moment, the value of ρ^2 is treated as constant. Firm 1 and firm 2 determine $(q_1^2(m), q_1^2(r), q_2^2)$ simultaneously in the second period.

For the profit-maximization-type of firm 1, let $q_1^2(m) \equiv \arg\max_{q_1^2} \pi_1^2$, where

$$\pi_1^2 = \int_{-\bar{\varepsilon}}^{\bar{\varepsilon}} (a - q_1^2 - bq_2^2(\rho^2) - c_1)q_1^2.$$

The profit-maximization-type of firm 1's best response to q_2^2 is

$$q_1^2(m) = \frac{(a - bq_2^2 - c_1)}{2}. \tag{5}$$

For the earnings-target-type of firm 1, $q_1^2(r)$ is denoted as the output to satisfy equation (6), i.e.,

$$q_1^2(r) \in \{q_1^2 | \pi_1^2 \geq \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)\},$$
$$\text{where } \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon) = \overline{\Pi} - \pi_1^1(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon). \tag{6}$$

Next, firm 2 chooses q_2^2 to maximize $\{a - q_2^2 - b[\rho^2 q_1^2(m) + (1-\rho^2)q_1^2(r)] + \varepsilon^2 - c_2\}q_2^2$. Firm 2's best response to $q_1^2(m)$ and $q_1^2(r)$ is

$$q_2^2 = \frac{\{a - b[\rho^2 q_1^2(m) + (1-\rho^2)q_1^2(r)] - c_2\}}{2}. \tag{7}$$

From equations (5), (6), and (7), we can see what profit-maximization-type does in the face of firm 2 being indifferent over a measurable set of options. The profit-maximization-type firm's best response to q_2^2 is determined by the first order condition of profit-maximization problem. This could be characterized by $q_1^2(m) = \frac{(a-bq_2^2-c_1)}{2}$ where firm 2's best response to $q_1^2(m)$ and $q_1^2(r)$ is determined by $q_2^2 = \frac{\{a-b[\rho^2 q_1^2(m)+(1-\rho^2)q_1^2(r)]-c_2\}}{2}$. Thus, the profit-maximization-type firm's response to the output from the earnings-target-type firm is affected by firm 2's ex-post belief about firm 1's type where ρ^2 is constant in second-period output competition. As ρ^2 decreases and approaches 0, the profit-maximization-type firm responds proportionally to the earnings-target-type firm's output.

When we discuss the best replies of the rival firm and the earnings-target-type firm, we take $q_1^2(m)$ as a given. This is because this value will be uniquely determined by equation (5). Then, we use a figure to depict the best replies of the rival firm and the earnings-target-type firm.

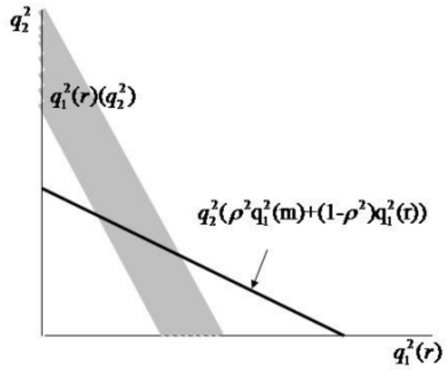

Figure 1. Best Replies of $q_1^2(r)$ given $q_1^2(m)$

The earnings-target-type firm needs to choose among a range of feasible outputs to reach the earnings target. The best replies of $q_1^2(r)$ are indicated by the shadow area in the diagram. As the first period profit gets lower, $\widehat{\Pi}$ gets higher. The feasible outputs set to reach the target will be smaller. Thus, it will be more difficult for the earnings-target-type firm to make up for the shortfall in profits earned in the first period.

The second-period equilibrium is determined by equations (5), (6), and (7) simultaneously.

As a benchmark of comparison, we consider that (q_1^o, q_2^o) denote the output level that maximizes firm $i\prime s$, second-period profit in a full information case, i.e.,

$$q_i^o \in \arg\max_{q_1^2} E\pi_i^2(a, q_i^2, q_j^2),\ \ i, j = 1, 2,\ \ i \neq j,$$

and π_1^o is the respective profit.

To describe the equilibrium properties, notice first that the first-period equilibrium will affect the continuation payoff through Bayesian updating for ρ^2 and through $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$, which will determine the second-period earnings target and affect the second-period output choices for meeting the earnings target. Specifically, when the first-period profit of earnings-target-type of firm 1 is higher than π_1^*, it may set a $q_1^2(r)$ to moderate the variation of $\pi_1^2(\rho^2, q_1^2(r), q_2^2(\rho^2))$ for smoothing of its two-period payoff, i.e.,

$$\left|\pi_1^2(\rho^2, q_1^2(r), q_2^2(\rho^2)) - \pi_1^o\right| \leq \left|\pi_1^1(\rho^1, q_1^1(r), q_2^1, \varepsilon) - \pi_1^*\right|.$$

We will determine the equilibrium properties for the earnings-target-type firm in the second period.

Lemma 1 *(i) For the earnings-target-type firm to reach a second-period earnings target equal to or lower than π_1^o in the Cournot competition, it can set its second-period output level equal at or lower than q_1^o.*

Proof. Since $\pi_1^2(\rho^2, q_1^2(r), q_2^2(\rho^2))$ is concave in $q_1^2(r)$ and decreasing in bq_2^2, if the earnings-target-type firm needs to meet a second-period earnings target level equal to lower than π_1^o, it requires $q_1^2(r) < q_2^o$. Then, since firm 2 faces an expected output $-(\rho^2 q_1^2(m) + (1-\rho^2)q_1^2(r))$, then q_2^2 increases and $q_1^2(m)$ responds with $q_1^2(r) < q_1^2(m) \leq q_2^o$. ■

Given that the earnings-target firm engages in real activities manipulation through production in the first period, this lemma demonstrates the cost of engaging in real activities manipulation where the earnings-target firm has a lower output and lower profit in the second period. This could happen when a myopic firm overproduces for greater short-term profits but reverse the abnormal production subsequently. We will demonstrate shortly that there exists equilibrium where firms raise the first-period outputs and then lower the second-period outputs.

Since the set of $q_1^2(r)$ is affected by the level of $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$, we rewrite the second-period payoff π_1^2 as $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$.

Lemma 2 *(i) Given that the earnings-target-type firm needs to reach a second-period earnings target lower than π_1^o, $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$ increases with ρ^2.*

(ii) The lower bound of $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$ for the earnings-target-type firm will increase with $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$ and decrease with ε.

Proof. (i) Given $q_1^2(r)$ lower than q_1^o, $q_1^2(m)$ responds with $q_1^2(r) < q_1^2(m) \leq q_2^o$. $-(\rho^2 q_1^2(m) + (1-\rho^2)q_1^2(r))$ decreases with ρ^2. With the fact that $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$ decreases with q_2^2, $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$ increases with ρ^2.

(ii) As $\widehat{\Pi}$ increases, by definition, the required level of $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$ to meet $\widehat{\Pi}$ for the earnings-target-type firm increases. As ε increases, π_1^1 increases and $\widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon)$ decreases. Thus, the required level of $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(r), q_2^2(\rho^2))$ for the earnings-target-type firm decreases. ■

Lemma 2 explains how the second-period earnings target $\widehat{\Pi}$ and the posterior belief (ρ^2) affect the equilibrium profit. Since both of them are influenced by the first-period output of firm 1, these effects are important for the earnings-target type of firm 1's strategic concern in the first period.

Corollary 3 *The lower bound of $q_1^2(r)$ will increase with $\widehat{\Pi}$ and decrease with ε.*

Proof. This directly follows Lemma 2. ■

Lemma 2 and Corollary 3 show that as $\widehat{\Pi}$ increases the lower bound of $q_1^2(r)$ will increase.

4.2 Market Equilibrium Strategies in Period 1

We characterize the first-period market equilibrium $(q_1^1(m), q_1^1(r), q_2^1)$, and consider the effects of firm 1's first-period output levels. First, firm 1's first-period output level with the realization of first-period demand uncertainty affects the required second-period profit for the earnings-target-type firm to meet the second-period earnings target, which will affect $q_1^2(r)$ and q_2^2. Second, firm 1's first-period output level will be taken as a signal about firm 1's type and then firm 2 will update its ex-ante belief to ρ^2. The impact of $q_1^1(k)$, $k = m, r$, on ρ^2 depends on whether firm 1 needs to set an earnings level higher than π_1^* in the first period.

Given the second-period equilibrium $(q_1^2(m), q_1^2(r), q_2^2(\rho^2))$ as characterized above, the intertemporal payoffs for each firm are given as follows. The profit-maximization-type of firm 1 needs to find $q_1^1(m)$ to solve the following problem:

$$\max_{q_1^1} \int_{-\bar{\varepsilon}}^{\bar{\varepsilon}} [(a\text{-}q_1^1\text{-}bq_2^1(\rho^1)+\varepsilon\text{-}c_1)q_1^1+\pi_1^2(\rho^2, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), q_1^2(r), q_2^2)]\frac{1}{2\bar{\varepsilon}}d\varepsilon. \quad (8)$$

The earnings-target-type of firm 1 needs to find a $q_1^1(r)$ such that:

$$q_1^1(r) \in \{q_1^1 | \int_{-\bar{\varepsilon}}^{\bar{\varepsilon}} [(a\text{-}q_1^1\text{-}bq_2^1(\rho^1)+\varepsilon\text{-}c_1)q_1^1+\pi_1^2(\rho^2, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), q_1^2(r), q_2^2)]\frac{1}{2\bar{\varepsilon}}d\varepsilon \geq \overline{\Pi}. \quad (9)$$

Firm 2 chooses a q_2^1 to solve the following problem given the ex-ante belief ρ^1 :

$$\max_{q_2^1} \int_{-\bar{\varepsilon}}^{\bar{\varepsilon}} [(a\text{-}q_2^1\text{-}b(\rho^1 q_1^1(m)+(1\text{-}\rho^1)q_1^1(r))+\varepsilon\text{-}c_2)q_2^1+\pi_2^2(\rho^2, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_2^2, q_1^2(m), q_1^2(r))]\frac{1}{2\bar{\varepsilon}}d\varepsilon. \quad (10)$$

As described in Corollary 3, the level of $\widehat{\Pi}$ will affect the lower bound of $q_1^2(r)$, and $\widehat{\Pi}$ is in turn affected by the first-period equilibrium and the first-period demand uncertainty ε.

Let $\varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$ denote the threshold value of ε such that $\pi_1^1 = \pi_1^*$ of the one-shot earnings. For $q_1^t \neq q_1^*$:

$$\varepsilon(q_1^1(m), q_1^1(r), q_2^1) \equiv c_1 - a + q_1^t(r) + q_1^* + b\frac{q_1^1 q_2^1 - q_1^* q_2^*}{q_1^1(r) - q_1^*}.$$

For $\varepsilon(q_1^1(m), q_1^1(r), q_2^1)$ to exist, it must be the case that: $q_1^1(r) \neq q_1^*$ and $\varepsilon(q_1^1(m), q_1^1(r), q_2^1) \in [-\bar{\varepsilon}, \bar{\varepsilon}]$. Lemma 4 describes the effect of firm 1's output level on $\varepsilon(q_1^1(m), q_1^1(r), q_2^1)$.

Lemma 4 *$\varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$ increases with bq_2^1 and increases with $q_1^1(r)$, if $q_1^1(r) > q_1^*$.*

Proof. $\frac{\partial \varepsilon(q_1^1(m), q_1^1(r), q_2^1)}{\partial q_1^1(r)} = 1 + b\frac{q_1^* q_2^* - q_1^* q_2^1}{(q_1^1(r) - q_1^*)^2} = 1 + b\frac{q_1^*(q_2^* - q_2^1)}{(q_1^1(r) - q_1^*)^2} > 0$, where $q_1^* = q_2^*$, $q_1^1 > q_1^* > q_2^1$. $\frac{\partial \varepsilon(q_1^1(m), q_1^1(r), q_2^1)}{\partial q_2^1} = b\frac{q_1^1(r)}{q_1^1(r) - q_1^*} > 0$. ■

This lemma shows that a higher level of $q_1^1(r)$, $q_1^1(r) > q_1^*$ and a lower level of q_2^1, $q_2^1 \leq q_1^*$, will induce a higher level of threshold value, $\varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$[5]. This implies that for the earnings-target-type firm meeting a first-period earnings target higher than π_1^*, the lower bound of $\pi_1^1(\rho^1, q_1^1(m), q_1^1(r), q_2^1)$ will increase with $\varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$. Moreover, by Lemma

[5] Since $0 < b < 1$, the net effect of a higher level of $q_1^1(r)$, $q_1^1(r) > q_1^*$ and a lower of q_2^1, $q_2^1 \leq q_1^*$ on $\varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$ is still positive.

4, we will consider the likelihood in which the profit-maximization firm may (or may not) mimics the earnings-target firm's first-period output decision.

We will consider firm 1 taking pure strategy or mixed strategy in the first period. A pure strategy for firm 1 is a map from the differential objective functions (i.e., profit-maximization and earnings-target) into the choice of first-period output. A mixed strategy for firm 1 is a probability distribution over a set of feasible first-period output choices for differential objective functions. Given that firm 1 knows its own type, it will choose each action from the feasible set with some probability. We consider θ, where $0 < \theta < 1$, is the probability for some ε that will result in the profit-maximization-type of firm 1 randomizing between $q_1^1(m)$ and $q_1^1(r)$.

4.2.1 Firm 1 Taking a Pure Strategy in Period 1

In the separating equilibrium, different types of firm 1 use different strategies. Therefore, the type is learned exactly, and firm 2 will set its output level to best fit each type of firm 1 in the first period. We focus on the equilibria, $(q_1^1(m),\ q_1^1(r))$, with $q_1^1(r) > q_1^*$ and $q_1^1(m)$ responding with $q_1^1(r) > q_1^1(m) \geq q_1^*$, in which the earnings-target-type of firm 1 sets its first-period output level $q_1^1(r)$ higher than q_1^*, which reflects the earnings-target-type firm's myopia and this type of firm will distort its first-period output level to pursue a higher first-period profit level; the profit-maximization-type of firm 1 pursues profits maximization within two periods and sets its first-period output $q_1^1(m)$, with $q_1^1(m) \geq q_1^*$. By Lemma 4, this could happen once the random demand shock falls below the threshold value $\varepsilon(q_1^1(m),\ q_1^1(r),\ q_2^1)$ in which the masked effect from the demand uncertainty on the first-period profit is low and a higher level of first-period output level will not increase the first-period profit level. Thus, the profit-maximization-type of firm 1 has no incentive to set a higher q_1^1 and further mislead firm 2 about firm 1's objective type. The probability for this case is $\frac{(\bar{\varepsilon}+\varepsilon(q_1^1(m),\ q_1^1(r),\ q_2^1))}{2\bar{\varepsilon}}$.

Recall that q_2^1 is determined by equation (10). We consider the following posterior beliefs:

$$\rho^2 = 0, \quad \text{for } q_1^1 \geq q_1^1(r),$$
$$= 1, \quad \text{for } q_1^1 < q_1^1(r).$$

In these posterior beliefs, after observing q_1^1 with $q_1^1 < q_1^1(r)$, firm 2 holds the belief that firm 1 is a profit-maximization-type firm, $\rho^2 = 1$; after observing q_1^1 with $q_1^1 \geq q_1^1(r)$, firm 2 holds the belief that firm 1 is earnings-target-type firm, $\rho^2 = 0$. Note that this on-equilibrium path belief for the firm 1's output choices (i.e., value of q_1^1 is either $q_1^1(m)$ or $q_1^1(r)$) follow Bayes' rule, and the setup for the off-equilibrium path belief for firm 1's output choices (i.e., value of q_1^1 other than $q_1^1(m)$ or $q_1^1(r)$) is referred to Gibbons (1992).

We replace ρ^2 with the above setting and rewrite the expected intertemporal profits for the profit-maximization-type of firm 1.

$$\begin{aligned}
&\int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} (a - q_1^1(m) - bq_2^1(\rho^1) + \varepsilon - c_1) q_1^1(m) \frac{1}{2\overline{\varepsilon}} d\varepsilon \\
+ &\int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)} \pi_1^2(1, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), \overline{q}_1^2(r), q_2^2) \frac{1}{2\overline{\varepsilon}} d\varepsilon \\
+ &\int_{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)}^{\overline{\varepsilon}} \pi_1^2(1, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), \underline{q}_1^2(r), q_2^2) \frac{1}{2\overline{\varepsilon}} d\varepsilon. \qquad (11)
\end{aligned}$$

Henceforth, we denote $\overline{q}_1^2(r)$ as the second-period output of the earnings-target-type firm for cases where the targeted profit is higher than π_1^o. Similarly, $\underline{q}_1^2(r)$ as the second-period output of the earnings-target-type firm for cases where the targeted profit is lower than than π_1^o.

As for the earnings-target-type of firm 1, denote Φ as its expected intertemporal profits, where

$$\Phi \equiv \int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} (a - q_1^1(r) - bq_2^1(\rho^1) + \varepsilon - c_1) q_1^1(r) \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

$$+ \int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)} \pi_1^2(0, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), \overline{q}_1^2(r), q_2^2) \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

$$+ \int_{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)}^{\overline{\varepsilon}} \pi_1^2(0, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), \underline{q}_1^2(r), q_2^2) \frac{1}{2\overline{\varepsilon}} d\varepsilon.$$

Profit-maximization-type of Firm 1 In the separating equilibrium, the following are required: (i) $q_1^1(m)$ maximizes the profit in (11), meaning that the equilibrium profit is higher than any $(q_1^{1'}(m), q_1^1(r))$ with $q_1^1(m) \neq q_1^{1'}(m)$ and $\rho^2 = 1$. This condition is the marginal condition that the partial derivation of (11) with respect to $q_1^1(m)$ is equal to zero. (ii) The equilibrium profit is at least greater than that of earnings-target type firm and setting outputs and belief to be $(q_1^1(r), q_1^1(r))$ and $\rho^2 = \rho^1$. This condition requires the profit in (11) to be at least as great as the following term:

$$\int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} (a - q_1^1(r) - bq_2^1(\rho^1) + \varepsilon - c_1) q_1^1(m) \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

$$\int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)} \pi_1^2(\rho^1, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), \overline{q}_1^2(r), q_2^2) \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

$$+ \int_{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)}^{\overline{\varepsilon}} \pi_1^2(\rho^1, \widehat{\Pi}(\rho^1, q_1^1(m), q_1^1(r), q_2^1, \varepsilon), q_1^2(m), \underline{q}_1^2(r), q_2^2) \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

Let the above condition bind, then we have

$$\int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} [\pi_1^1(q_1^1(m), q_2^1(\rho^1), \varepsilon) - \pi_1^1(q_1^1(r), q_2^1(\rho^1), \varepsilon)] \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

$$+ \int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)} [\pi_1^2(1, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2) - \pi_1^2(\rho^1, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2)] \frac{1}{2\overline{\varepsilon}} d\varepsilon$$

$$+ \int_{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)}^{\overline{\varepsilon}} [\pi_1^2(1, \widehat{\Pi}, q_1^2(m), \underline{q}_1^2(r), q_2^2) - \pi_1^2(\rho^1, \widehat{\Pi}, q_1^2(m), \underline{q}_1^2(r), q_2^2)] \frac{1}{2\overline{\varepsilon}} d\varepsilon = 0. \quad (12)$$

where we have abbreviated the second-period earnings benchmark $\widehat{\Pi}(\rho^1, q_1^1(r), q_2^1, \varepsilon)$ as $\widehat{\Pi}$ for simplification.

Earnings-target-type of Firm 1 For the earnings-target-type of firm 1, it is only required that the expected intertemporal payoffs satisfy: $E(\pi_1^1 + \pi_1^2) = \overline{\Pi}$. Hence, for $q_{_1}^1(r)$ to be the equilibrium strategy, we need a $q_{_1}^1(r)$ to satisfy (15),

$$q_1^1(r) \in \{q_1^1 | \int_{-\bar{\varepsilon}}^{\bar{\varepsilon}} (a - q_1^1(r) - bq_2^1(\rho^1) + \varepsilon - c_1) q_1^1(r) \frac{1}{2\bar{\varepsilon}} d\varepsilon + \int_{-\bar{\varepsilon}}^{\varepsilon(q_{_1}^1(m), q_{_1}^1(r), q_2^1)} \pi_1^2(0, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2)] \frac{1}{2\bar{\varepsilon}} d\varepsilon \tag{13}$$

$$+ \int_{\varepsilon(q_{_1}^1(m), q_{_1}^1(r), q_2^1)}^{\bar{\varepsilon}} \pi_1^2(0, \widehat{\Pi}, q_1^2(m), \underline{q}_{_1}^2(r), q_2^2) \frac{1}{2\bar{\varepsilon}} d\varepsilon \geq \overline{\Pi}\}$$

Overall, the separating equilibrium is determined by the marginal condition in (11), equality (12) and marginal condition in (13). The following proposition describes the properties for separating equilibrium.

Proposition 5 *There exists separating equilibria in which the profit-maximization firm and the earnings-target firm choose* $q_1^1(m)$ *and* $q_1^1(r)$ *in the first period, respectively, with* $q_1^1(r) > q_1^1(m) \geq q_1^*$, *and choose* $q_1^2(m)$ *and* $q_1^2(r)$ *in the second period, respectively, with* $q_1^2(m) \geq q_1^o > q_1^1(r)$.

Proof. See Appendix. ■

As mentioned above, firm 1's first-period output level could influence firm 2's posterior belief, which in turn affects the size of the second-period earnings target for the earnings-target firm. Given the earnings-target firm's myopic incentive, this type of firm second-period equilibrium profit could be lower than its first-period equilibrium profit (and could also be lower than the profit-maximization type of firm's second-period equilibrium profit).

This proposition addresses the competitive effects of meeting earnings target and illustrates a grim picture of the long-term consequences of meeting earnings target. We show that when the earnings-target firm prefers a higher first-period profit and a lower second-period profit and attempts to meet the two-period earnings target, this type of firm will distort its outputs decision to produce greater short-term profits at the expense of long-term profit through over-production in the first period and then lower the output in the second period. Moreover, this proposition also implies the following corollary.

Corollary 6 *When the earnings-target firm faces higher earnings target, the rival firm will respond more aggressively in the second period.*

This corollary predicts that firms experiencing higher earnings target will shift their focus toward generating current earnings by exercising market power and raising the outputs toward a higher level. Moreover, this earnings target will further affect competitive interactions and encourage greater expansion by rival firms subsequently.

4.2.2 Firm 1 Taking a Mixed Strategy in Period 1

In the hybrid equilibrium, a certain type of firm 1 uses mixed strategy and chooses randomly between $q_1^1(m)$ and $q_1^1(r)$. Therefore, firm 2 does not perfectly learn the type of firm 1, and this particular type of firm 1 will take advantage of the impact on firm 2's uncertainty (ρ^2). Firm 2 will set an output level which best replies to a weighted sum of $q_1^2(m)$ and $q_1^2(r)$. We focus on the equilibria, $(\theta q_1^1(m) + (1-\theta)q_1^1(r),\, q_1^1(r))$, $0 < \theta < 1$, with $q_1^1(r) > q_1^1(m) \geq q_1^*$, in which the profit-maximization-type firm takes a mixed strategy, and the earnings-target-type firm selects a pure strategy. By Lemma 4, this could happen once the random demand shock exceeds the threshold value $\varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$. The probability for this case is $\frac{(\bar{\varepsilon} - \varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1))}{2\bar{\varepsilon}}$. In this case, firm 1 will take advantage of ρ^1, with the effect of an expectation on high demand uncertainty on its first-period profit level and raise its first-period output level in an attempt to increase the first-period profit. The profit-maximization-type of firm 1 has incentive to set a higher q_1^1 and further to mislead firm 2 about firm 1's objective type.

Recall that q_2^1 is determined by (10). We consider the following posterior beliefs:

$$\rho^2 = \frac{\rho^1(1-\theta)}{\rho^1(1-\theta)+(1-\rho^1)}, \quad \text{for } q_{_1}^1 = q_1^1(r),$$
$$= 1, \quad \text{for } q_{_1}^1 \neq q_1^1(r).$$

In these posterior beliefs, after observing q_1^1 with $q_1^1 \neq q_1^1(r)$, firm 2 holds the belief that firm 1 is a profit-maximization-type firm, $\rho^2 = 1$; after observing q_1^1 with $q_1^1 = q_1^1(r)$, firm 2 holds the belief that firm 1 may be a profit-maximization-type firm, $\rho^2 = \frac{\rho^1(1-\theta)}{\rho^1(1-\theta)+(1-\rho^1)}$. Note that these on-equilibrium path beliefs, i.e., $\rho^2 = 1$, for $q_{_1}^1 \neq q_1^1(r)$ and $\rho^2 = \frac{\rho^1(1-\theta)}{\rho^1(1-\theta)+(1-\rho^1)}$, for $q_{_1}^1 = q_1^1(r)$ follow Bayes' rule. Novaes (2002) also used similar on-equilibrium path beliefs in which a manager uses leverage to convey information about his ability and avoids the threat of shareholders' activism under a takeover threat.

We replace ρ^2 with the above setting and rewrite the expected intertemporal profits for the profit-maximization-type of firm 1.

$$\int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} (a - q_1^1(r) - bq_2^1(\rho^1) + \varepsilon - c_1)q_1^1(m)\frac{1}{2\overline{\varepsilon}}d\varepsilon$$
$$+ \int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m),q_1^1(r),q_2^1)} \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2)]\frac{1}{2\overline{\varepsilon}}d\varepsilon$$
$$+ \int_{\varepsilon(q_1^1(m),q_1^1(r),q_2^1)}^{\overline{\varepsilon}} \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \underline{q}_1^2(r), q_2^2)]\frac{1}{2\overline{\varepsilon}}d\varepsilon. \tag{14}$$

As for the earnings-target-type of firm 1, denote Φ as its expected intertemporal profits, where

$$\Phi \equiv \int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} (a - q_1^1(r) - bq_2^1(\rho^1) + \varepsilon - c_1)q_1^1(r)\frac{1}{2\overline{\varepsilon}}d\varepsilon$$
$$+ \int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m),q_1^1(r),q_2^1)} \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2)\frac{1}{2\overline{\varepsilon}}d\varepsilon$$
$$+ \int_{\varepsilon(q_1^1(m),q_1^1(r),q_2^1)}^{\overline{\varepsilon}} \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \underline{q}_1^2(r), q_2^2)\frac{1}{2\overline{\varepsilon}}d\varepsilon.$$

Profit-maximization-type of Firm 1 We replace ρ^2 with the above setting, and rewrite the expected intertemporal payoffs for the profit-maximization-type of firm 1. In the hybrid equilibrium, $q_1^1(m)$ maximizes the profit in (11), meaning that the equilibrium profit is higher than any $(q_1^{1'}(m), q_1^1(r))$ with $q_1^1(m) \neq q_1^{1'}(m)$ and $\rho^2 = 1$. This condition is the marginal condition that the partial derivation of (11) with respect to $q_1^1(m)$ is equal to zero. Moreover, the mixed strategy between $q_1^1(m)$ and $q_1^1(r)$ lead to the same expected intertemporal profits. This condition is equivalent to the following:

$$\int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} [\pi_1^1(q_{_1}^1(m), q_2^1(\rho^1), \varepsilon) - \pi_1^1(q_{_1}^1(r), q_2^1(\rho^1), \varepsilon)]\frac{1}{2\overline{\varepsilon}}d\varepsilon$$

$$+ \int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)} [\pi_1^2(1, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2) - \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2)]\frac{1}{2\overline{\varepsilon}}d\varepsilon$$

$$+ \int_{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)}^{\overline{\varepsilon}} [\pi_1^2(1, \widehat{\Pi}, q_1^2(m), \underline{q}_{_1}^2(r), q_2^2) - \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \underline{q}_{_1}^2(r), q_2^2)]\frac{1}{2\overline{\varepsilon}}d\varepsilon = 0. \tag{15}$$

Earnings-target-type of Firm 1 For the earnings-target-type of firm 1, it is only required that the intertemporal payoffs satisfy: $E(\pi_1^1 + \pi_1^2) = \overline{\Pi}$. Hence, for $q_{_1}^1(r)$ to be the equilibrium strategy, we need a $q_{_1}^1(r)$ to satisfy (16),

$$q_1^1(r) \in \{q_1^1 | \int_{-\overline{\varepsilon}}^{\overline{\varepsilon}} (a - q_1^1(r) - bq_2^1(\rho^1) + \varepsilon^1 - c_1)q_1^1(r)\frac{1}{2\overline{\varepsilon}}d\varepsilon^1 + \int_{-\overline{\varepsilon}}^{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)} \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2)]\frac{1}{2\overline{\varepsilon}}d\varepsilon \tag{16}$$

$$+ \int_{\varepsilon(q_1^1(m), q_1^1(r), q_2^1)}^{\overline{\varepsilon}} \pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \underline{q}_{_1}^2(r), q_2^2)\frac{1}{2\overline{\varepsilon}}d\varepsilon \geq \overline{\Pi}.$$

Overall, the hybrid equilibrium is determined by the marginal condition in (11), equality in (15), and marginal condition in (16). The following proposition describes the hybrid equilibrium.

Proposition 7 *There exists a hybrid equilibrium in which the profit-maximization-type firm and the earnings-target-type firm choose* $\theta q_1^1(m) + (1 - \theta)q_1^1(r)$, $0 < \theta < 1$ *and* $q_1^1(r)$ *in the* *first period, respectively, with* $q_1^1(r) > q_1^1(m) \geq q_1^*$*, and choose* $q_1^2(m)$ *and* $q_1^2(r)$ *in the second period, respectively, with* $q_1^2(m) \geq q_1^o > q_1^2(r)$.

Proof. See Appendix. ■

For the informational impact of meeting earnings target, we show that the tendency for firms to meet target is motivated by marketwide demand conditions in which once the expected first-period demand shock is high ($E(\varepsilon^1) > \varepsilon(q_1^1(m),\, q_1^1(r),\, q_2^1)$) the profit-maximization-type firm is motivated to conceal its identity by exploiting the effect of high level of expected demand shock on its first-period output choice and mimicking the earnings-target-type firm (so that firm 2 does not perfectly learn the type of firm 1). Consequently, the profit-maximization-type firm could boost its first-period output level for a higher profit level. Moreover, this proposition also implies the following corollary.

Corollary 8 *As the expected demand uncertainty further increases, there will be a higher probability,* $1 - \theta$*, that the profit-maximization-type firm pools with the earnings-target-type firm and firm 2 responds less aggressively in the second period.*

This corollary predicts that as the expected level demand uncertainty further increases, there will be a higher likelihood that the profit-maximization-type firm pools with the earnings-target-type firm. This further confuses firm 2's assessment of firm 1's type and thus the profit-maximization-type firm's absolute amount of output manipulation gain is higher. However, a higher level of $1 - \theta$ will lead to a higher level of ρ^2, in which the rival firm will respond less aggressively in the second period.

This corollary implies that the tendency for firms to meet earnings target is positively related to the marketwide business conditions. This is consistent with Cohen and Zarowin (2007) who provided evidence that the tendency for firms to meet or beat earnings benchmarks is positively related to marketwide P/E ratio. In addition, this corollary also suggests that the great economic booms further confound a rival firm's ability to identify opportunistic abnormal output activities and enhance a market-leader firm's absolute amount of output manipulation gain. Thereby, the rival firm responds less aggressively later and this may improve the market-leader firm's long-term product market competitiveness. This enhances the market-leader firm's absolute amount of output manipulation gain and induces the rival firm response less aggressively later. Consequently, our analysis predicts that the negative impact of short-term earnings pressure on long-term product market competition will be lowered when market transparency (on the producer side) is lower.

5 Conclusion

This study investigates how a firm manages earnings through real activities manipulation triggered by product market consideration production, and how this affects the real operating decisions of other firms in the same industry. To address this issue we consider a two-period oligopoly model with one-sided asymmetric information in which a firm has private information about its objective type (profit-maximization-type or earnings-target-type) and characterize the perfect Bayesian equilibria in which a firm's first-period real decisions are not only strategically made but are also used to reveal its objective type to its rival.

We show that one firm will engage in real activities manipulation through over-production for greater short-term profits at the expense of long-term profits. For the informational impact of meeting earnings target, we show that the tendency for firms to meet target is motivated by marketwide conditions. Specifically, once the expected level of demand uncertainty is high, the profit-maximization firm partially acts as the earnings-target firm to mask the effect of demand uncertainty on its first-period profit. The analysis of our game implies that earnings target will affect competitive interactions, because it encourages expansion by competitors. The analysis also yields the prediction that when a dominant firm face a higher earnings target, it will induce rival firms to respond more aggressively. It is shown that the extent to which firms are involved in meeting earnings target may positively relate to marketwide business conditions. Our analysis further yields the prediction that when the market is less transparent (on the producer side) is lower, there will be a higher probability that the profit-maximization-type firm pools with the earnings-target-type firm in which the earnings kink phenomenon is less relevant to opportunistic real activities manipulation.

For extending our study, one can consider a two-way feedback game between a firm and the stock market: a firm will devote more efforts on either real smoothing in production or intertemporal profit maximization to give the stock market what it wants; it can be rational for the stock market to weigh either real smoothing measure or intertemporal profitability measure based on investors' knowledge about the firm's preference over possible strategy. Brown and Revankar (1971) and Aghion and Stein (2008) proposed a generalized utility in which a firm devotes efforts on both sales and profits. More specifically, a firm devotes efforts on combined sales and profit-maximization in Brown and Revankar (1971) and on either sales growth or profit margins in Aghion and Stein (2008). These studies and ours consider a generalized setting in which a firm can change its strategic orientation deviated from profit-maximization. However, different from Brown and Revankar (1971) and Aghion and Stein (2008), the firms' deviated behaviors in our model are put into a multi-period environment in which the earnings target is taken as pre-commitment to a higher first-period output and used to coordinate a firm's intertemporal output decisions. Thus, engaging in real smoothing over periods versus intertemporal profitability may reduce real-side volatility which is contrast to Aghion and Stein (2008). Moreover, consideration of the effect of combined sales and profit maximization may also alter Aghion and Stein (2008)'s results. We leave it to future research.

Appendix

Proof of Proposition 5. (i) The conditions for the hybrid equilibrium consist of the marginal condition of (11), equality (12), and the marginal condition of (13).

Given that earnings-target-type firm's second-period output is $q_1^2(r)$, with $q_1^2(r) < q_1^o$ and the second-period profit is $\pi_1^2(0, \widehat{\Pi}, q_1^2(m), q_1^2(r), q_2^2)$, with $\pi_1^2(0, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2, \varepsilon^2) < \pi_1^o$, Let $q_1^1(r)$ satisfy the condition of (13). By Lemma 4, when $q_1^1(r) > q_1^*$ and $q_1^1(r) < q_1^*$, given that ρ^1 is small enough and approaches 0, then $\pi_1^1(\rho^1, q_1^1(r), q_2^1, \varepsilon) \geq \pi_1^*$.

Let $q_1^1(m)$ satisfy the marginal condition of (11),

$$\frac{\partial E(\pi_1^1+\pi_1^2)}{\partial q_1^1(m)} = \frac{\partial E\pi_1^1}{\partial q_1^1(m)} + \frac{\partial \pi_1^2}{\partial \rho^2}\frac{\partial \rho^2}{\partial q_1^1(m)} = 0.$$

Given that $q_1^1(r) > q_1^*$, since $\pi_1^1(\rho^1, q_1^1(r), q_2^1, \varepsilon)$ is concave in $q_1^1(r)$ and decreasing in bq_2^1 and firm 2 faces an expected quantity $(\rho^1 q_1^1(m) + (1-\rho^1)q_1^1(r))$, with $0 < \rho^1 < 1$, $q_1^1(m)$ could be set to satisfy $q_1^1(r) > q_1^1(m) \geq q_1^*$, with $\frac{\partial E\pi_1^1}{\partial q_1^1(m)} = 0$. Moreover, since ρ^2 is equal to 0 for $q_1^1 \geq q_1^1(r)$, and is equal to 1, for $q_1^1 < q_1^1(r)$, output competition in the second period is reduced to full information case where $q_1^2(m)$ is set to q_1^o, q_2^2 is set to q_2^o, and π_2^2 is equal to π_2^*. In this case, $\frac{\partial \pi_1^2}{\partial q_1^1(m)} = 0$.

Given the expected random demand shock in the first period falls below the threshold value $\varepsilon(q_1^1(m),\ q_1^1(r),\ q_2^1)$, we have $E(\pi_1^1(q_1^1(m), q_2^1(\rho^1), \varepsilon)) < E(\pi_1^1(q_1^1(r), q_2^1(\rho^1), \varepsilon))$, where $q_1^1(r) > q_1^1(m) \geq q_1^*$. For the equality (12) to hold, we need $\pi_1^2(1, q_1^2(m), q_1^2(r), q_2^2) > \pi_1^2(\rho^1, q_1^2(m), q_1^2(r), q_2^2)$ and $q_1^2(m) > \rho^1 q_1^2(m) + (1-\rho^1)q_1^2(r)$. The latter condition implies that $q_1^2(r) < q_1^o \leq q_1^2(m)$, where $q_1^2(r)$ would be $\overline{q}_1^2(r)$. By Lemma 1, if firm 1 needs to meet a second-period earnings target equal to or lower than π_1^o, it could achieve this by setting $q_1^2(r) < q_1^o$ where the second-period demand uncertainty lies within a high range.

In summary, $(q_1^1(m), q_1^1(r))$, with $q_1^1(r) > q_1^1(m) \geq q_1^*$ and $q_1^2(r) < q_1^o \leq q_1^2(m)$ forms a separating equilibrium. ■

Proof of Proposition 7. The conditions for the hybrid equilibrium consist of the marginal condition of (11), equality (15), and the marginal condition of (16).

Given that earnings-target-type firm's second-period output is $q_1^2(r)$, with $q_1^2(r) < q_1^o$ and the second-period profit is $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), q_1^2(r), q_2^2)$, with $\pi_1^2(\rho^2, \widehat{\Pi}, q_1^2(m), \overline{q}_1^2(r), q_2^2, \varepsilon^2) < \pi_1^o$, Let $q_1^1(r)$ satisfy the condition of (16). By Lemma 4, when $q_1^1(r) > q_1^*$ and $q_1^1(r) < q_1^*$, given that ρ^1 is small enough and approaches 0, then $\pi_1^1(\rho^1, q_1^1(r), q_2^1, \varepsilon) \geq \pi_1^*$.

Let $q_1^1(m)$ satisfy the marginal condition of (11),

$$\frac{\partial E(\pi_1^1+\pi_1^2)}{\partial q_1^1(m)} = \frac{\partial E\pi_1^1}{\partial q_1^1(m)} + \frac{\partial \pi_1^2}{\partial \rho^2}\frac{\partial \rho^2}{\partial q_1^1(m)} = 0.$$

Given that $q_1^1(r) > q_1^*$, since $\pi_1^1(\rho^1, q_1^1(r), q_2^1, \varepsilon)$ is concave in $q_1^1(r)$ and decreasing in bq_2^1 and firm 2 faces an expected quantity $(\rho^1 q_1^1(m) + (1-\rho^1)q_1^1(r))$, with $0 < \rho^1 < 1$, $q_1^1(m)$ could be set to satisfy $q_1^1(r) > q_1^1(m) \geq q_1^*$, with $\frac{\partial E\pi_1^1}{\partial q_1^1(m)} = 0$. Moreover, since ρ^2 is equal to $\frac{\rho^1(1-\theta)}{\rho^1(1-\theta)+(1-\rho^1)}$ for $q_1^1 = q_1^1(r)$, and is equal to 1, for $q_1^1 \neq q_1^1(r)$, output competition in the second period is reduced to full information case where $q_1^2(m)$ is set to q_1^o, q_2^2 is set to q_2^o, and π_2^2 is equal to π_2^*. In this case, $\frac{\partial \pi_1^2}{\partial q_1^1(m)} = 0$.

Given the expected random demand shock in the first period exceeds the threshold value $\varepsilon(q_1^1(m),\ q_1^1(r),\ q_2^1)$, we have $E(\pi_1^1(q_1^1(m), q_2^1(\rho^1), \varepsilon)) < E(\pi_1^1(q_1^1(r), q_2^1(\rho^1), \varepsilon))$, where $q_1^1(r) > q_1^1(m) \geq q_1^*$. For the equality (12) to hold, we need $\pi_1^2(1, q_1^2(m), q_1^2(r), q_2^2) > \pi_1^2(\rho^2, q_1^2(m), q_1^2(r), q_2^2)$ and $q_1^2(m) > \frac{\rho^1(1-\theta)}{\rho^1(1-\theta)+(1-\rho^1)} q_1^2(m) + (1 - \frac{\rho^1(1-\theta)}{\rho^1(1-\theta)+(1-\rho^1)}) q_1^2(r)$. The latter condition implies that $q_1^2(r) < q_1^o \leq q_1^2(m)$, where $q_1^2(r)$ would be $\underline{q}_1^2(r)$. By Lemma 1, if firm 1 needs to meet a second-period earnings target equal to or lower than π_1^o, it could achieve this by setting $q_1^2(r) < q_1^o$.

Finally, the profit-maximization-type firm takes a mixed strategy $\theta q_1^1(m) + (1-\theta) q_1^1(r)$ in the first period, where $q_1^1(r) > q_1^1(m) \geq q_1^*$. Then, we can observe that $\theta q_1^1(m) + (1-\theta) q_1^1(r)$ is higher than $q_1^1(m)$, $\forall \theta \in (0,1)$. In summary, $(\theta q_1^1(m) + (1-\theta) q_1^1(r), q_1^1(r))$ with $q_1^1(r) > q_1^1(m) \geq q_1^*$ forms a hybrid equilibrium. ■

6 References

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