Hui Chen and Bjorn Jorgensen

Market exit through divestment: the effect of accounting bias on competition

Article (Accepted version) (Refereed)

Original citation: Chen, Hui and Jorgensen, Bjorn (2016) *Market exit through divestment: the effect of accounting bias on competition.* Management Science. ISSN 0025-1909

DOI: 10.1287/mnsc.2016.2578

Market Exit Through Divestment – The Effect of Accounting Bias on Competition

Hui Chen
University of Zurich
hui.chen@business.uzh.ch
Bjorn Jorgensen
London School of Economics and Political Science
b.n.jorgensen@lse.ac.uk

ABSTRACT

We analyze the effect of accounting bias on the competition and market structure of an industry. In our model, firms' interim accounting reports on investment projects may contain bias introduced by the mandatory accounting system. We find that this bias strictly decreases firms' profits when investors do not have an abandonment option, but different results emerge when we allow the investors to divest in the interim. Specifically, a conservative accounting regime may increase the likelihood of projects being discontinued, inducing some firms to exit from the product market and leaving rivals to capture their market share. A conservative regime can thus soften market competition and result in ex ante higher investment payoff, higher consumer surplus, and higher total social welfare. Since industries often have common reporting standards, we also identify the degrees of industry-wide accounting bias that maximize the expected investor payoffs. Finally, we allow for investors to coordinate their divestment decisions when both firms report unfavorable costs and show an improvement to both firm profits and consumer surplus.

The authors are grateful to Mary Barth (the editor), an associate editor, and four reviewers for helpful suggestions. The authors thank Tim Baldenius, Jay Ballantine, Anne Beyer, Tom Fields, Pingyang Gao (discussant), Mike Kirschenheiter (discussant), Eva Labro, Jing Li, Jeremy Michels, Nathalie Moyen, Steve Rock and workshop participants at Carnegie Mellon University, George Washington University, the University of Colorado, 2012 Financial Accounting and Reporting Section Mid-year Meeting, and the 8th Accounting Research Workshop at the University of Basel and the Kellogg Accounting Research conference for helpful discussions and comments. The authors thank Tim Gray for editing assistance.

1 Introduction

Companies sometimes discontinue a product and exit from a market. In an imperfect product market, one firm's exit means its market share is taken over by the surviving rivals. For example, when Microsoft discontinued Zune, all its market share in the portable media player market shifted to Apple. It is well established that exit inducement, similar to entry deterrence, can soften competition in a market. In this paper, we demonstrate how mandated accounting conservatism might encourage investors to divest, which would result in firms exiting a particular industry. Accounting conservatism thus plays the role of a coordination mechanism and leads to less competition.[1]

This effect arises primarily through the investors' divestment decisions, which are based on the accounting signals reported for the projects they invest in. The accounting conservatism contained in financial reports could lead the investors to abandon the projects, thus softening competition or even completely shutting down the product market. However, excessive divestment need not leave the investors worse off. A conservative bias in accounting can result in higher ex ante expected investment payoff than under the benchmark of unbiased accounting. Thus firms competing in an oligopoly and their investors may prefer an accounting regime with a deliberate conservative bias.

We consider two firms that compete in a Cournot market. Each is owned by an investor and run by a hired manager. The firms operate under the same accounting regime that, for exogenous reasons, generates project reports with a conservative or aggressive bias. Even though each firm's managers privately learns the true cost information, he must issue a public report following the requirements of the accounting regime. Investors then decide whether to leave or stay, based on the reported cost information.

As a starting point, we examine the case where the investors have no interim abandonment option. We show that, relative to unbiased accounting, a firm's profit is strictly lower under both conservatively and aggressively biased accounting. We also show that the profitability decreases with the degree of conservatism or aggressiveness. In addition, we find the consumer surplus is strictly higher and the total social welfare is strictly lower under both biased regimes.

In contrast, when investors can divest in the interim, mandated conservative accounting leads to excessive divestment. After the divestment of one firm, its rival becomes the monopolist of the market. The rival can then earn a higher profit due to the change in the market structure. We show that firms are ex ante better off with conservative accounting, when the potential gain in profits due to the change in market

[1] Prior research examines other forms of exit inducement. Specifically, a firm can adopt predatory pricing (dumping) as well as nonprice strategies to force rivals to exit. For example, Kreps and Wilson (1982) and Milgrom and Roberts (1982) model how a predatory firm could develop a reputation for always preying on other firms to scare them off. Fudenberg and Tirole (1986) analyze a setting in which the predator uses signal-jamming to mislead the prey into leaving the market.

structure outweighs the potential loss due to excessive divestment. Furthermore, we show that consumer surplus and total social welfare could be higher under a conservative regime. Under an aggressive regime, however, firms may divest less frequently, leading to intensified competition in the product market. The effects of aggressive bias on firm profit and consumer surplus in our model are ambiguous.

Next, we examine whether a degree of industry-wide mandatory accounting bias exists that maximizes the firms' expected profits. Every industry has its own reporting norms. These norms can be explicitly lobbied for and formalized into accounting rules, or they can be implicitly coordinated by industry participants in their reporting practices. We find interior solutions of a profit-maximizing degree of bias for both conservative and aggressive regimes.

Last, we explore the case where both firms report bad costs. If one of the investors chooses not to abandon her project while the other investor does, the first firm becomes a monopolist. A monopolist with unfavorable costs may still generate a profit that is higher than its assets' liquidation value. We allow for a solution with correlated equilibrium, through which the firms can coordinate on a public signal for their divestment decisions. This coordination leaves not only the investors better off but also the consumer surplus higher, since the product market survives with at least one monopolist.

Our results depend on two critical assumptions. First, investors must have an interim abandonment option. Firm assets may depreciate over time but must maintain a positive interim value. The investors choose to divest only if future investment payoffs are lower than the assets' interim value. This value could partially proxy for the exit barrier faced by firms competing in the industry. A higher value of the liquidated assets indicates a lower exit barrier. Second, the interim report about the firm's future investment payoff can only be generated by a mandated accounting system, and the managers have no other channel to communicate with the investors about future profit.

Our paper closely relates to prior studies on the impact of potential entry on the incumbent's disclosure behavior, when the incumbent has private information.[2] To scare off entrants, a monopolist with private firm-specific information could adopt a limit pricing strategy (charging a price below monopoly-price level) or aggressive advertising to signal its superior costs (Milgrom and Roberts, 1982; Harrington, 1986; Srinivasan, 1991; Bagwell, 2007; etc.). On the other hand, when the private information concerns a market-wide factor, the incumbent will prefer to deter entry by reporting bad news to indicate a lack of prospects. Darrough and Stoughton (1990) examine how the threat of entry may affect a firm's incentive to disclose information about the product market. They show that the incumbent prefers full disclosure only when projections about the market are optimistic or the entry barrier is low. Guo (2012) examines the effect of conservatism in an oligopoly and finds that it could benefit firms

[2]Without private information, strategies of entry deterrence and exit inducement are often the same. A firm, for example, could commit to building excess production capacity, which could drive out rivals and scare away potential entrants. However, when private information is present, strategies may differ depending on the nature of the information.

when there is no entry threat but that the opposite is true when faced with a potential entrant.

The firms in our model possess firm-specific private information. However, they prefer to report a downwardly biased signal to promote exit, including their own potential exit, from the product market. This differs from the entry deterrence strategies used in prior studies. While firms prefer to report good firm-specific news in an entry deterrence game, firms in our model prefer to report bad firm-specific news. They also face a trade-off quite different from the firms in prior studies. The incumbent in Darrough and Stoughton (1990), for example, faces a trade-off between disclosing good information to improve its stock price and not disclosing to deter entry. Our firms' decision involves weighing the benefit of becoming the surviving monopolist against the cost of shutting down.

Our paper also relates to studies of the interaction of accounting disclosure and product market competition without entry and exit. Darrough (1993) examines the reporting of firms with private information when engaged in Cournot or Bertrand competition. She finds that firms in a Cournot market with substitutable products prefer full disclosure and that reporting bias reduces their expected profits. Our analysis for the case where there is no interim abandonment option confirms her results. Wagenhofer (1990) studies a firm's optimal voluntary disclosure strategy when facing a rival and finds that these disclosures may increase the firm's product price while simultaneously imposing a proprietary cost. Reis and Stocken (2007) contrast the informativeness of historical costing and fair value measurement in a strategic setting. Bagnoli and Watts (2010) examine how two firms bias their accounting reports when competing in a Cournot product market and the effect of accounting bias on the firms' production decision. Corona and Nan (2013) find that firms competing with each other strategically over-report their planned future activities in pre-announcements. Finally, Friedman et al. (2016) examine the effect of conservatism on firm and industry profits and find that industry profits increase/decrease when the reported information is firm-specific/industry-wide. None of these studies involves a change in market structure through entry or exit.

Another stream of literature our paper relates to looks at accounting conservatism and debt.[3] Prior studies examine the effect of conservatism on debt covenants. Venugopalan (2009) and Gigler et al. (2009) show that conservatism does not improve debt-contracting efficiency. Li (2013) demonstrates that conservatism may increase the borrower's profits when renegotiation is allowed. Caskey and Hughes (2012), in contrast, show that debt covenants based on conservative measures outperform those based on fair value measures in deterring asset substitution. Several other studies focus

[3] Several studies explain conservatism from perspectives other than debt contracting. Bagnoli and Watts (2005), for example, model conservatism in a signaling model. Kwon et al. (2001), Kwon (2005), Chen et al. (2007), and Raith (2009) justify conservatism as a mechanism to mitigate contracting problems in an agency setting. Kirschenheiter and Ramakrishnan (2012) regard conservatism as a natural consequence of managers' risk aversion and prudence. Beyer (2013) explains the benefits of conservatism in lieu of accounting information aggregation.

on the effect of conservatism on collateral. Goex and Wagenhofer (2009) find conservatism is optimal in the reporting of collateral value, especially in the case of asset impairment. Cheynel and Michaeli (2012) study optimal accounting measurement of assets in an n-firm economy. Their firms can provide and receive financing from each other. Using a general equilibrium approach, they characterize how the optimal accounting policy and cost of capital depend on the economic environment. With the exception of Cheynel and Michaeli (2012), all of these studies focus on a single-firm setting.

Our contribution is threefold. First, we show biased accounting can soften product market competition and induce changes in market structure; accounting regulation and practice can have real effects. Second, we show that conservatism need not decrease the expected profits of an industry or firms. Prior analytical studies demonstrate a negative effect on debt efficiency absent market competition. Our results, in contrast, show that investors may prefer conservatism in the presence of imperfect product market competition. In fact, conservatism could even lead to a higher total social welfare under certain conditions. Third, we examine a competition-softening mechanism that has not been studied. Firm exit through interim abandonment under conservative accounting differs from the strategies used by firms in prior research to deter entry. In fact, Watts (2003) argues that an abandonment option is necessary to create demand for conservatism in an equity setting.[4] Our results could help explain the market structures of industries that have low entry threat, perhaps due to high entry barriers, but varied exit strategies.

Our results have empirical implications, especially related to inter-industry variation of accounting conservatism. We predict that industries with more conservative accounting will, ceteris paribus, have a higher return on investment and lower cost of equity. An event study could empirically test our predictions. For example, when all firms in an industry face a mandated increase in conservatism, we predict that the total production quantity and cost of capital will decrease, while product price and return on investment will increase. A key control variable for these tests is the proxy for exit barrier—the market value for liquidated assets. When an industry requires highly customized technology and equipment, its assets are likely to have low market value once liquidated. Thus we predict liquidation value to be positively associated with all major dependent variables.

[4]Empirical evidence also supports the use of accounting information in shareholders' abandonment decisions. Berger, Ofek, and Swary (1996) show that shareholders use balance sheet information to determine their abandonment option value, which is then integrated into the stock price. Hayn (1995) finds that the income statement information also reflects shareholders' consideration for abandonment option. Specifically, she shows that different qualities of profits and losses are primarily due to this abandonment option. Since the shareholders can choose to divest, should the firm values drop below certain thresholds, losses do not perpetuate and therefore have a lower earnings response coefficient.

2 The Model

We consider a setting with two firms, i and j, each owned by an investor and run by a hired manager. Each firm has invested cash I in a project to produce and sell a new product to the consumer. Without losing generality, we assume the products produced by the two firms are identical and perfectly substitutable. In each firm, the investor approves the investment project, but the manager is responsible for the firm's operations including reporting and production.

Firm i's manager privately observes the true realized costs of his firm's product. However, he cannot communicate the cost information to his investor except through public accounting reports, which may be subject to bias imposed by the accounting regime. Upon receiving the reports, firm i's investor decides whether to continue to invest or divest. If the investor decides to continue, the manager chooses a production quantity to maximize the expected firm profit. To keep the model parsimonious, the managers in our model do not create cost, nor do they add value to the firms' production. They merely observe the true costs and report them to the investors through accounting signals. We then examine the interaction between these two firms and their investors.

Following Vives (1984), the representative consumer's utility from the two products is $U(Q_i, Q_j) = a(Q_i + Q_j) - \frac{1}{2}\left(Q_i^2 + 2Q_iQ_j + Q_j^2\right)$. The consumer's problem is thus

$$(1) \qquad \max_{Q_i;Q_j} a(Q_i + Q_j) - \frac{1}{2}\left(Q_i^2 + 2Q_iQ_j + Q_j^2\right) - P_iQ_i - P_jQ_j,$$

where P is the unit price for the product; a is the intercept of market demand; and Q_i and Q_j are the quantities produced and sold by firm i and j, respectively. Solving the representative consumer's problem by taking the first-order conditions with regard to Q_i and Q_j, we derive the inverse demand function for the product:

$$(2) \qquad P = a - Q_i - Q_j.$$

Firm i's marginal cost C_i is its private information. We assume $C_i \in \{c_g, c_b\}$, with $c_b > c_g > 0$, where c_b denotes unfavorable cost and c_g denotes favorable cost. We denote the probability of a firm having a low marginal cost as $\theta = \Pr\{C_i = c_g\}$ and the probability of the firm having a high marginal cost as $1 - \theta = \Pr\{C_i = c_b\}$. The marginal costs of the two firms are independent. Firm i's profit from the investment project is $\Pi_i = Q_i(P - C_i)$.

We model the firms' accounting environment through two variables, $\gamma \in [0, 1]$ and $\delta \in [0, 1]$, that represent the firms' reporting requirements. First, nature determines whether firm i's true cost is c_g or c_b. A report is then produced by an exogenously determined accounting regime. There are three different accounting regimes: unbiased, conservative, and aggressive. An unbiased regime generates a truthful cost report with probability one. A conservative regime is defined as generating an upwardly biased cost report. Specifically, it generates an unfavorable cost report with probability one when the true cost is unfavorable but generates a favorable cost report with probability γ (and an unfavorable cost report with probability $1-\gamma$) when the true cost is favorable.[5] An aggressive regime is the opposite of the conservative regime, generating a favorable cost report with probability one when the true cost is favorable, and a favorable cost report with probability δ (and an unfavorable cost report with probability $1-\delta$) when the true cost is unfavorable. The degree of conservatism is thus $1-\gamma$ under a conservative regime, and the degree of aggressiveness is δ under an aggressive regime. For ease of presentation, we denote the posterior probabilities of true cost being consistent with the report as $Pr\left[c_g|\hat{c}_g\right]=\alpha$ and $Pr\left[c_b|\hat{c}_b\right]=\beta$. Specifically, under an unbiased regime, α and β are both 1; under a conservative regime, α is 1 and β is $\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}$; under an aggressive regime, $\alpha=\frac{\theta}{\theta+((1-\theta)\delta)}$ and β is 1.[6]

Upon privately observing his own firm's project cost, firm i's manager discloses the cost report $\widehat{C}_i \in \{\widehat{c}_g, \widehat{c}_b\}$ generated by the firm's accounting system. The cost report is observed by everyone in the economy, including the firm j's competitor and the two investors. The report may contain an accounting bias. When both firms' managers simultaneously decide their firms' output quantities, firm i's manager maximizes his firm's expected profit, conditional on (i) the realized value of its own true cost C_i, (ii) its own cost report $\widehat{C}_i$, and (iii) its competitor's cost report $\widehat{C}_j$. That is, the expected profit for firm i from the investment project is

$$\Pi_i=\Pi_i\left(C_i,\widehat{C}_i,\widehat{C}_j\right)=E\left[(Q_i(a-Q_i-Q_j-C_i)|C_i,\widehat{C}_i,\widehat{C}_j\right]. \tag{3}$$

Obviously, firm i's profit from Cournot competition varies under the different accounting regimes. With perfect/unbiased accounting information, we know $C_i=\widehat{C}_i$ is always true. We thus denote a firm's profit as a function of its own cost and the competitor's cost. For example, $\Pi_d\left(c_g,c_b\right)$ refers to a firm's expected profit from duopolistic competition when its own cost is good and its competitor's cost is bad. With conservative or aggressive accounting information, a firm's expected profit is a function of its own cost, its reported cost, and its competitor's reported cost. For example, we denote $\Pi_d\left(c_g,\widehat{c}_b,\widehat{c}_b\right)$ as the firm's duopolistic profit when its true cost is good, its report is bad, and its competitor's report is bad. For monopolistic profit, we use the notation

[5] Our definition of conservative accounting bias presumes that unfavorable reports are less informative, which is consistent with Venugopalan (2004), Chen et al. (2007), Gigler et al. (2009), Lu et al. (2011), Gao (2013), and Li (2013). Other studies, however, model conservative accounting as favorable reports being more informative in different contexts (Guay and Verrecchia, 2006; Goex and Wagenhofer, 2009). In addition, Beyer (2012) models conservatism as a measurement rule such as lower of cost or market. See Beyer (2012) for a more comprehensive summary.

[6] We construct the accounting regimes in this paper similar to the model of Venugopalan (2004), who uses two variables, informativeness and conservatism, to define an accounting system. However, our analyses only focus on three special cases: 1) the unbiased regime, which coincides with the case of maximum informativeness in Venugopalan (2004); 2) the conservative regime, corresponding to partial informativeness and maximum conservatism; 3) the aggressive regime, corresponding to partial informativeness and minimum conservatism. We do not consider the intermediate case of partial conservatism, as the results of analyses become intractable in oligopoly setting.

of $\Pi_m(c_g)$ or $\Pi_m(c_b)$, as the reported cost plays no role here.

Figure 1 below summarizes the timeline of events.

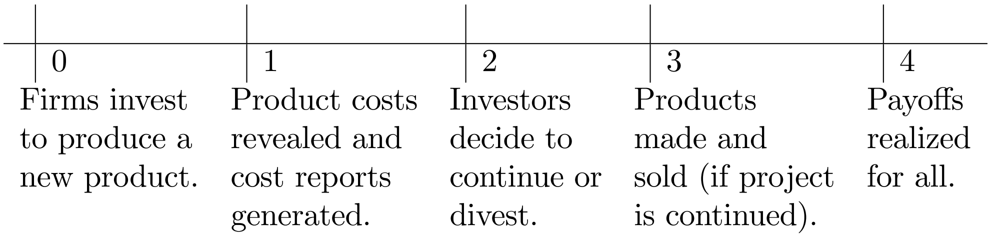


Figure 1: Timeline of events in equity financing.

In time 0, the firms' investors decide to invest in a project to produce and sell a new product. In time 1, the product costs are realized and the cost reports are generated by the respective firms' accounting regimes. Based on the reports, the investors decide to continue or divest. In time 3, the firms compete in the product market and the managers make production quantity decisions. Finally, in time 4, the investors receive their payoffs. We assume that the structure of the model and its parameters are common knowledge and employ the standard subgame perfect Nash equilibrium concept (except in section 4.5 where we discuss correlated equilibrium).

3 Without Abandonment Option

As a benchmark, we first examine the firms' profits when the investors commit to always continue the investment projects, regardless of the accounting reports. That is, the investors never abandon the projects, and the two firms always get to compete in a Cournot market. Firm i's expected profit is simply the sum of its profits under the three different accounting regimes weighted by the corresponding probabilities.[7] Under an unbiased accounting regime, the ex ante expected profit for firm i is

$$\begin{aligned} E[\Pi_{unb.}] &= \theta^2 \Pi_d(c_g, c_g) + (1-\theta)^2 \Pi_d(c_b, c_b) \\ &\quad + \theta(1-\theta)\Pi_d(c_g, c_b) + (1-\theta)\theta \Pi_d(c_b, c_g). \end{aligned} \tag{4}$$

Under a conservative regime, the ex ante expected firm profit is

$$\begin{aligned} E[\Pi_{con.}] &= \theta^2\gamma^2 \Pi_d(c_g, \widehat{c}_g, \widehat{c}_g) + \theta\gamma(1-\theta\gamma)\Pi_d(c_g, \widehat{c}_g, \widehat{c}_b) \\ &\quad + \theta^2\gamma(1-\gamma)\Pi_d(c_g, \widehat{c}_b, \widehat{c}_g) + \theta(1-\gamma)(1-\theta\gamma)\Pi_d(c_g, \widehat{c}_b, \widehat{c}_b) \\ &\quad + \theta\gamma(1-\theta)\Pi_d(c_b, \widehat{c}_b, \widehat{c}_g) + (1-\theta)(1-\theta\gamma)\Pi_d(c_b, \widehat{c}_b, \widehat{c}_b). \end{aligned} \tag{5}$$

[7] Please refer to Appendix A for the calculations.

Under an aggressive regime, the ex ante expected firm profit is

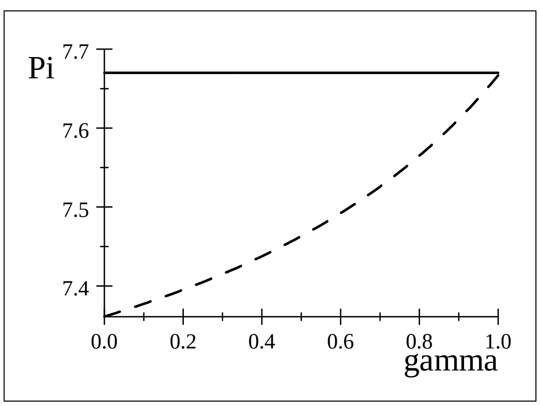
$$\begin{aligned} E\left[\Pi_{agg.}\right] &= \theta\left(\theta+\delta-\theta\delta\right)\Pi_d\left(c_g,\widehat{c}_g,\widehat{c}_g\right)+\theta\left(1-\theta\right)\left(1-\delta\right)\Pi_d\left(c_g,\widehat{c}_g,\widehat{c}_b\right) \\ &\quad +\delta\left(1-\theta\right)\left(\theta+\delta-\theta\delta\right)\Pi_d\left(c_b,\widehat{c}_g,\widehat{c}_g\right)+\left(1-\theta\right)^2\delta\left(1-\delta\right)\Pi_d\left(c_b,\widehat{c}_g,\widehat{c}_b\right) \\ &\quad +\left(1-\theta\right)\left(1-\delta\right)\left(\theta+\delta-\theta\delta\right)\Pi_d\left(c_b,\widehat{c}_b,\widehat{c}_g\right)+\left(1-\theta\right)^2\left(1-\delta\right)^2\Pi_d\left(c_b,\widehat{c}_b,\widehat{c}_b\right). \end{aligned} \tag{6}$$

Proposition 1. *When firms compete in a Cournot fashion with investors who always choose to let the projects continue, their profits under the conservative or the aggressive accounting regime are strictly lower than that under the unbiased regime, and the profits decrease with the level of conservatism/aggressiveness.*

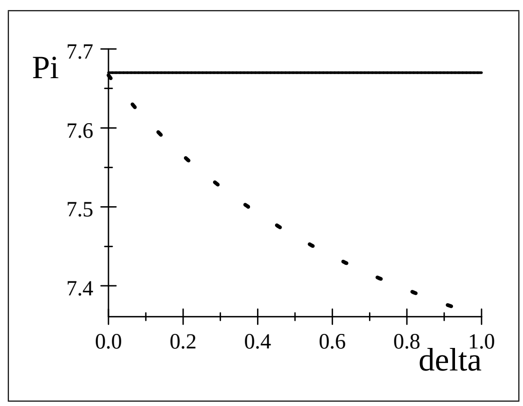
Proof. See appendix.

Proposition 1 demonstrates that accounting bias decreases expected firm profit in a Cournot setting. The firms thus prefer a less biased accounting regime. The reason for the decreased profit is the efficiency loss caused by the accounting distortion. For example, there are two scenarios when the firm profit is higher under a conservative accounting system than under an unbiased system: $\Pi_d\left(c_g,\widehat{c}_g,\widehat{c}_b\right)$ and $\Pi_d\left(c_g,\widehat{c}_b,\widehat{c}_b\right)$. However, the profits from the other four scenarios are all lower under a conservative accounting system than under an unbiased one. The losses thus outweigh the gains. Note that this result resembles the finding of Darrough (1993), who shows that reporting noise about cost information reduces expected firm profits in Cournot competition. However, our result also differs from that of Darrough (1993) in that the noise in her model is independent of the state, while the bias/noise in our model is state-dependent.

The following figure demonstrates the efficiency loss due to accounting distortion.



A: Conservative bias



B: Aggressive bias

— unbiased regime; - - - conservative regime; $\cdots$ aggressive regime

Numerical values: $\theta = 0.5$, $a = 10$, $c_g = 1$, $c_b = 3$.

Figure 2: Profit profit as a function of accounting bias.

We also analyze the effect of accounting bias on consumer surplus and social welfare.

We denote consumer surplus as V, which is:

$$V = \int_0^{(Q_i^*+Q_j^*)} (P(Q) - P^*)\, dQ$$

$$= \frac{1}{2}\left(Q_i^* + Q_j^*\right)^2, \tag{7}$$

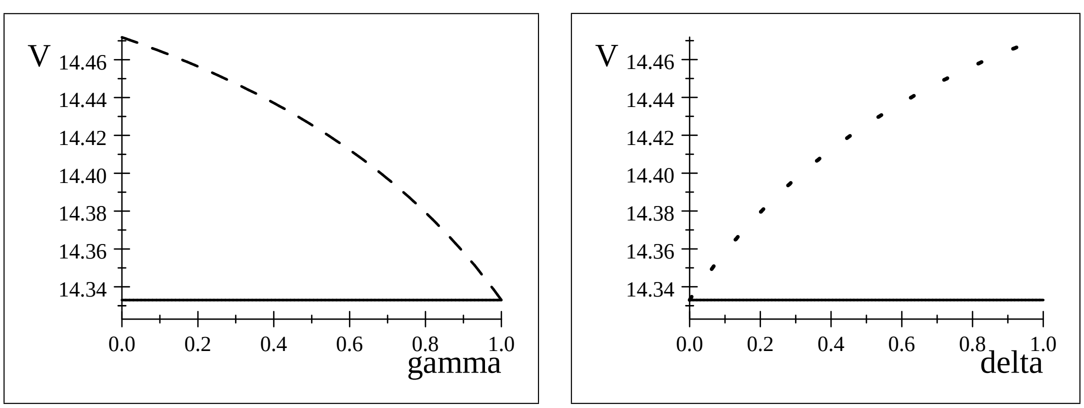
where $P(Q) = a - (Q_i + Q_j)$, Q_i^* and Q_j^* are the equilibrium production quantities for firm i and j in Cournot competition and P^* is the equilibrium price for the product. We denote the total social welfare as W, the sum of firm profit and consumer surplus:

$$W = V + \Pi_i + \Pi_j - 2I. \tag{8}$$

Corollary 2. *When firms compete in a Cournot fashion with investors who always choose to let the firms continue with operations, the consumer surplus under the conservative or the aggressive accounting system is strictly higher than that under the unbiased accounting system, but the total social welfare under the conservative or the aggressive accounting system is strictly lower than that under the unbiased accounting system.*

Proof. See appendix.

Corollary 2 shows that the consumer surplus is higher when accounting reports are biased. This is because the expected production quantity under the conservative or the aggressive accounting regime is higher than under the unbiased accounting regime. Higher production quantity then leads to a higher level of consumer surplus. Figure 3 demonstrates the increase of consumer surplus as a function of the accounting conservatism or aggressiveness.



A: Conservative bias

B: Aggressive bias

— unbiased regime; - - - conservative regime; $\cdots$ aggressive regime

Numerical values: $\theta = 0.5$, $a = 10$, $c_g = 1$, $c_b = 3$.

Figure 3: Consumer surplus as a function of accounting bias.

However, since the loss in the firms' profits is greater than the increase in the consumer surplus, the total social welfare is still lower under the conservative or the aggressive accounting system than under the unbiased one. Corollary 2 thus demonstrates that accounting bias hurts the total social welfare when interim abandonment is not allowed.

4 With Abandonment Option

We now allow the investors the interim option to abandon the projects. We assume the assets employed by the projects depreciate. At time zero, the investor invests cash I to acquire assets. At time two, these assets depreciate to an amount $K < I$, which is the abandonment value should the investors decide to terminate the project. By time 4, the assets would have depreciated to zero market value. The value of K matters in the investors' termination decision, as it represents the exit barrier of firms competing in the same industry.[8] We assume K is neither too high nor too low, to ensure that the investors only divest when receiving a bad cost report.

The investors rely on the firms' cost reports to make their divestment decisions. For firm i's investor, there are four scenarios of cost reports: 1) both firms report good costs; 2) firm i reports good cost, and firm j reports bad cost; 3) firm i reports bad cost, and firm j reports good cost; 4) both firms report bad costs. We denote the firm's expected payoff as a function of the investor's information set, $\Pi\left(\widehat{c}_i, \widehat{c}_j\right)$. For each of the four scenarios, investor i must compare the expected future project payoff with the abandonment value K to determine whether to divest or continue.

4.1 Unbiased accounting regime

Under an unbiased accounting regime, both favorable and unfavorable cost realizations are reported truthfully. That is, $\Pi\left(\widehat{c}_i, \widehat{c}_j\right)$ is exactly the same as $\Pi_d\left(c_i, c_j\right)$. Examining the firms' Cournot profits under an unbiased accounting regime, we know $\Pi_d\left(c_g, c_b\right) > \Pi_d\left(c_g, c_g\right) > \Pi_d\left(c_b, c_b\right) > \Pi_d\left(c_b, c_g\right)$. We assume $\Pi_d\left(c_g, c_g\right) > K > \Pi_d\left(c_b, c_b\right)$. Thus a firm whose project has a favorable cost is always going to have higher profit than a firm whose project has an unfavorable cost. Furthermore, the profit of a firm whose project has a favorable/unfavorable cost is always higher/lower than K. The investor i thus always chooses to divest when receiving an unfavorable report.[9]

An interesting result emerges when one firm issues a favorable report and the other issues an unfavorable one. The firm with an unfavorable report terminates its project,

---

[8] Although we assume the value of K as exogenous, it is often determined by a separate market for liquidated assets. Cheynel and Michaeli (2012) adopt a general equilibrium approach for the valuation of such assets. Shleifer and Vishny (2010), on the other hand, examine a market for assets in which demand and supply are determined by the number of firms going bankrupt in an industry. The more firms are bankrupt, the less valuable the liquidated assets and hence the resulting fire sale.

[9] Of course, for sufficiently high abandonment value K, such as $K > \Pi_m\left(c_g\right)$, both investors would abandon their projects. If $K < \Pi_d\left(\widehat{c}_b, \widehat{c}_g\right)$, the investors would never divest, and the firms' profits remain the same as when there is no interim abandonment option.

and the remaining firm becomes a monopolist in that product market and earns a higher profit than when both firms have a favorable cost. That is, $\Pi_m(c_g) > \Pi_d(c_g, c_g) > K$. Table 1 presents the firms' profits from their investment projects:

Firm 1 Firm 2	$C = c_g$ Prob. $= \theta$	$C = c_b$ Prob. $= 1 - \theta$
$C = c_g$ Prob. $= \theta$	$\Pi_d(c_g, c_g)$ $\Pi_d(c_g, c_g)$	$\Pi_m(c_g)$ K
$C = c_b$ Prob. $= 1 - \theta$	K $\Pi_m(c_g)$	K K

Table 1. Firm profits under an unbiased accounting regime

Firm i's total expected profit under an unbiased accounting regime is

$$E[\Pi_{unb.}] = \theta^2 \Pi_d(c_g, c_g) + \theta(1-\theta)\Pi_m(c_g) + (1-\theta)K. \tag{9}$$

4.2 Conservative accounting regime

Under a conservative accounting regime, the firms must report an unfavorable cost when the true cost is unfavorable. But when the true cost is favorable, the firm may report a favorable cost with probability γ and report an unfavorable cost with probability $1 - \gamma$. The investors only observe the cost reports from both firms but do not know the firms' true costs. Examining firm i's profits, we know $\Pi_d(\widehat{c}_g, \widehat{c}_b) \geq \Pi_d(\widehat{c}_g, \widehat{c}_g) \geq \Pi_d(\widehat{c}_b, \widehat{c}_b) \geq \Pi_d(\widehat{c}_b, \widehat{c}_g)$ always holds true. Similar to the unbiased regime, we assume $\Pi_d(\widehat{c}_g, \widehat{c}_g) \geq K \geq \Pi_d(\widehat{c}_b, \widehat{c}_b)$[10], which implies that the investors divest when they receive a bad project cost report from their respective firms.

[10]Note that $\Pi_d(\widehat{c}_g, \widehat{c}_g)$ under the conservative accounting regime is equivalent to $\Pi_d(c_g, c_g)$ under the unbiased accounting regime, as $Pr\{c_g | \widehat{c}_g\} = 1$ when there is a conservative bias. $\Pi_d(\widehat{c}_b, \widehat{c}_b)$ is generally higher in value than $\Pi_d(c_b, c_b)$ under the unbiased regime. When the level of conservatism approaches zero, the value of $\Pi_d(\widehat{c}_b, \widehat{c}_b)$ approaches $\Pi_d(c_b, c_b)$.

The firms' profits from the investment projects are summarized in Table 2.

Firm 1 Firm 2	$C = c_g$; $\widehat{C} = \widehat{c}_g$ Prob. $= \theta\gamma$	$C = c_g$; $\widehat{C} = \widehat{c}_b$ Prob. $= \theta(1-\gamma)$	$C = c_b$; $\widehat{C} = \widehat{c}_b$ Prob. $= (1-\theta)$
$C = c_g$; $\widehat{C} = \widehat{c}_g$ Prob. $= \theta\gamma$	$\Pi_d(c_g, c_g)$ $\Pi_d(c_g, c_g)$	$\Pi_m(c_g)$ K	$\Pi_m(c_g)$ K
$C = c_g$; $\widehat{C} = \widehat{c}_b$ Prob. $= \theta(1-\gamma)$	K $\Pi_m(c_g)$	K K	K K
$C = c_b$; $\widehat{C} = \widehat{c}_b$ Prob. $= (1-\theta)$	K $\Pi_m(c_g)$	K K	K K

Table 2. Firm profits under a conservative accounting regime, with $\Pi_d(c_g, c_g) > K > \Pi_d(\widehat{c}_b, \cdot) \geq \Pi_d(c_b, c_b)$.

When the value of K is higher than $\Pi_d(\widehat{c}_b, \widehat{c}_b)$, investor i always chooses to divest when receiving an unfavorable report. The total expected profit for firm i is

$$E[\Pi_{con.}] = \theta^2\gamma^2\Pi_d(c_g, c_g) + \theta\gamma(1-\theta\gamma)\Pi_m(c_g) + (1-\theta\gamma)K. \tag{10}$$

A conservative accounting bias induces two effects in firm i's expected project payoff. The first effect comes from misclassifying firm i's cost as bad when it is actually good, which increases the chance of firm i's project being terminated and decreases its expected profit. The second effect comes from misclassifying firm j's cost as bad when it is actually good, which increases firm i's profit. The difference between firm i's expected profits under the conservative and unbiased regimes can be written as

$$\begin{aligned} E[\Pi_{con.}] - E[\Pi_{unb.}] &= \underbrace{\gamma(1-\gamma)\theta^2(\Pi_m(c_g) - \Pi_d(c_g, c_g))}_{\text{misclassify competitor with good cost as bad}} \\ &\quad - \underbrace{(1-\gamma)\theta((1-\theta)\Pi_m(c_g) + \theta\Pi_d(c_g, c_g) - K)}_{\text{misclassify own firm with good cost as bad}}. \end{aligned} \tag{11}$$

Clearly, a firm's expected profit is higher under the conservative accounting regime than under the unbiased regime, if the effect of misclassifying its competitor's cost as bad outweighs the effect of misclassifying the firm's own cost as bad when, in fact, it is good.

Proposition 3. *When firms compete in Cournot fashion and have investors who have an interim abandonment option,* $E[\Pi_{con.}] > E[\Pi_{unb.}]$ *if* $\theta > \frac{1}{2}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$ *and* $1-\gamma < 2 - \frac{1}{\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$; *and* $E[\Pi_{con.}]$ *increases in the degree of conservatism if* $\theta > \frac{1}{2}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$ *and* $1-\gamma < 1 - \frac{1}{2\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$.

Proof. See appendix.

Without the abandonment option, the investors' payoffs are strictly lower under the conservative accounting regime than under the unbiased accounting regime. However, Proposition 3 shows that the opposite effect could emerge when interim abandonment is allowed, provided the state of nature, θ, is sufficiently good, and the degree of conservatism, $1-\gamma$, is sufficiently low. This is because the competition-softening effect of conservatism must outweigh its cost in divestment when the costs are favorable. Specifically, the difference between the firm's duopoly profit $\Pi_d(c_g, c_g)$ and monopoly profit $\Pi_m(c_g)$ must be sufficiently large compared to the difference between K and $\Pi_d(c_g, c_g)$ for conservatism to benefit the firm.

The firm profits also increase in the degree of conservatism imposed by the mandatory accounting system. This result is quite different from the prior literature, which typically shows conservatism decreases investment efficiency (e.g. Gigler et al., 2009; Li, 2011). The reason for the different result in our setting is due to the fact that accounting conservatism can indirectly change the industry structure and soften competition.

Similarly, the expected consumer surplus, V, and expected total social welfare, W, are also affected by the accounting regimes.

Corollary 4. *When firms compete in Cournot fashion and have investors who have an interim abandonment option,* $E[V_{con.}] > E[V_{unb.}]$ *if* $1-\gamma < \frac{7}{8}$*; and* $E[W_{con.}] > E[W_{unb.}]$ *if* $1-\gamma < \frac{72K-(18-13\theta)(a-c_g)^2}{2\theta(a-c_g)^2}$ *and* $\theta > \frac{18(a-c_g)^2-72K}{13(a-c_g)^2}$.

Proof. See appendix.

Without the interim abandonment option, the consumer surplus strictly increases but firm profits strictly decrease with the conservative accounting bias. However, with the interim abandonment option, both consumer surplus and firm profits can be higher under the conservative accounting system. The consumer surplus under the conservative regime is higher than under the unbiased regime as long as the degree of accounting conservatism $1-\gamma$ is not too high. This is largely consistent with the results of Corollary 2, except when the degree of conservatism is too high, which results in a high chance of the projects being terminated. The condition for a higher total social welfare under the conservative system is primarily driven by the investors' payoffs, rather than consumer surplus. Compared to the conditions in Proposition 1, the total social welfare with interim abandonment may be higher under conservative regime because the investors' payoffs are higher.

4.3 Aggressive accounting regime

Under aggressive accounting regime, a firm may provide a good cost report even when the true cost is bad with probability δ. Therefore a firm with truly bad cost may still be allowed to continue and compete in the product market. Again we know $\Pi_d(\widehat{c}_g, \widehat{c}_b) \geq \Pi_d(\widehat{c}_g, \widehat{c}_g) \geq \Pi_d(\widehat{c}_b, \widehat{c}_b) \geq \Pi_d(\widehat{c}_b, \widehat{c}_g)$ always holds true, and we assume

$\Pi_d(\widehat{c}_g, \widehat{c}_g) \geq K \geq \Pi_d(\widehat{c}_b, \widehat{c}_b)$.[11] The investors thus divest when they receive a bad report from their respective firms and stay when they receive a good report. The firm profits are summarized in Table 3.

Firm 1 Firm 2	$C = c_g$; $\widehat{C} = \widehat{c}_g$ Prob. $= \theta$	$C = c_b$; $\widehat{C} = \widehat{c}_g$ Prob. $= (1-\theta)\delta$	$C = c_b$; $\widehat{C} = \widehat{c}_b$ Prob. $= (1-\theta)(1-\delta)$
$C = c_g$; $\widehat{C} = \widehat{c}_g$ Prob. $= \theta$	$\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g)$ $\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g)$	$\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g)$ $\Pi_d(c_b, \widehat{c}_g, \widehat{c}_g)$	$\Pi_m(c_g)$ K
$C = c_b$; $\widehat{C} = \widehat{c}_g$ Prob. $= (1-\theta)\delta$	$\Pi_d(c_b, \widehat{c}_g, \widehat{c}_g)$ $\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g)$	$\Pi_d(c_b, \widehat{c}_g, \widehat{c}_g)$ $\Pi_d(c_b, \widehat{c}_g, \widehat{c}_g)$	$\Pi_m(c_b)$ K
$C = c_b$; $\widehat{C} = \widehat{c}_b$ Prob. $= (1-\theta)(1-\delta)$	K $\Pi_m(c_g)$	K $\Pi_m(c_b)$	K K

Table 3. Firm profits under an aggressive accounting regime with $\Pi_d(c_g, c_g) > \Pi_d(\widehat{c}_g, \cdot) > K > \Pi_d(c_b, c_b)$

The total expected profit for firm i's investor is

$$E[\Pi_{agg.}] = \left(\theta^2 + \theta(1-\theta)\delta\right)\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g) + \left((1-\theta)^2\delta^2 + \theta(1-\theta)\delta\right)\Pi_d(c_b, \widehat{c}_g, \widehat{c}_g)$$
$$+\theta(1-\theta)(1-\delta)\Pi_m(c_g) + (1-\theta)^2\delta(1-\delta)\Pi_m(c_b) + (1-\theta)(1-\delta)K, \quad (12)$$

and the difference between expected profits under aggressive and unbiased regimes can be written as

$$E[\Pi_{agg.}] - E[\Pi_{unb.}] = -\underbrace{(1-\theta)\delta\left(K - ((1-\theta)\delta + \theta)\Pi_d(c_b, \widehat{c}_g, \widehat{c}_g) - (1-\theta)(1-\delta)\Pi_m(c_b)\right)}_{\text{misclassify own firm with bad cost as good}}$$
$$-\underbrace{\theta(1-\theta)\delta\left(\Pi_m(c_g) - \Pi_d(c_g, \widehat{c}_g, \widehat{c}_g)\right)}_{\text{misclassify competitor with bad cost as good}}$$
$$+\underbrace{(\theta(\theta + \delta - \theta\delta))\left(\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g) - \Pi_d(c_g, c_g)\right)}_{\text{correctly classify both firms as good}}. \quad (13)$$

Three effects arise from the aggressive accounting bias in cost reports. When firm i itself has bad cost but is misclassified as good, it earns a monopolist profit when the competitor j's project is terminated but loses the assets' potential liquidation value K when j also survives. When competitor j with bad cost is misclassified as good, firm i that has true good cost loses its monopoly profit. A third differential effect also arises when both firms with good costs are correctly classified as good. Under the conservative accounting regime, $\Pi_d(c_g, \widehat{c}_g, \widehat{c}_g) = \Pi_d(c_g, c_g)$, since both firms know the

[11] Under the aggressive accounting regime, $\Pi_d(\widehat{c}_b, \widehat{c}_b) = \Pi_d(c_b, c_b)$. $\Pi_d(\widehat{c}_g, \widehat{c}_g)$ is generally lower than $\Pi_d(c_g, c_g)$ under the unbiased regime, except when the level of aggressiveness is zero. In that case, $\Pi_d(\widehat{c}_g, \widehat{c}_g) = \Pi_d(c_g, c_g)$. Thus the upper and lower bounds required for K under the aggressive system are both lower than under the conservative system.

other firm must have true good cost when good cost is reported. However, under the aggressive accounting, $\Pi_d\left(c_g,\widehat{c}_g,\widehat{c}_g\right) > \Pi_d\left(c_g,c_g\right)$, because the rival firm j that reports a good cost could have a bad cost.

The first effect, when firm i is misclassified as having good cost, is ambiguous on firm i's investment payoff. The second effect, when firm j is misclassified as having good cost, results in a strict reduction in firm i's profit. The third effect, when both firms are correctly classified as having good costs, results in an increase in firm i's profit. In general, the overall effect of aggressive accounting on the firm profit and consumer surplus is inconclusive.

4.4 Optimal level of industry-wide accounting bias

Accounting demonstrates distinct industry characteristics. Many industries, such as the oil and gas industry and the financial services industry, have specific accounting rules and reporting requirements. Empirical research shows that public accounting firms also respond to such demand by developing industry specializations (Craswell, Francis, and Taylor 1995, Ferguson and Stokes 2002). Within a given industry, firms can therefore coordinate and lobby for a financial reporting standard that maximizes their profits. It is thus not surprising that the firms settle on a commonly agreed level of accounting bias.

When the investors do not have an interim abandonment option, accounting bias leads to strictly lower level of firm profit. That is, the level of industry-wide accounting bias that maximizes the firms' profit is zero. When there is an abandonment option available, however, the optimal levels of accounting bias have interior solutions.

Proposition 5. *When firms compete in Cournot fashion and have investors who have an interim abandonment option, the profit-maximizing level of industry-wide mandatory accounting bias is* $1-\gamma=\frac{36K-(9-10\theta)(a-c_g)^2}{10\theta(a-c_g)^2}$ *under the conservative regime, and* $\delta=\frac{\left(5\theta\left((c_b-c_g)^2-(a-c_g)^2-(a-c_b)^2\right)+9\left((a-c_b)^2-4K\right)\right)}{10(1-\theta)(a-c_b)^2}$ *under the aggressive regime.*

Proof. See appendix.

We can also easily see that the profit-maximizing degree of conservatism increases in both the abandonment value K and the state of nature θ. On the contrary, the profit-maximizing degree of aggressiveness decreases in both K and θ.

4.5 Divestment and Coordination

When both firms report unfavorable costs, we have shown that the investors choose to divest since $\Pi_d\left(\widehat{c}_b,\widehat{c}_b\right) < K$. However, if we allow the investors to coordinate their abandonment decisions, an improvement could result in the expected firm profits. Specifically, when one of the investors chooses not to terminate her project, while the other investor does, the first firm becomes a monopolist in the specific product market. A monopolist with unfavorable cost may still generate a level of profit that is higher than the assets' liquidation value. That is, the investor may be better off not to divest all the time if $\Pi_m(c_b) > K$.

Using the concept of correlated equilibrium, we let the two investors follow a random public signal to coordinate their actions on divestment. This signal could be the weather, the stock market performance, or anything that both investors could observe publicly. The public signal has two outcomes, $\{A, B\}$, each with a $\frac{1}{2}$ probability of occurrence. The two investors agree that investor i divests when A occurs and does not when B occurs, and investor j divests when B occurs and does not divest when A occurs. We can easily verify that such strategies are the best responses for both investors and the investors have no incentive to deviate.

Proposition 6. *When both firms give unfavorable cost reports, given a random public signal with two outcomes $\{A, B\}$ and $\Pr[A] = \Pr[B] = \frac{1}{2}$, investor i can follow a strategy to always divest when observing A and not divest when observing B. The resulted profit for firm i is $\frac{4K+(a-c_b)^2}{8}$ under the unbiased and the aggressive accounting regimes and $\frac{4K+(1-\beta)(a-c_g)^2+\beta(a-c_b)^2}{8}$ under the conservative accounting regime.*

Proof. See appendix.

The correlated equilibrium generates a positive improvement in the firms' profits, because it helps the firms avoid the undesirable outcome of $(\Pi_d(c_b, c_b), \Pi_d(c_b, c_b))$ while capturing the benefit of $(\Pi_m(c_b), K)$. In addition, the consumer surplus increases from 0 to $\frac{(a-c_b)^2}{8}$ under the unbiased and the aggressive accounting regimes, and from 0 to $\frac{(1-\beta)(a-c_g)^2+\beta(a-c_b)^2}{8}$ under the conservative accounting regime. This is because, without correlated equilibrium, both firms would be shut down, and there would be no products sold on the market. When the two firms are allowed to coordinate through the public signal, at least one firm will be producing at a time. The correlated equilibrium thus leads to a Pareto improvement for all players when both firms report bad costs.

5 Conclusions

We show that accounting bias reduces expected profitability when firms compete in a Cournot product market and investors do not have an interim abandonment option. In contrast, when investors are allowed to divest in the interim, firm profits can be higher under the conservative accounting regime than under the unbiased regime. This is because the investors rely on interim accounting reports to make their abandonment decisions, and conservative bias in the reports increases the likelihood of divestment and softens competition. In addition, we show that consumer surplus and total social welfare can both be higher under the conservative regime.

We also identify optimal degrees of accounting bias that maximize the expected investment payoff under both conservative and aggressive regimes. Since the firms in a given industry can lobby for the norms of financial reporting, they may agree on a degree of accounting bias that is ex ante preferred. Finally, we discuss the possibility of coordinated divestment decisions when both firms report unfavorable costs and show a Pareto improvement through a correlated equilibrium concept.

This insight of our results can be extended to debt financing. When a debt covenant is based on accounting reports, conservative accounting triggers debt covenant violation more frequently. However, similar to the equity setting, the creditors' liquidation decisions can soften product market competition. The surviving firms get to capture the entire market share and are more likely to generate enough profit to pay back the debt. Therefore firms under conservative accounting regime that borrow can enjoy an ex ante lower cost of debt.

In summary, our study shows how accounting can have a real effect on firms' operating decisions through the investors' abandonment option. Accounting bias is often perceived to be merely a distortion of information and devoid of any real impact on economic behavior. In our setting, however, accounting bias can change the competitive nature of product markets in which the invested firms compete.

Our model is subject to several limitations. For example, we analyze a Cournot market with two firms. As the number of participating firms in an industry rises, firm profit decreases, and so does the firms' ex ante incentive to exit and the competition-softening effect of accounting conservatism. Also, we only model identical firms. If the participating firms are heterogeneous, it may become more difficult for them to agree on a common conservative accounting system that coordinates exit. However, none of these scenarios should change our result qualitatively.

REFERENCES

[1] Bagnoli, M., and S. Watts. 2005. Conservative accounting choices. *Management Science* 51 (5): 786–801.

[2] Bagnoli, M., and S. Watts. 2010. Oligopoly, disclosure, and earnings management. *The Accounting Review* 85 (4): 1191–1214.

[3] Bagwell K. 2007. Signalling and entry deterrence: A multidimensional analysis. *RAND Journal of Economics* 38 (3): 670–697.

[4] Berger, P., E. Ofek, and I. Swary. 1996. Investor valuation of the abandonment option. *Journal of Financial Economics* 42: 257–287.

[5] Beyer, A. 2014. Conservatism and aggregation: The effect on cost of equity capital and the efficiency of debt contracts. Working paper.

[6] Caskey, J., and J. Hughes. 2012. Assessing the impact of alternative fair value measures on the efficiency of project selection and continuation. *The Accounting Review* 87 (2): 483–512.

[7] Chen, Q., T. Hemmer, and Y. Zhang. 2007. On the relation between conservatism in accounting standards and incentives for earnings management. *Journal of Accounting Research* 45 (3): 541–565.

[8] Cheynel, E., and B. Michaeli. 2012. Asset measurement, loanable funds and the cost of capital. Working paper.

[9] Corona, C., and L. Nan. 2013. Preannouncing competitive decisions in oligopoly markets. *Journal of Accounting and Economics* 56 (1): 73–90.

[10] Craswell, A., J. Francis, and S. Taylor. 1995. Auditor brand name reputations and industry specializations. *Journal of Accounting and Economics* 20, 297–322.

[11] Darrough, M. 1993. Disclosure policy and competition: Cournot vs. Bertrand. *The Accounting Review* 68 (3): 534–561.

[12] Darrough, M., and N. M. Stoughton. 1990. Financial disclosure policy in an entry game. *Journal of Accounting and Economics* 12 (1–3): 219–243.

[13] Ferguson, A., and D. Stokes. 2002. Brand name audit pricing, industry specialization and industry leadership premiums post Big 8 and Big 6 mergers. *Contemporary Accounting Research* 19: 77–110.

[14] Friedman, H., J. Hughes, and R. Saouma. 2016. Implications of biased reporting: Conservative and liberal accounting policies in oligopolies. *Review of Accounting Studies* 21 (1): 251-279.

[15] Fudenberg, D., and J. Tirole. 1986. A "signal-jamming" theory of predation. *RAND Journal of Economics* 17 (3): 366–376.

[16] Gao, P. 2013. A measurement approach to conservatism and earnings management. *Journal of Accounting and Economics* 55 (2-3): 251–268.

[17] Gigler, F., C. Kanodia, H. Sapra, and R. Venugopalan. 2009. Accounting conservatism and the effciency of debt contracts. *Journal of Accounting Research* 47 (3): 767–797.

[18] Goex, R., and A. Wagenhofer. 2009. Optimal impairment rules. *Journal of Accounting and Economics* 48: 2–16.

[19] Guay, W., and R. Verrecchia. 2006. Discussion of an economic framework for conservative accounting and Bushman and Piotroski. *Journal of Accounting and Economics* 42 (1-2): 149–165.

[20] Guo, Q. 2012. Conservative reporting and product market competition. Working paper.

[21] Harrington, J.E., Jr. 1986. Limit pricing when the potential entrant is uncertain of its cost function. *Econometrica* 54: 429–37.

[22] Hayn, C. 1995. The information content of losses. *Journal of Accounting and Economics* 20: 125–153.

[23] Kirschenheiter, M. T., and R. Ramakrishnan. 2012. Prudence demands conservatism. Working paper.

[24] Kreps, D., and R. Wilson. 1982. Reputation and imperfect information. *Journal of Economic Theory* 27 (2): 253–279.

[25] Kwon, Y. K. 2005. Accounting conservatism and managerial incentives. *Management Science* 51 (11): 1626–1632.

[26] Kwon, Y. K., D. P. Newman, and Y. S. Suh. 2001. The demand for accounting conservatism for management control. *Review of Accounting Studies* 6: 29–51.

[27] Li, J. 2013. Accounting conservatism and debt contracts: Efficient liquidation and covenant renegotiation. *Contemporary Accounting Research* 30 (3): 1082–1098.

[28] Lu, T., H. Sapra, and R. Venugopalan. 2011. Asset substitution, debt covenants and conservatism. Working paper.

[29] Milgrom, P., and J. Roberts. 1982. Predation, reputation and entry deterrence. *Journal of Economic Theory* 27 (2): 280–312.

[30] Milgrom, P., and J. Roberts. 1982. Limit pricing and entry under incomplete information: An equilibrium analysis. *Econometrica* 50: 443–460.

[31] Raith, M. 2009. An agency theory of conservative accrual accounting. Working paper.

[32] Reis, R., and P. Stocken. 2007. Strategic consequences of historical cost and fair value measurements. *Contemporary Accounting Research* 24 (2): 557–584.

[33] Shleifer, A., and R. Vishny. 2010. Asset fire sales and credit easing. *American Economic Review* 100 (2): 46–50.

[34] Srinivasan K. 1991. Multiple market entry, cost signalling and entry deterrence. *Management Science* 37 (12): 1539–1555.

[35] Venugopalan, R., 2001. Conservatism in accounting: Good or bad? Working paper.

[36] Vives, X. 1984. Duopoly information equilibrium: Cournot and Bertrand. *Journal of Economic Theory* 34 (1): 71–94.

[37] Wagenhofer, A. 1990. Voluntary disclosure with a strategic opponent. *Journal of Accounting and Economics* 12 (4): 341–363.

[38] Watts, R. 2003. Conservatism in accounting part I: Explanations and implications. *Accounting Horizons* 17 (3): 207–221.

Appendix

A Firms' production quantities and firm profits

Under the unbiased accounting regime, the reported costs are the same as the realized costs. There are thus four different scenarios of information structure, resulting in four different levels of production quantity and firm profit. Under the conservative and the aggressive accounting regimes, the reported costs and the realized costs may not be the same. Under the conservative accounting regime, a firm may have favorable realized cost but unfavorable reported cost. Under the aggressive accounting regime, a firm may have unfavorable realized cost but favorable reported cost. There are thus six different scenarios under each regime, resulting in six different levels of production quantity and firm profit.

The firms' production quantities and profits under the three different accounting regimes are summarized below.

A.1 Unbiased accounting regime

Firm i's cost	Firm j's cost	Firm i's production quantity	Firm i's profit
$C_i = c_g$	$C_j = c_g$	$Q_d(c_g, c_g) = \frac{(a-c_g)}{3}$	$\Pi_d(c_g, c_g) = \frac{(a-c_g)^2}{9}$
$C_i = c_b$	$C_j = c_b$	$Q_d(c_b, c_b) = \frac{(a-c_b)}{3}$	$\Pi_d(c_b, c_b) = \frac{(a-c_b)^2}{9}$
$C_i = c_g$	$C_j = c_b$	$Q_d(c_g, c_b) = \frac{(a-c_g)+(c_b-c_g)}{3}$	$\Pi_d(c_g, c_b) = \frac{((a-c_g)+(c_b-c_g))^2}{9}$
$C_i = c_b$	$C_j = c_g$	$Q_d(c_b, c_g) = \frac{(a-c_b)-(c_b-c_g)}{3}$	$\Pi_d(c_b, c_g) = \frac{((a-c_b)-(c_b-c_g))^2}{9}$

A.2 Conservative accounting regime

Firm i's realized cost	Firm i's reported cost	Firm j's reported cost	Firm i's prodution quantity	Firm i's profit
$C_i = c_g$	$\widehat{C}_i = \widehat{c}_g$	$\widehat{C}_j = \widehat{c}_g$	$Q_d\left(c_g, \widehat{c}_g, \widehat{c}_g\right) = \frac{(a-c_g)}{3}$	$\Pi_d\left(c_g, \widehat{c}_g, \widehat{c}_g\right) = \frac{(a-c_g)^2}{9}$
$C_i = c_g$	$\widehat{C}_i = \widehat{c}_g$	$\widehat{C}_j = \widehat{c}_b$	$Q_d\left(c_g, \widehat{c}_g, \widehat{c}_b\right) = \frac{2(a-c_g)+2\beta(c_b-c_g)}{6}$	$\Pi_d\left(c_g, \widehat{c}_g, \widehat{c}_b\right) = \frac{(2(a-c_g)+2\beta(c_b-c_g))^2}{36}$
$C_i = c_g$	$\widehat{C}_i = \widehat{c}_b$	$\widehat{C}_j = \widehat{c}_g$	$Q_d\left(c_g, \widehat{c}_b, \widehat{c}_g\right) = \frac{2(a-c_g)-\beta(c_b-c_g)}{6}$	$\Pi_d\left(c_g, \widehat{c}_b, \widehat{c}_g\right) = \frac{(2(a-c_g)-\beta(c_b-c_g))^2}{36}$
$C_i = c_g$	$\widehat{C}_i = \widehat{c}_b$	$\widehat{C}_j = \widehat{c}_b$	$Q_d\left(c_g, \widehat{c}_b, \widehat{c}_b\right) = \frac{2(a-c_g)+\beta(c_b-c_g)}{6}$	$\Pi_d\left(c_g, \widehat{c}_b, \widehat{c}_b\right) = \frac{(2(a-c_g)+\beta(c_b-c_g))^2}{36}$
$C_i = c_b$	$\widehat{C}_i = \widehat{c}_b$	$\widehat{C}_j = \widehat{c}_g$	$Q_d\left(c_b, \widehat{c}_b, \widehat{c}_g\right) = \frac{2(a-c_b)-(1+\beta)(c_b-c_g)}{6}$	$\Pi_d\left(c_b, \widehat{c}_b, \widehat{c}_g\right) = \frac{(2(a-c_b)-(1+\beta)(c_b-c_g))^2}{36}$
$C_i = c_b$	$\widehat{C}_i = \widehat{c}_b$	$\widehat{C}_j = \widehat{c}_b$	$Q_d\left(c_b, \widehat{c}_b, \widehat{c}_b\right) = \frac{2(a-c_b)-(1-\beta)(c_b-c_g)}{6}$	$\Pi_d\left(c_b, \widehat{c}_b, \widehat{c}_b\right) = \frac{(2(a-c_b)-(1-\beta)(c_b-c_g))^2}{36}$

A.3 Aggressive accounting regime

Firm i's realized cost	Firm i's reported cost	Firm j's reported cost	Firm i's prodution quantity	Firm i's profit
$C_i = c_g$	$\widehat{C}_i = \widehat{c}_g$	$\widehat{C}_j = \widehat{c}_g$	$Q_d\left(c_g, \widehat{c}_g, \widehat{c}_g\right) = \frac{2(a-c_g)+(1-\alpha)(c_b-c_g)}{6}$	$\Pi_d\left(c_g, \widehat{c}_g, \widehat{c}_g\right) = \frac{(2(a-c_g)+(1-\alpha)(c_b-c_g))^2}{36}$
$C_i = c_g$	$\widehat{C}_i = \widehat{c}_g$	$\widehat{C}_j = \widehat{c}_b$	$Q_d\left(c_g, \widehat{c}_g, \widehat{c}_b\right) = \frac{2(a-c_g)+(1+\alpha)(c_b-c_g)}{6}$	$\Pi_d\left(c_g, \widehat{c}_g, \widehat{c}_b\right) = \frac{(2(a-c_g)+(1+\alpha)(c_b-c_g))^2}{36}$
$C_i = c_b$	$\widehat{C}_i = \widehat{c}_g$	$\widehat{C}_j = \widehat{c}_g$	$Q_d\left(c_b, \widehat{c}_g, \widehat{c}_g\right) = \frac{2(a-c_b)-\alpha(c_b-c_g)}{6}$	$\Pi_d\left(c_b, \widehat{c}_g, \widehat{c}_g\right) = \frac{(2(a-c_b)-\alpha(c_b-c_g))^2}{36}$
$C_i = c_b$	$\widehat{C}_i = \widehat{c}_g$	$\widehat{C}_j = \widehat{c}_b$	$Q_d\left(c_b, \widehat{c}_g, \widehat{c}_b\right) = \frac{2(a-c_b)+\alpha(c_b-c_g)}{6}$	$\Pi_d\left(c_b, \widehat{c}_g, \widehat{c}_b\right) = \frac{(2(a-c_b)+\alpha(c_b-c_g))^2}{36}$
$C_i = c_b$	$\widehat{C}_i = \widehat{c}_b$	$\widehat{C}_j = \widehat{c}_g$	$Q_d\left(c_b, \widehat{c}_b, \widehat{c}_g\right) = \frac{2(a-c_b)-2\alpha(c_b-c_g)}{6}$	$\Pi_d\left(c_b, \widehat{c}_b, \widehat{c}_g\right) = \frac{(2(a-c_b)-2\alpha(c_b-c_g))^2}{36}$
$C_i = c_b$	$\widehat{C}_i = \widehat{c}_b$	$\widehat{C}_j = \widehat{c}_b$	$Q_d\left(c_b, \widehat{c}_b, \widehat{c}_b\right) = \frac{(a-c_b)}{3}$	$\Pi_d\left(c_b, \widehat{c}_b, \widehat{c}_b\right) = \frac{(a-c_b)^2}{9}$

B Proof of Proposition 1

Based on Appendix A, firm i's expected profits under the three different accounting regimes are calculated below.

Unbiased regime:

$$
\begin{aligned}
E\left[\Pi_{unb.}\right] &= \theta^2 \frac{(a-c_g)^2}{9} + (1-\theta)^2 \frac{(a-c_b)^2}{9} \\
&\quad + \theta(1-\theta)\frac{((a-c_g)+(c_b-c_g))^2}{9} + (1-\theta)\theta\frac{((a-c_b)-(c_b-c_g))^2}{9} \qquad (14)
\end{aligned}
$$

Conservative regime:

$$
\begin{aligned}
E\left[\Pi_{con.}\right] &= \theta^2\gamma^2\frac{(a-c_g)^2}{9} + \theta\gamma\left(\theta(1-\gamma)+(1-\theta)\right)\frac{\left(2\left(a-c_g\right)+2\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \theta\gamma\theta(1-\gamma)\frac{\left(2(a-c_g)-\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}(c_b-c_g)\right)^2}{36} \\
&\quad + \theta(1-\gamma)\left(\theta(1-\gamma)+(1-\theta)\right)\frac{\left(2(a-c_g)+\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \theta\gamma\left(1-\theta\right)\frac{\left(2\left(a-c_b\right)-\left(1+\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\right)\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \left(1-\theta\right)\left(\theta(1-\gamma)+(1-\theta)\right)\frac{\left(2(a-c_b)-\left(1-\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\right)\left(c_b-c_g\right)\right)^2}{36} \qquad (15)
\end{aligned}
$$

Aggressive regime:

$$
\begin{aligned}
E\left[\Pi_{agg.}\right] &= \left(\theta^2+\theta\left(1-\theta\right)\delta\right)\frac{\left(2\left(a-c_g\right)+\left(1-\frac{\theta}{\theta+((1-\theta)\delta)}\right)\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \theta\left(1-\theta\right)\left(1-\delta\right)\frac{\left(2\left(a-c_g\right)+\left(1+\frac{\theta}{\theta+((1-\theta)\delta)}\right)\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \left(\theta(1-\theta)\delta+\left(1-\theta\right)^2\delta^2\right)\frac{\left(2\left(a-c_b\right)-\frac{\theta}{\theta+((1-\theta)\delta)}\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \left(1-\theta\right)\delta\left(1-\theta\right)\left(1-\delta\right)\frac{\left(2(a-c_b)+\frac{\theta}{\theta+((1-\theta)\delta)}(c_b-c_g)\right)^2}{36} \\
&\quad + \left(\theta\left(1-\theta\right)\left(1-\delta\right)+\left(1-\theta\right)\delta\left(1-\theta\right)\left(1-\delta\right)\right)\frac{\left(2\left(a-c_b\right)-2\frac{\theta}{\theta+((1-\theta)\delta)}\left(c_b-c_g\right)\right)^2}{36} \\
&\quad + \left(1-\theta\right)^2\left(1-\delta\right)^2\frac{(a-c_b)^2}{9} \qquad (16)
\end{aligned}
$$

To compute the difference in these payoffs, we deduct the conservative/aggressive payoff from the unbiased payoff.

$$E\left[\Pi_{unb.}\right]-E\left[\Pi_{con.}\right]=\frac{11}{36}\theta\left(1-\theta\right)\frac{1-\gamma}{1-\theta\gamma}\left(c_b-c_g\right)^2>0 \tag{17}$$

$$E\left[\Pi_{unb.}\right]-E\left[\Pi_{agg.}\right]=\frac{11}{36}\theta\left(1-\theta\right)\frac{\delta}{\theta+\delta-\theta\delta}\left(c_b-c_g\right)^2>0 \tag{18}$$

Thus we know the payoff level under the unbiased accounting regime is always higher than that under the conservative/aggressive accounting regime.

To demonstrate the relationship between the firm profit and the level of conservative/aggressive bias, we take the first-order derivative of firm i's payoff w.r.t. γ and δ, respectively.

$$\frac{\partial}{\partial\gamma}E\left[\Pi_{con.}\right]=\frac{11}{36}\frac{\theta\left(1-\theta\right)^2}{\left(1-\theta\gamma\right)^2}\left(c_b-c_g\right)^2>0 \tag{19}$$

$$\frac{\partial}{\partial\delta}E\left[\Pi_{agg.}\right]=\frac{11}{36}\frac{\left(1-\theta\right)\theta^2}{\left(\theta+\delta-\theta\delta\right)^2}\left(c_b-c_g\right)^2<0 \tag{20}$$

It is clear that the expected firm profit decreases in the level of accounting bias.

C Proof of Corollary 2

Based on Appendix A, the expected consumer surplus in the three different accounting regimes is calculated below.

Unbiased regime:

$$\begin{aligned} E\left[V_{unb.}\right] &= \theta^2\frac{1}{2}\left(\frac{2\left(a-c_g\right)}{3}\right)^2+(1-\theta)^2\frac{1}{2}\left(\frac{2\left(a-c_b\right)}{3}\right)^2 \\ &\quad +(1-\theta)\theta\left(\frac{2a-\left(c_b+c_g\right)}{3}\right)^2 \end{aligned} \tag{21}$$

Conservative regime:

$$
\begin{aligned}
E\left[V_{con.}\right] \;=\;& \theta^2\gamma^2\frac{1}{2}\left(\frac{2\left(a-c_g\right)}{3}\right)^2+\theta^2\gamma(1-\gamma)\left(\frac{4\left(a-c_g\right)+\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\left(c_b-c_g\right)}{6}\right)^2 \\
&+\theta\left(1-\theta\right)\gamma\left(\frac{4\left(a-c_b\right)+\left(1+\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\right)\left(c_b-c_g\right)}{6}\right)^2 \\
&+\theta^2(1-\gamma)^2\frac{1}{2}\left(\frac{2(a-c_g)+\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\left(c_b-c_g\right)}{3}\right)^2 \\
&+\ \left(1-\theta\right)\theta(1-\gamma)\left(\frac{4(a-c_b)+\left(1+2\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\right)\left(c_b-c_g\right)}{6}\right)^2 \\
&+\left(1-\theta\right)^2\frac{1}{2}\left(\frac{2(a-c_b)-\left(1-\frac{1-\theta}{(1-\theta)+\theta(1-\gamma)}\right)\left(c_b-c_g\right)}{3}\right)^2 \qquad (22)
\end{aligned}
$$

Aggressive regime:

$$
\begin{aligned}
E\left[V_{agg.}\right] \;=\;& \theta^2\frac{1}{2}\left(\frac{2\left(a-c_g\right)+(1-\frac{\theta}{\theta+((1-\theta)\delta)})\left(c_b-c_g\right)}{3}\right)^2 \\
&+2\theta\left(1-\theta\right)\delta\frac{1}{2}\left(\frac{4\left(a-c_b\right)+\left(3-2\frac{\theta}{\theta+((1-\theta)\delta)}\right)\left(c_b-c_g\right)}{6}\right)^2 \\
&+2\theta\left(1-\theta\right)\left(1-\delta\right)\frac{1}{2}\left(\frac{4\left(a-c_g\right)-(1+\frac{\theta}{\theta+((1-\theta)\delta)})(c_b-c_g)}{6}\right)^2 \\
&+2(1-\theta)^2\delta\left(1-\delta\right)\frac{1}{2}\left(\frac{4\left(a-c_b\right)-\frac{\theta}{\theta+((1-\theta)\delta)}\left(c_b-c_g\right)}{6}\right)^2 \\
&+\left(1-\theta\right)^2\delta^2\frac{1}{2}\left(\frac{2\left(a-c_b\right)-\frac{\theta}{\theta+((1-\theta)\delta)}\left(c_b-c_g\right)}{3}\right)^2 \\
&+\left(1-\theta\right)^2\left(1-\delta\right)^2\frac{1}{2}\left(\frac{2(a-c_b)}{3}\right)^2 \qquad (23)
\end{aligned}
$$

To compute the difference in these values, we deduct the conservative/aggressive consumer surplus from the unbiased consumer surplus.

$$
E[V_{unb.}]-E[V_{con.}]=-\frac{5}{36}\theta\left(1-\theta\right)\frac{1-\gamma}{1-\theta\gamma}\left(c_b-c_g\right)^2<0 \qquad (24)
$$

$$(25) \qquad E[V_{unb.}] - E[V_{agg.}] = -\frac{5}{36}\theta(1-\theta)\frac{\delta}{\theta+\delta-\theta\delta}(c_b - c_g)^2 < 0$$

Thus we know the level of consumer surplus under the unbiased accounting regime is always lower than that under the conservative or aggressive accounting regime.

The total social welfare is simply the sum of two investors' payoffs (firm profit net of investment I) and consumer surplus. Compared to the unbiased accounting regime, the increase in consumer surplus is not as high as the decrease in investment payoff under the conservative or aggressive accounting regime. Therefore the total social welfare is lower under the conservative or aggressive accounting regime than under the unbiased accounting regime.

D Proof of Proposition 3

First, we compare the expected firm profits under the conservative accounting regime and the unbiased regime. The expected firm profit under the unbiased accounting regime is

$$(26) \qquad E[\Pi_{unb.}] = \theta^2\Pi_d(c_g, c_g) + \theta(1-\theta)\Pi_m(c_g) + (1-\theta)K.$$

The expected firm profit under the conservative accounting regime is

$$(27) \qquad E[\Pi_{con.}] = \theta^2\gamma^2\Pi_d(c_g, c_g) + \theta\gamma(1-\theta\gamma)\Pi_m(c_g) + (1-\theta\gamma)K.$$

Taking the difference between these two expected profits, we have

$$\begin{aligned} & E[\Pi_{con.}] - E[\Pi_{unb.}] \\ (28) \quad = \; & \theta(1-\gamma)(\theta(1+\gamma)-1)\Pi_m(c_g) - \theta^2\left(1-\gamma^2\right)\Pi_d(c_g, c_g) + \theta(1-\gamma)K \end{aligned}$$

For the expected profit under the conservative regime to be higher than the under unbiased regime, it must be true that $\theta(1-\gamma)(\theta(1+\gamma)-1)\Pi_m(c_g)+\theta^2(\gamma^2-1)\Pi_d(c_g, c_g)+\theta(1-\gamma)K > 0$. Solving for γ, we have $\gamma > \frac{1}{\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)} - 1$, or $1-\gamma < 2 - \frac{1}{\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$. Since $\Pi_m(c_g) = \frac{(a-c_g)^2}{4} > \Pi_d(c_g, c_g) = \frac{(a-c_g)^2}{9} > K$, we know $\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)} > 1$ and thus $\gamma > 0$ is always satisfied. It must also be true that $\frac{1}{\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)} - 1 < 1$, which implies $\theta > \frac{1}{2}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$. Thus we need $1-\gamma < 2 - \frac{1}{\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$ and $1 > \theta > \frac{1}{2}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$ for $E[\Pi_{con.}] > E[\Pi_{unb.}]$ to be true.

Next we examine the change of the firm profit in $1-\gamma$. Taking the partial derivative, we have

$$\begin{aligned} & \frac{\partial}{\partial(1-\gamma)}\left(\theta^2\gamma^2\Pi_d(c_g, c_g) + \theta\gamma(1-\theta\gamma)\Pi_m(c_g) - (I - K + \theta\gamma K)\right) \\ (29) \quad = \; & 2\theta\gamma(\Pi_m(c_g) - \Pi_d(c_g, c_g)) - (\Pi_m(c_g) - K). \end{aligned}$$

The firms' profits will decrease in γ if $2\theta\gamma\left(\Pi_m\left(c_g\right)-\Pi_d\left(c_g,c_g\right)\right)-\left(\Pi_m\left(c_g\right)-K\right)>0$, which is $1-\gamma<1-\frac{1}{2\theta}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$. We know $\gamma>0$ is always satisfied. Since we also require $\gamma<1$, $\theta>\frac{1}{2}\frac{\Pi_m(c_g)-K}{\Pi_m(c_g)-\Pi_d(c_g,c_g)}$ must hold true.

E Proof of Corollary 4

The expected consumer surplus in the two different accounting regimes is listed below.

Unbiased regime:

$$\begin{aligned} E\left[V_{unb.}\right] &= \theta^2\frac{1}{2}\left(\frac{2\left(a-c_g\right)}{3}\right)^2+2\theta\left(1-\theta\right)\frac{1}{2}\left(\frac{\left(a-c_g\right)}{2}\right)^2 \\ &= \frac{1}{36}\theta\left(9-\theta\right)\left(a-c_g\right)^2. \end{aligned} \tag{30}$$

Conservative regime:

$$\begin{aligned} E\left[V_{con.}\right] &= \theta^2\gamma^2\frac{1}{2}\left(\frac{2\left(a-c_g\right)}{3}\right)^2+2\theta\left(1-\theta\gamma\right)\frac{1}{2}\left(\frac{\left(a-c_g\right)}{2}\right)^2 \\ &= \frac{1}{36}\theta\left(9-\theta\left(9\gamma-8\gamma^2\right)\right)\left(a-c_g\right)^2. \end{aligned} \tag{31}$$

It is thus clear that $E\left[V_{con.}\right]>E\left[V_{unb.}\right]$ when $\left(9\gamma-8\gamma^2\right)>1$, which requires $\gamma\in\left(\frac{1}{8},1\right)$, or $1-\gamma\in\left(1,\frac{7}{8}\right)$.

The total social welfare is the sum of the two investors' payoffs net of investment I and consumer surplus.

Unbiased regime:

$$\begin{aligned} E[W_{unb.}] &= 2\left(\theta^2\frac{\left(a-c_g\right)^2}{9}+\theta\left(1-\theta\right)\frac{\left(a-c_g\right)^2}{4}+\left(1-\theta\right)K-I\right) \\ &\quad +\frac{1}{36}\theta\left(9-\theta\right)\left(a-c_g\right)^2. \end{aligned} \tag{32}$$

Conservative regime:

$$\begin{aligned} E[W_{con.}] &= 2\left(\theta^2\gamma^2\frac{\left(a-c_g\right)^2}{9}+\theta\gamma\left(1-\theta\gamma\right)\frac{\left(a-c_g\right)^2}{4}+\left(1-\theta\gamma\right)K-I\right) \\ &\quad +\frac{1}{36}\theta\left(9-\theta\left(9\gamma-8\gamma^2\right)\right)\left(a-c_g\right)^2. \end{aligned} \tag{33}$$

Taking the difference between these two expected welfare levels, we have

$$\begin{aligned} & E\left[W_{con.}\right]-E\left[W_{unb.}\right] \\ (34) \qquad = & \frac{1}{36}\theta\left(1-\gamma\right)\left(72K+11\theta\left(a-c_g\right)^2+2\theta\gamma\left(a-c_g\right)^2-18\left(a-c_g\right)^2\right) \end{aligned}$$

For the $\left(72K+11\theta\left(a-c_g\right)^2+2\theta\gamma\left(a-c_g\right)^2-18\left(a-c_g\right)^2\right)$ to be positive, $\gamma > \frac{(18-11\theta)(a-c_g)^2-72K}{2\theta(a-c_g)^2}$ must hold, which is equivalent to $1-\gamma < \frac{72K-(18-13\theta)(a-c_g)^2}{2\theta(a-c_g)^2}$. Since $\Pi_d\left(c_g,c_g\right)=\frac{(a-c_g)^2}{9} > K$, we know the numerator $18\left(a-c_g\right)^2-11\theta\left(a-c_g\right)^2-72K$ must be positive. Thus $\gamma > 0$ is satisfied. We also require $\gamma < 1$ and therefore $\frac{(18-11\theta)(a-c_g)^2-72K}{2\theta(a-c_g)^2} < 1$ must hold. That is, $\theta > \frac{18(a-c_g)^2-72K}{13(a-c_g)^2}$ has to be true. Therefore we need $1-\gamma < \frac{72K-(18-13\theta)(a-c_g)^2}{2\theta(a-c_g)^2}$ and $1 > \theta > \frac{18(a-c_g)^2-72K}{13(a-c_g)^2}$ for $E\left[W_{con.}\right] > E\left[W_{unb.}\right]$ to be true.

F Proof of Proposition 5

We take the first-order derivative of the firm profit under the conservative accounting regime with regard to $1-\gamma$ and set it to equal 0. Solving for $1-\gamma$, we have

$$1-\gamma=\frac{36K-\left(9-10\theta\right)\left(a-c_g\right)^2}{10\theta\left(a-c_g\right)^2}.$$

We also check the second-order condition, which is negative, thus satisfying the requirement for the maximization problem.

$$\frac{\partial^2}{\partial\left(1-\gamma\right)^2}E\left[\Pi_{con.}\right]=-\frac{5}{18}\theta^2\left(a-c_g\right)^2<0$$

Taking the first-order derivative of the firm profit under the aggressive accounting regime with regard to δ, setting it to equal 0, and solving for δ, we have

$$\delta=\frac{\left(5\theta\left(\left(c_b-c_g\right)^2-\left(a-c_g\right)^2-\left(a-c_b\right)^2\right)+9\left(\left(a-c_b\right)^2-4K\right)\right)}{10\left(1-\theta\right)\left(a-c_b\right)^2}.$$

The second-order condition holds since

$$\frac{\partial^2}{\partial\delta^2}E\left[\Pi_{agg.}\right]=-\frac{5}{18}\left(\theta-1\right)^2\left(a-c_b\right)^2<0.$$

G Proof of Proposition 6

When both firms report high costs, the following subgame describes the investors' potential divestment decisions and the corresponding payoffs.

Firm 1 / Firm 2	Divest	Do not divest
Divest	K K	K $\Pi_m(c_b)^*$ or $(1-\beta)\Pi_m(c_g)+\beta\Pi_m(c_b)^\dagger$
Do not divest	$\Pi_m(c_b)^*$ or $(1-\beta)\Pi_m(c_g)+\beta\Pi_m(c_b)^\dagger$ K	$\Pi_d(c_b,c_b)$ $\Pi_d(c_b,c_b)$

* unbiased and aggressive regimes; † conservative regime

Suppose there is a random public signal that has two outcomes, $\{A, B\}$, each with a $\frac{1}{2}$ probability of occurrence. Suppose, too, investor i agrees to terminate her project when A occurs and not when B occurs, and investor j agrees to terminate when B occurs and not when A occurs. Neither investor has incentive to deviate from this strategy, as it is the best response to each other. Clearly, the resulted investment payoff is $\frac{K+\Pi_m(c_b)}{2} = \frac{4K+(a-c_b)^2}{8}$ under the unbiased and the aggressive accounting regimes, and $\frac{K+(1-\beta)\Pi_m(c_g)+\beta\Pi_m(c_b)}{2} = \frac{4K+(1-\beta)(a-c_g)^2+\beta(a-c_b)^2}{8}$ under the conservative accounting regime.