Accounting Conservatism and the Efficient Provision of Capital to Privately Informed Firms*

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1. Introduction

This study addresses conservatism in financial reporting. Conservatism is usually defined in terms of accounting regulations requiring higher verification standards for profits than for losses. Empirical researchers have documented conservatism in returns-based approaches (see Basu 1997), in which conservatism is measured as the asymmetric timeliness of earnings to bad and good news, and in balance sheet approaches (see Penman and Zhang 2002), in which conservatism is measured as the degree of understatement of assets and income. Researchers have also provided evidence that conservatism is a property of accounting systems globally (Bushman and Piotroski 2006). Watts (2003) surveys common explanations for the prevalence of accounting conservatism: contracting (debt contracting and managerial control), shareholder litigation, political costs, and taxation. This study contributes to the theoretical literature by modeling the role of accounting conservatism in a setting in which a firm seeking financing has private information about a project's expected return.

In the model, a firm (good or bad type) seeks debt financing for a new project. A good firm's project yields positive cash flow with certainty. The bad firm is a gamble—its project's expected cash flow conditional on success is higher than the good firm's, but the project fails often enough that the unconditional expected cash flow is lower. A binary (high or low) accounting signal improves the creditor's decision. The study addresses both pre- and post-investment signals. The pre-investment signal is directly useful to creditors in determining repayment terms. The post-investment signal is useful to provide a contractual basis for a debt covenant.[1] I consider the post-investment setting both with and without renegotiation of the debt covenant.

The accounting signal has two properties meant to reflect those of empirically observed accounting systems. First, there is a baseline level of classification error. The baseline error arises because accounting classifications are the product of complex processes of judgment, analysis, and aggregation of information. The baseline error is an inherent property of the financial reporting system and not a regulatory choice. Second, the accounting signal has a tendency, all other things equal, toward pessimistic classification, labeled conservatism. Conservatism arises through the agency of an unmodeled regulatory body, and is implemented through institutional means such as rules and auditing practices. The most natural interpretation of conservatism in the model is as the inverse of the verification standard for bad news events. That is, as the verification standard for bad news becomes lower (easier to satisfy), the overall conservatism of the signal increases.

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1. There is no uniformity in the literature about the timing of the signal. In Smith (2007) and Nan and Wen (2011), the signal arrives before the investment. In Gigler, Kanodia, Sapra, and Venugopalan (2009) and Gao (2013), the signal arrives after investment but before an abandonment decision. In Gox and Wagenhofer (2009), the signal refers to pledged assets, not to the investment being financed, and arrives after the realization of investment cash flows.

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There are more frequent low-signal (bad news) realizations, but the informativeness of the high signal (good news) increases.

A setting without private information provides the benchmark in each setting. In the pre-investment signal setting, conservatism is optimal only when the average project has a negative net present value (NPV). Conservatism reduces the probability that a bad firm will receive financing but also increases the probability that a good firm will not. This trade-off maximizes profits only if the proportion of good firms is so low that the average return is less than the creditor's required rate of return. In the post-investment setting without renegotiation, conservatism is optimal only when the payoff from the average project is less than its abandonment value. Because all (or no) firms receive financing in a post-investment signal equilibrium, the signal's value is limited to improving the abandonment decision. Conservatism reduces the probability that an unsuccessful project will be continued but also increases the probability that a successful project will be abandoned. Analogous to the pre-investment setting, this trade-off is optimal only if the expected continuation value is lower than the abandonment value. Finally, conservatism is not optimal in the renegotiation setting unless the failure rate on bad projects is high enough.

These results echo several recent studies focusing on the role of conservatism in mediating financing relationships. Smith (2007) examines the properties of accounting systems in the context of an investment with a real-option and finds that conservatism is optimal only if the incremental value derived from the real-option is necessary to induce the firm to make the initial investment.[2] Gigler et al. (2009) model a setting in which the realization of a public accounting signal potentially triggers a debt covenant-related liquidation of an investment. The optimal debt covenant varies in equilibrium with the properties of the accounting system. The authors find that conservatism is efficient only if the ex ante value of the investment is less than its liquidation value, a result analogous to the Smith (2007) real-options result. Li (2012) examines a post-investment setting with renegotiation, limiting the analysis to positive NPV projects. In the benchmark case with prohibitively high renegotiation costs, conservatism is never optimal. In all the papers, conservatism is optimal only for relatively low-value projects. This is an intuitive result, as it is vital to increase the information content in the upper part of the distribution when the projects have low value.[3]

The introduction of private information creates the demand for conservatism for higher ex ante value projects.[4] While the details of the equilibria are subtly different in the various scenarios, the unifying theme is that a trading equilibrium with uninformed firms may require good firms to subsidize (i.e., realize a loss) bad firms when the proportion of good firms and/or the baseline accuracy of the signal are relatively low. Privately informed firms are unwilling to provide such a subsidy. As a result, a financing equilibrium may not be possible without a mechanism to reallocate surplus to the good firm via a lower debt service payment. By protecting the creditor from risk, conservatism serves as such a mechanism. For some settings/parameter values, this protection allows a debt service payment low enough that the good firm can profitably invest but high enough to provide the creditor with

2. The abandonment option section in Smith (2007) resembles the post-investment no private information setting in section 3.
3. In a paper focusing on financing efficiency rather than investment efficiency, Nan and Wen (2011) also find that conservatism is optimal only for less profitable projects. In Gox and Wagenhofer (2009), conservatism is optimal when firms must pledge additional assets because the expected cash available for the repayment of debt is insufficient to provide the creditors with their required rate of return.
4. Chen and Deng (2011) also examine the interaction between private information and conservatism. In their model, privately informed firms choose the level of conservatism to signal their type. In my model, privately informed firms make investment decisions taking as given the level of conservatism chosen by accounting regulators.

its required rate of return, and a financing equilibrium still exists. For others, the trading equilibrium is infeasible under private information even with maximum conservatism.

In the pre-investment signal setting, increasing conservatism protects the creditor by increasing the proportion of good firms in the high-signal pool. A trading equilibrium is always possible because only good firms can generate a high signal with maximum conservatism. In the post-investment signal setting, a financing equilibrium may not exist even with uninformed firms because all firms must receive financing. The signal is useful for the abandonment decision or for renegotiation. The creditor receives payoffs both from the debt service payment paid by firms continuing successful projects and from the abandonment value of discontinued projects. Increasing conservatism protects the creditor by increasing the frequency of, and therefore the expected cash collection from, abandonment. In the renegotiation setting, the creditor also gets part of its payoff from a renegotiation of the debt contract triggered by an inaccurate low signal. Conservatism protects the creditor in this setting by allowing it to collect the renegotiation payoff more often. In all the settings, a level of conservatism inefficient with uninformed firms may be necessary to make possible financing with informed firms. In general, this occurs when the proportion of good firms is not so low that a trading equilibrium cannot exist but not so high that one exists regardless of the signal's properties. That is, private information extends the range of project profitability for which there is a demand for conservatism.

While the desirability of conservatism for low ex ante value investments has been a theme in several recent theoretical studies on conservatism, there are also some in which a demand for conservatism exists for higher value ex ante value projects. Bagnoli and Watts (2005) show that a manager who balances the benefit of a high interim valuation against the cost of missing future earnings expectations may choose a conservative accounting policy to signal relatively good future prospects to investors. Caskey and Hughes (2012) model an asset substitution problem and show that conservatism can be useful to mitigate inefficient abandonment decisions for relatively high-value projects. Finally, Gao (2013) shows that conservatism can be useful to mitigate earnings management in a financing setting that does not exclude the possibility of higher valued projects.

Researchers have also addressed conservatism in managerial control problems. In some of these studies, conservatism is useful if the ex ante probability of success is relatively low, consistent with the results in Gigler et al. (2009), Smith (2007), and the no private information version of this study. For example, Kwon, Newman, and Suh (2001) address the effect of varying conservatism in a principal-agent setting. While their main results pertain to a limited liability setting in which conservatism is optimal, they also show that conservatism is optimal in an unlimited liability setting only if the probability that the desired action generates the high outcome is below ½. In addition, Venugopalan (2001) examines the role of conservatism in an adverse-selection model. The manager has private information about the prior probability of project success and chooses an investment level before market exchange occurs. In the fully revealing signaling equilibrium, the manager distorts investment levels to induce a higher signal. If the prior probability is below ½, a maximally conservative signal induces lower investment distortions than a maximally liberal one. This result and the aforementioned result in Kwon et al. (2001) hinge on conservatism being optimal because it generates a more informative signal if the prior probability of success is low. Conservatism can be optimal in my model even if it undermines the overall informativeness of the reporting system. In another managerial control study, Lin (2006) models a two-period setting in which the principal must induce efficient project selection and appropriate agent effort. A conservative depreciation schedule, replicating the direct communication outcomes, is valuable only if the output from the more profitable project is less informative about effort than the output from the less profitable project. This is loosely analogous to my result that conservatism is useful only

if a good project is not too much better than a bad project. Relative to these studies, my study expands the scope of conservatism.

In the next section, I introduce and analyze the pre-investment signal version of the model. In section 3, I introduce and analyze the post-investment signal version of the model without renegotiation. In section 4, I address a post-investment signal with renegotiation. In section 5, I summarize and discuss the results.

2. Pre-investment signal

There are two types of firms, good and bad. The probability that a firm is good is g, which is common knowledge. Both types of firms require k for the financing of a project. The cash flow from a good project is C_G. The cash flow from a bad project is 0 with probability d and C_B with probability $1-d$, with $0 \leq d \leq 1$. I assume that the cash flow conditional on success is higher for the bad project, but that the unconditional expected cash flow is higher for the good project: $C_B > C_G > (1-d)\ C_B$.[5] In this sense, the bad project resembles a high-risk, lottery-type investment. The competitive financial institution receives a return of r on its capital, with $C_G > k(1 + r) > (1-d)\ C_B$. The last assumption implies that the bad project has negative NPV.

The total expected surplus is:

$$S = g\pi_g[C_G - k(1+r)] - (1-g)\pi_b[k(1+r) - (1-d)C_B], \tag{1}$$

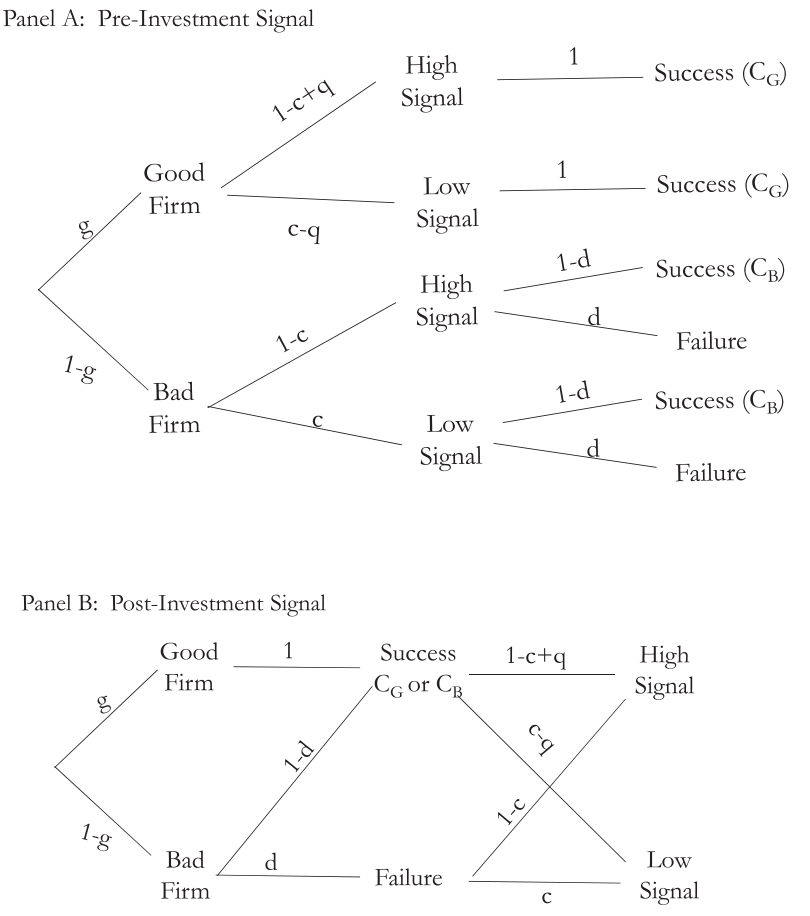
where π_g (π_b) is the probability that a good (bad) firm receives financing. The first term is the positive surplus arising from good firms investing. The second term is the negative surplus arising from bad firms investing. Implicitly, regulators set the properties of the accounting system to maximize the quantity in equation 1. Surplus can decline either because good projects are not financed or bad ones are. If all projects are financed, the expected surplus is $gC_G + (1-g)(1-d)\ C_B - k(1 + r)$. If $g = \frac{k(1+r)-(1-d)C_B}{C_G-(1-d)C_B}$, the average project breaks even.

The creditor has access to an accounting signal that provides information about the firm's prospects. One interpretation of the signal is that it is a report on a small existing investment. For example, the initial reported-upon investment could be a product trial in a limited geographical area, or preliminary research and development, and the subsequent investment could entail expansion of the project. A more general interpretation is that it is a report of the earnings generated by existing assets, and therefore provides information about the firm's underlying ability to generate positive expected value projects.

In this section, the signal separates on firm type (good or bad), not on outcome (success or failure). If the firm is good, the signal is S_H with probability $1 - c + q$, S_L otherwise. If the firm is bad, the signal is S_H with probability $1 - c$, S_L otherwise. The parameter restriction $0 \leq q \leq c \leq 1$ assures that these are valid probabilities. I assume that there is no scope for manipulation of the underlying signal by management.[6] Both upward and downward misclassifications can occur. I interpret q as the baseline level of classification accuracy (inverse of classification error) in the accounting system. An increase in q lowers the probability that a good project is misclassified. If c is at its lower bound, an increase in q also leads to an increase in c. Thus, q is indirectly related to the probability of misclassifying bad projects. The parameter c is a measure of the conservatism of the accounting system. At the maximum level of conservatism, only a good firm can generate

5. Chen and Deng (2011) make a similar assumption in their study.
6. For studies analyzing the interaction between information production and conservatism, see Bushman and Indjejikian (1993), Chen, Hemmer, and Zhang (2007), Gao (2013), and Fan and Zhang (2012).

Figure 1 Information structure



a high signal. At the minimum level of conservatism, only a bad firm can generate a low signal. Increases in conservatism increase the informativeness of the high signal, but reduce the informativeness of the low signal. The overall effect on the informativeness of the reporting system is ambiguous.[7] Figure 1, panel A illustrates the probability structure for the pre-investment version of the model.

No private information

The creditor conditions the required debt service payment on the imperfect accounting signal. In equilibrium, the debt service payment is set to provide the creditor with $k(1 + r)$ in expectation. If the signal is high, the creditor's expected return for a given high-signal debt service payment D^H is $p_{SH}\ D^H - k\ (1 + r)$. The probability $p_{SH} = \frac{p_{GH}+p_{BHS}}{p_{GH}+p_{BHS}+p_{BHF}}$ is the posterior probability that the project is successful given a high signal, with p_{Gj} the probability that the firm is good and the signal is $j \in \{H, L\}$ and p_{Bij} the probability that the firm is

7. The modeling follows Venugopalan (2001) with a slight notation change. In Venugopalan (2001), $P(S_H \mid G) = \lambda + \delta$ and $P(S_H \mid B) = \delta$. The parameter δ is the inverse of conservatism. The mapping is $\lambda = q$ and $\delta = 1 - c$. If $c > 1/2[1 + 2q(1 - d + dg)]$, then the precision of the posterior estimate of type is increasing in conservatism.

bad, the signal is $i \in \{H, L\}$ and the outcome is $j \in \{S, F\}$.[8] Setting the expected return equal to 0 and solving yields the zero-profit debt service payment:

$$D^H = \frac{k(1+r)(p_{GH} + p_{BHS} + p_{BHF})}{p_{GH} + p_{BHS}} = \frac{k(1+r)(1-c+gq)}{(1-c)[1-d(1-g)] + gq}.$$

The debt service payment is the required rate of return "grossed up" by the probability that it will be paid, that is, a successful project will reach fruition. Because conservatism screens bad firms from the high-signal pool, D^H is strictly decreasing in conservatism. If the high-signal firm borrows and makes the investment, its expected profit is:

$$\frac{p_{GH}}{p_{GH} + p_{BHS} + p_{BHF}}(C_G - D^H) + \frac{p_{BHS}}{p_{GH} + p_{BHS} + p_{BHF}}(C_B - D^H),$$

equivalent to:

$$p_{GH}C_G + p_{BHS}C_B - (p_{GH} + p_{BHS} + p_{BHF})k(1+r).$$

The firm obtains the cash payoffs in the high/successful states, and provides the creditor with its required rate of return in expectation in the high state. The firm will not invest unless the expected profit is positive. The following proposition summarizes the financing equilibrium when the firm does not have private information. Let the ex ante break-even proportion of good firms $\frac{k(1+r)-(1-d)C_B}{C_G-(1-d)C_B}$ be denoted as g_1^+. Below g_1^+, the average expected payoff is increasing in conservatism.[9]

PROPOSITION 1. *In the pre-investment setting with no private information, if $g < g_1^+$, high-signal firms receive financing if the baseline level of classification accuracy is high enough or the accounting is conservative enough. The expected surplus is weakly increasing in conservatism.*

PROOF: All proofs are in Appendix S1.[10]

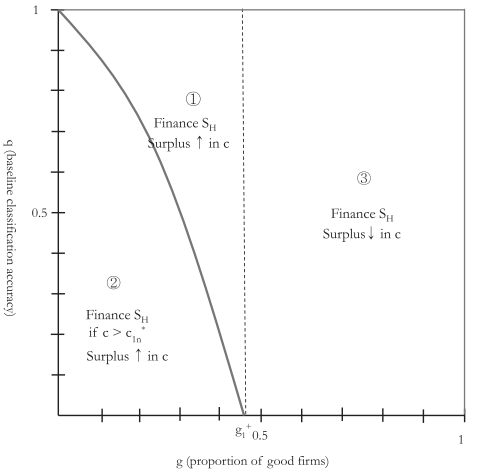
Because good and bad firms all have the same beliefs about their type, financing is attractive either to all firms or to none. There is no way to screen out bad firms. The ex ante expected surplus is negative if $g < g_1^+$. Without further information, then, the expected cash flows from the project are lower than the debt service payment required by the creditor, and the firm does not pursue financing. The high accounting signal identifies a pool of firms with a higher than ex ante probability of being good.

If the baseline level of classification accuracy, q, is high enough, it is predominantly good firms that generate the high signal. As a result, a financing equilibrium exists even without conservatism, as illustrated in region 1 of Figure 2, panel A. Increasing conservatism results in more projects generating low signals and not being financed, which increases expected surplus if mostly bad firms generate the projects, but decreases it if mostly good firms do. In regions 1 and 2, relatively few firms are good. Thus, though not necessary for financing to occur in region 1, conservatism increases the expected surplus.

8. The probabilities are $p_{GH} = g(1 - c + q)$, $p_{BHS} = (1 - g)(1 - c)(1 - d)$, and $p_{BHE} = (1 - g)(1 - c)d$.
9. The g_i^+ and g_{i1}^{++} notation, with $i \in \{1, 2, 3\}$ will be used throughout the paper. The subscript 1 refers to the pre-investment setting, the subscript 2 refers to the post-investment/no renegotiation setting, and the subscript 3 refers to the post-investment/renegotiation setting.
10. Please see supporting information, "Appendix S1: Proofs" as an addition to the online article.

Figure 2 Pre-investment signal

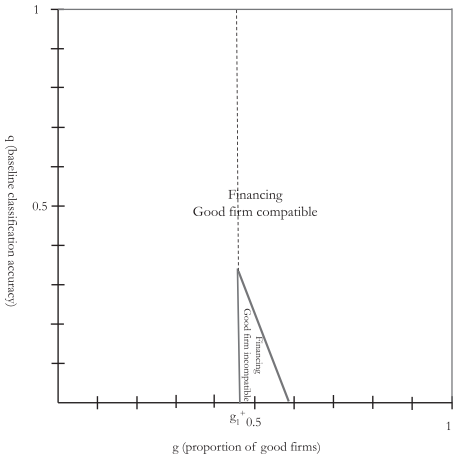
Panel A: No private information



Finance S_H for all c in regions ① and ③
Finance S_H for high c in region ②

Surplus increasing in c in regions ① and ②
Surplus decreasing in c in region ③

Panel B: No private information

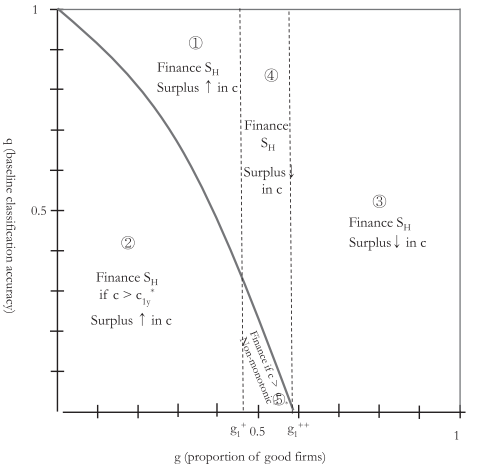


Financing is always possible in the absence of private information

The optimal uninformed debt service payment is lower than C_G in the region labeled "good firm compatible" and higher than C_G in the region labeled "good firm incompatible".

The debt service payment is decreasing in conservatism for the entire parameter space.

Panel C: Private information



Finance S_H for all c in regions ①, ③ and ④
Finance S_H for high c in regions ② and ⑤

Surplus increasing in c in regions ① and ②
Surplus decreasing in c in regions ③and ④
Surplus non-monotonic in c in region ⑤

If q and g are both low, as in region 2, bad firms generate a relatively high proportion of high signals. By lowering this proportion, conservatism protects the creditor from default, acting as a substitute for classification accuracy. Thus, the high-signal firm in region 2 receives financing only if the signal is sufficiently conservative. The expected surplus is weakly increasing in c in this region (0 if no financing occurs, strictly increasing once the threshold level of conservatism is attained). The signal is still valuable if the ex ante expected surplus is positive ($g \geq g_1^+$), though financing occurs without it, as illustrated in region 3.[11] Because relatively many firms are good in this region, conservatism assigns too many potentially successful projects to the low signal, reducing the expected surplus. Absent concerns about the feasibility of an equilibrium, the regulator would set conservatism to its expected surplus-maximizing level: maximum conservatism for low-value projects ($g \leq g_1^+$) and minimum conservatism for high-value projects ($g > g_1^+$). The Proposition shows that these conservatism levels also always result in a financing equilibrium.

The results are consistent with Gigler et al. (2009), Smith (2007) and Gox and Wagenhofer (2009). Conservatism is useful in each of these studies only if the investment has low ex ante expected profits. In Gigler et al. (2009), the profit threshold is defined with respect to the abandonment value. In Smith (2007), it is defined with respect to the second-stage investment. Finally, in Gox and Wagenhofer (2009), conservatism is optimal only if the ex ante expected value of the pledged assets is insufficient to satisfy creditor demands. In all cases, conservatism is desirable to improve the viability of a relatively low-value investment opportunity, potentially limiting the role of conservatism in the real economy.

Private information

I now assume that the firm knows its type (good or bad). The firm, however, does not know the investment outcome (success or failure). The good firm's expected profit conditional on receiving a high signal is $C_G - D^H$. The bad firm's expected profit conditional on receiving a high signal is $d \cdot 0 + (1 - d)(C_B - D^H)$. The assumption that the cash flow conditional on success is higher for the bad firm implies that the debt service payment cannot screen out bad firms. That is, any debt service payment providing a positive expected profit for the good firm also provides a positive expected profit for the bad firm.

After the signal realization, there are four types of firms: high-signal good firms, low-signal good firms, high-signal bad firms, and low-signal bad firms. Each type decides whether or not to solicit financing and invest. The creditor sets signal-contingent payments D^H and D^L, respectively. The requirements for the equilibrium are:

1. The strategy of each type of firm is optimal, given the strategies of the other types of firms and D^H and D^L set by investors.
2. The payments D^H and D^L satisfy Bayes' Rule, that is, are consistent with the underlying information structure and the firm strategies.

Establishing a financing equilibrium requires setting a debt service payment low enough to allow the average uninformed or good informed firm, depending on the setting, to earn profits. In general, increasing the proportion of successful firms receiving high signals lowers the debt service payment. There are two ways to increase this proportion: increase the baseline accuracy, q, or increase conservatism, c. Thus, the threshold $c_{ij}^*(g, q)$,

11. While the propositions focus on the parameter space for which conservatism is optimal, note that the c^*, q^1, q^q, g^+ and g^{++} thresholds derived in this and other settings characterize the equilibrium in the other regions.

defined as the level of conservatism for which the firm (average or good, depending on private information) has a profit of 0, will be useful to characterize the equilibria in the following propositions.[12] In particular, when c_{ij}^* is decreasing in q, $c \geq c_{ij}^*$ may be a requirement for an equilibrium to exist.

The following proposition characterizes the financing equilibrium with a pre-investment signal and private information about type. Let $g_1^{++} = \frac{k(1+r)-(1-d)C_G}{dC_G}$. This is the proportion of good firms such that financing occurs regardless of the level of baseline classification accuracy.

PROPOSITION 2. *In the pre-investment setting with private information, if* $g < g_1^{++}$, *with* $g_1^{++} > g_1^+$ *high-signal firms receive financing if the baseline level of classification accuracy is high enough or the accounting is conservative enough. The expected surplus is weakly increasing in conservatism for* $g < g_1^+$, *and nonmonotonic for* $g_1^+ \leq g \leq g_1^{++}$ (0 *if* $c < c_{1y}^*$ *with a discrete increase at* c_{1y}^* *and decreasing thereafter*).

Comparing the uninformed (no private information) and informed (private information) settings yields insight into the results. An equilibrium is always possible in the uninformed setting. If the uninformed surplus-maximizing zero-profit debt service payment is less than C_G, then an equilibrium is feasible in the informed setting with the same combination of conservatism and debt service payment. Other combinations may maximize the informed expected surplus, but feasibility is guaranteed. When g is low ($g \leq g_1^+$), maximum conservatism maximizes the uninformed surplus. Because it also minimizes the debt service payment, the same equilibrium is feasible in the informed setting. When g is high ($g > g_1^+$), minimum conservatism maximizes the uninformed surplus. It also maximizes the zero-profit debt service payment, which may exceed C_G if baseline accuracy q is low enough, as illustrated by Figure 2, panel B. The uninformed equilibrium cannot hold in this region because informed good firms would opt out. The debt service payment is decreasing in c, however. Therefore, filtering out bad firms by increasing conservatism until the debt service payment reaches C_G recovers the equilibrium, as illustrated by region 5 in Figure 2, panel C. Absent concerns about equilibrium feasibility, minimum conservatism maximizes expected surplus in region 5. A greater than minimum level of conservatism is necessary to elicit the participation of the good firms. As a result, the expected surplus is nonmonotonic in conservatism. If c is too low ($q \leq c < c_{1y}^*$), good firms cannot make a profit and there is no equilibrium. At c_{1y}^*, the debt service payment equals C_G, and the good firm seeks financing. The surplus is decreasing for $c > c_{1y}^*$ because, although firms that receive financing are better off, inefficiently few firms receive financing.[13]

Figure 2, panel C fully illustrates the results. If q is relatively high, the debt service payment is low enough to support an equilibrium regardless of conservatism, illustrated by regions 1, 3, and 4. Otherwise, some degree of conservatism ($c \geq c_{1y}^*$) is necessary for an equilibrium to exist, as in regions 2 and 5. In region 5, there is an interior solution to the optimal level of conservatism in contrast to Proposition 1, in which an extreme value is always optimal.

12. The numerical subscript has the same meaning as the subscripts for the g_i^+ and g_i^{++} thresholds. The subscript n refers to a setting without private information. The subscript y pertains to a setting with private information. Thus, c_{1y}^* is the conservatism threshold in the predecision signal setting with private information.

13. Expected surplus is is positive C_{1y}^* because bad firms are profitable: $C_B > C_G = D^H$.

3. Post-investment signal (without renegotiation)

In this section, the signal arrives after the investment decision but early enough to be useful for an abandonment decision. The investment has a value in an alternative use of A regardless of type. I assume that $C_B(1 - d) < A < k(1 + r)$. The alternative has a higher return than the bad project, but not high enough to provide the creditor's required rate of return. Because a bad project is abandoned more often than a good one, an upper limit of $A \leq \frac{C_G-(1-d)C_B}{d}$ is necessary to guarantee that the bad project yields lower total expected cash flows than a good one.

I also assume the debt contract includes a debt covenant that gives the creditor the right to terminate the project if the signal is low. The creditor's decision to terminate must maximize its expected profit given its information. I focus on conditions under which the debt contract optimally assigns abandonment decision rights to the creditor.[14] Finally, it is prohibitively costly to renegotiate the debt contract, an assumption relaxed in the next section.

The signal is a variation on the pre-investment signal. If the project is successful (which always occurs for good firms and occurs with probability $1 - d$ for bad firms), the signal is S_H with probability $1 - c + q$, S_L otherwise. If the project is unsuccessful (which never happens for good firms, and occurs with probability d for bad firms), the signal is S_H with probability $1 - c$, S_L otherwise. The signal reports on the type of cash flow (successful or unsuccessful) rather than the type of project (good or bad). Good projects are unconditionally more likely to generate S_H, but successful good projects are not more likely to generate S_H than successful bad projects. The natural accounting interpretation of this signal is that it reports the outcome of an asset impairment test. Please refer to Figure 1, panel B for an illustration of the information structure in the post-investment setting.

The creditor's expected payoff in the post-investment, no renegotiation setting is:

$$(p_{GH} + p_{BSH})D + (p_{GL} + p_{BSL} + p_{BFL})A,$$

where D is the debt service payment and p_{Bij} is the probability that the firm is bad, the outcome is $i \in \{S, F\}$, and the signal is $j \in \{H, L\}$.[15] The creditor is paid the debt service payment if the project is a success and is not abandoned, and receives the abandonment value if abandoned. Setting the payoff to $k(1 + r)$ and solving for D yields:

$$D = \frac{k(1 + r) - (p_{GL} + p_{BSL} + p_{BFL})A}{p_{GH} + p_{BSH}}.$$

The creditor's return comes from both the debt service payment and the abandonment value. The zero-profit debt service payment is the net of the required rate of return and the expected collections from abandonment, "grossed up" by the probability that the creditor collects the debt service payment. Increasing conservatism increases the expected collections from abandonment (decreases the numerator) but lowers the probability that a

14. The debt contract optimally allocates the decision rights to the firm only under conditions for which conservatism is not optimal. The firm has incentive to continue the project always. The creditor has incentive to continue the project if the expected debt service payment exceeds the abandonment value. The efficient abandonment rule is to continue the project if the expected terminal cash flows exceed the abandonment value. If the latter condition holds, then efficiency requires that the firm has the decision rights. In general, this condition holds only for low q/high g combinations, that is, combinations for which conservatism is not optimal.

15. The probabilities are $p_{BSH} = (1 - g)(1 - d)(1 - c + q)$, $P_{BSL} = (1 - g)(1 - d)(c - q)$, $p_{BFL} = (1 - g)dc$, and $p_{BFH} = (1 - g)d(1 - c)$.

successful project reaches fruition (decreases the denominator). As a result, the debt service payment is not necessarily decreasing in c.

No private information

An uninformed firm at the abandonment stage has expected cash flows of $gC_G + (1 - g)(1 - d)C_B$. Alternatively, the firm could abandon the project and earn A. If $g < g_2^+ = \frac{A-(1-d)C_B}{C_G-(1-d)C_B}$, then the average firm optimally uses the asset in its alternative use. This threshold is related to but different from the analogous threshold in the pre-investment setting ($g_1^+ = \frac{k(1+r)-(1-d)C_B}{C_G-(1-d)C_B}$). The pre-investment signal provides information directly useful to creditors to set an appropriate debt service payment. Hence, the pre-investment threshold is a function of the overall return to the project. In the post-investment setting, the signal provides information directly useful for the abandonment decision. As a result, the threshold is a function of the alternative value of the investment. The threshold is also equivalent to the threshold in the Gigler et al. (2009) paper.

In addition to the previously introduced c_{ij}^*, the firm's breakeven level of conservatism, the thresholds q_{ij}^q and q_{ij}^1 will also be useful to characterize the equilibria in the following propositions. The thresholds exploit the restriction on c between q and 1. The threshold q_{ij}^q is defined as the q such that $c_{ij}^*(q) = q$. The interpretation of this threshold is that if the baseline level of accuracy is high enough ($q \leq q_{ij}^q$), then the firm has positive profit regardless of the level of conservatism (because c must be greater than or equal to q). If the baseline level of signal accuracy is lower than this, some degree of conservatism is necessary in order for the firm to make a profit. Conservatism cannot exceed 1, however. Thus, the threshold q_{ij}^1 is defined as the q such that $c_{ij}^*(q) = 1$. The interpretation of this threshold is that if q is too low (i.e., below q_{ij}^1), then the firm cannot make a profit even with the maximum level of conservatism. The last two thresholds are useful in some of the results that follow to describe when an equilibrium exists without conservatism ($q > q_{2n}^q$) and does not exist even with maximum conservatism ($q < q_{2n}^1$).[16] The following proposition characterizes the equilibrium when the firm has no private information.

> Proposition 3. *In the post-investment setting with no private information, if $g < g_2^+$ the firm receives financing if $q > q_{2n}^q$ regardless of conservatism. The expected surplus is strictly increasing in conservatism in this region. The firm also receives financing for $q_{2n}^1 \leq q \leq q_{2n}^q$ as long as the accounting is conservative enough ($c > c_{2n}^*$). The expected surplus is weakly increasing in conservatism in this region.*

For an equilibrium to exist, the debt service payment must be high enough that the creditor receives its required rate of return and low enough that the firm can profitably seek financing. This can always be accomplished with a pre-investment signal by setting the debt service payment to $k(1 + r)$ and conservatism to its maximum of 1. Only good firms receive financing, and their expected cash flow exceeds the creditor's required rate of return. A maximally conservative post-investment signal, however, cannot prevent bad firms from being financed. If there are few good firms and/or the baseline level of accuracy is low (regions 3 and 4 in Figure 3, panel A), the expected cash flows from the project are insufficient to provide the creditor its required rate of return and there is no-financing equilibrium.

As the baseline level of classification accuracy improves, successful projects are abandoned less frequently. As conservatism increases, unsuccessful projects are abandoned

16. The roles reverse for g greater than the level of g at which the curves intersect.

Figure 3 Post-investment signal/no renegotiation

Panel A: No private information

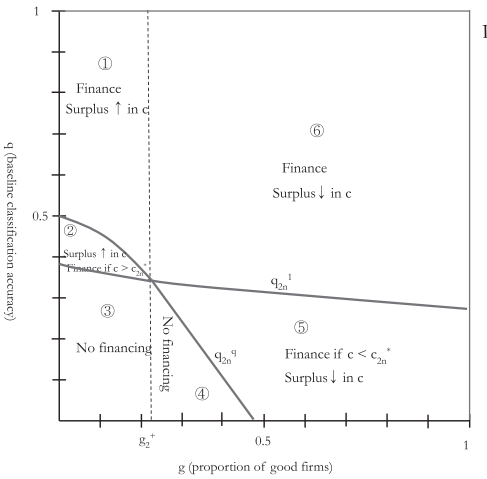
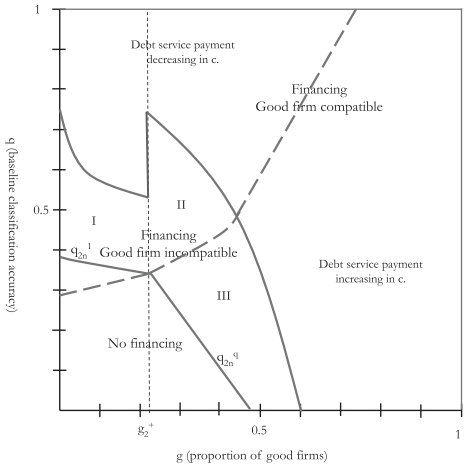


Figure 3 Panel A
Post-Investment/No renegotiation
No private information

Financing for all c in regions ① and ⑥
Financing for high c in region ②
Financing for low c in region ⑤
No financing for in regions ③ and ④

Surplus increasing in c in regions ① and ②
Surplus decreasing in c in regions ⑤ and ⑥

Panel B: No private information



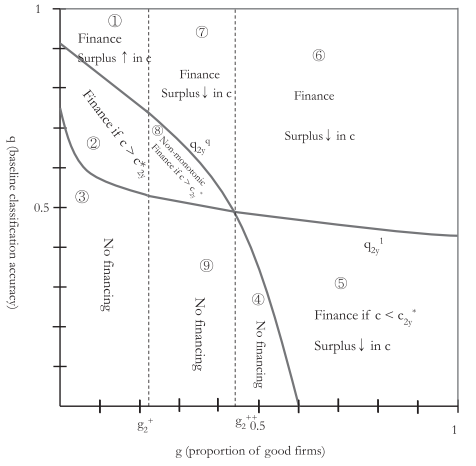
This panel shows where financing is possible in the absence of private information.

The optimal uninformed debt service payment is lower than C_G in the region labeled "good firm compatible" and higher than C_G in the region labeled "good firm incompatible".

The debt service payment is decreasing (increasing) in conservatism for points to the left (right) of the dashed line.

The optimal uninformed level of conservatism is 1 for $g < g_2^+$ and q otherwise.

Panel C: Private information



Financing for all c in regions ①, ⑥ and ⑦
Financing for high c in regions ② and ⑧
Financing for low c in region ⑤
No financing for in regions ③, ④ and ⑨

Surplus increasing in c in regions ① and ②
Surplus decreasing in c in regions ⑤, ⑥ and ⑦
Surplus non-monotonic in c in region ⑧

more frequently. Both forces increase the expected cash flows from the project to a level high enough to pay off the creditor (region 2). If the baseline level of accuracy is even higher, this is true even without conservatism (region 1). Surplus is at least weakly increasing in conservatism in both regions. There are few enough good firms that preventing frequent defaults of unsuccessful projects dominates avoiding infrequent abandonment of successful projects. When there are many good firms (high g), increasing conservatism decreases the expected profits of an average firm because successful projects are abandoned too often. If the baseline level of accuracy is also low, the average firm may not break even unless conservatism is sufficiently low, as illustrated in region 5. If both g and q are high, then a debt service payment acceptable both to the firm and the creditor is always possible, as illustrated in region 6. In both of these regions, expected surplus is at least weakly decreasing in conservatism.

Private information

The firm knows its type (good or bad) but not the cash-flow realization (success or failure). The assumption that $C_B > C_G$ eliminates the possibility of a separating equilibrium, analogous to the pre-investment signal setting.[17] The equilibrium is simpler than in the pre-investment setting because either both types of firms receive financing or neither does. Thus, for an equilibrium to hold it is necessary only that the debt service payment provides the creditor with the required rate of return and satisfies the participation constraint for both types of firms.

The following proposition summarizes the characteristics of the private information equilibrium. Let $g_2^{++} = \frac{A-(1-d)C_G}{dC_G}$. The threshold g_2^{++} is the highest proportion of good firms such that the expected good firm profits are increasing in conservatism given the pooled debt service payment.

PROPOSITION 4. *In the post-investment setting with private information:*

(i) If $g < g_2^+$ the firm receives financing if $q > q_{2y}^q$ regardless of conservatism. The expected surplus is strictly increasing in conservatism in this region. The firm also receives financing for $q_{2y}^1 \le q \le q_{2y}^q$ as long as the accounting is conservative enough ($c > c_{2y}^*$). The expected surplus is weakly increasing in conservatism in this region.

(ii) If $g_2^+ \le g \le g_2^{++}$ and $q_{2y}^1 \le q \le q_{2y}^q$ the firm receives financing as long as the accounting is conservative enough ($c \ge c_{2y}^*$). The expected surplus is nonmonotonic in conservatism in this region (0 if $c < c_{2y}^*$ with a discrete increase at c_{2y}^* and decreasing thereafter).

If there is no equilibrium with uninformed firms, there cannot be one with informed firms. This corresponds to the region closest to the origin (low g/low q) in Figure 3, panel B. In the region furthest from the origin, the creditor has a high probability of receiving the debt service payment because the proportion of good firms and/or baseline accuracy is high. As a result, the zero-profit debt service payment is lower than C_G. Thus, in this region the same combination of debt service payment and conservatism represents an equilibrium for informed firms. In the middle (Incompatible) region, the optimal uninformed equilibrium does not hold for informed firms because the debt service payment exceeds C_G. In this mid-range of g/q combinations, the expected cash flows are high enough to provide the creditor with its required return, but only if good firm losses subsidize bad

17. Because I impose no restriction guaranteeing that the bad project has negative NPV in this section, a separating equilibrium with bad firms only may be feasible. It can be shown that the pooling equilibrium surplus dominates the bad-only separating equilibrium surplus when the former is feasible.

firms. If the optimal uninformed level of conservatism does not minimize the debt service payment, however, it may be possible to recover an informed equilibrium. The properties of the debt service payment and uninformed expected surplus are important here. When g is relatively high and q is relatively low, fixing A, increasing conservatism sharply lowers the probability that a successful project will reach fruition and result in the payment of the debt service payment. A lower frequency of payment means that debt service payment must increase. Otherwise, D is decreasing in c. Also, as summarized in Proposition 3, the expected uninformed surplus (ES) is increasing (decreasing) in c if $g \leq g_2^+ (g > g_2^+)$. Combining the comparative statics results, in region I of the Incompatible zone ($\frac{\partial ES}{\partial c} > 0, \frac{\partial D}{\partial c} < 0$), uninformed conservatism is set to 1, therefore, minimizing D. In region III ($\frac{\partial ES}{\partial c} < 0, \frac{\partial D}{\partial c} > 0$), uninformed conservatism is set to q, also minimizing D. Because the minimum zero-profit debt service payment exceeds C_G in these two regions, no financing can occur in the informed setting. It is only in region II ($\frac{\partial ES}{\partial c} < 0, \frac{\partial D}{\partial c} < 0$) that recovering an informed equilibrium by increasing conservatism may be possible. Region 8 of Figure 3, panel C represents the portion of region II where an informed equilibrium exists. Absent concerns about feasibility, the regulator would set minimum conservatism here. Higher conservatism, however, is necessary to elicit the participation of good firms. Hence, the expected surplus is nonmonotonic with respect to c in region 8.

Figure 3, panel C illustrates the full results. In general, either higher classification accuracy or higher conservatism is necessary for an equilibrium to exist, as illustrated in the no-financing regions 3, 4, and 9. Regions 1 and 2 (surplus increasing in c) and 5 and 6 (surplus decreasing in c) are similar to the corresponding regions in the no private information setting. Region 7 has the same properties as region 6—financing always occurs and the expected surplus is strictly decreasing in conservatism. As noted above, the expected surplus is nonmonotonic in region 8. If c is too low, there is no equilibrium and surplus is 0. At c_{2y}^*, the good firm is at breakeven and seeks financing; surplus is above 0. Further increases in conservatism benefit the good firm by lowering the debt service payment, but reduce total expected surplus because too many successful projects are abandoned. As in the pre-investment setting, private information can result in an optimal interior level of conservatism.

In both the pre- and post-investment signal settings, the participation of privately informed good firms may require that low signals occur more often than would be socially efficient without private information. Because only high-signal firms receive financing in the pre-investment setting, the low signal can serve as a screening mechanism. Distorting the proportion of good firms in the high-signal pool lowers the equilibrium debt service payment required by the creditor. Because all (or no) firms receive financing in the post-investment signal setting, the creditor cannot use the signal to screen out bad firms. Instead, increasing conservatism reduces the creditor's exposure to bad projects by increasing the likelihood of their abandonment. The creditor collects more cash from abandonment states and can lower the debt service payment it receives in successful/high states to a level assuring the good firm's profitability. It may not be socially efficient because too many successful projects receive low signals. The good firm bears no cost from the abandonment of the bad firm's successful projects, however.

4. Post-investment signal (with renegotiation)

In this section, I assume that the realization of the state (success or failure) is observable to both the creditor and the firm at the time of the release of the accounting signal, but that this information is not contractible. This incomplete contracts (see Grossman and Hart 1986) assumption is consistent with the modeling in Li (2012) and Caskey and Hughes (2012). The incomplete contract environment allows for the possibility of renegotiation of the debt covenant. If the high signal is realized, implying no violation of the

debt covenant, but the observable state is failure, the firm has incentive to renegotiate the debt contract and abandon the project. If the low signal is realized, implying debt covenant violation, but the observable state is success, the creditor has an incentive to renegotiate the debt contract and continue the project. Following Li (2012), renegotiation costs of R are borne by the party initiating the renegotiation (the firm in the high/failure state and the bank in the low/success state). I also assume that the party initiating renegotiation extracts all the surplus from the negotiation. In the high/failure state, the firm receives a payoff of $A - R$; the creditor receives 0 with or without renegotiation and is indifferent. In the low/success state, the bank receives a payoff of $C_G - R$ ($C_B - R$) if the firm is good (bad); the firm receives 0 with or without renegotiation and is indifferent. In equilibrium, the firm extracts all of the benefit of renegotiation ex ante through the pricing of the debt contract. I also assume that R is low enough that both renegotiations are optimal. To guarantee that a good project yields higher expected total cash flows than a bad project for all values of c and q, an additional requirement that $R \leq \frac{c_G(1-d)c_B - d_A}{d}$ is necessary.

The creditor's expected payoff in the renegotiation scenario is:

$$(p_{GH} + p_{BSH})D^R + p_{GL}(C_G - R) + p_{BSL}(C_B - R) + p_{BFL}A,$$

where p_{Bij} is the probability is the probability that the firm is bad, the outcome is $i \in \{S, F\}$, and the signal is $i \in \{H, L\}$.[18] The creditor receives the debt service payment only if the realization is success/high signal. The creditor also extracts all the surplus from renegotiation (cash-flow realizations less renegotiation costs) for the success/low signal states. Finally, the creditor receives the abandonment cash flows in the failure/low state. Solving for the D that provides the creditor with its required rate of return yields the equilibrium debt service payment of:

$$D^R = \frac{k(1+r) - p_{BFL}A - p_{GL}(C_G - R) - p_{BSL}(C_B - R)}{p_{GH} + p_{BSH}}.$$

As before, conservatism decreases the probability that the firm pays the debt service payment and increases the expected collection from abandonment. Conservatism increases the probability that the creditor extracts surplus from the renegotiation of incorrect low signals, a new force in this setting. Therefore, D^R is decreasing in c under broader parameter conditions than in the no renegotiation setting.

No private information

If there is no private information about type, the firm's expected profit is:

$$p_{GH}(C_G - D^R) + p_{BSH}(C_B - D^R) + p_{BPH}(A - R).$$

The firm nets the difference between the cash flows and the debt service payment in the event of success/high. In the failure/high state, the firm renegotiates the debt contract and receives the net of the abandonment value and the renegotiation cost. Because the firm extracts all the surplus via the lower debt service payment, its expected profit is equivalent to:

$$gC_B + (p_{BSH} + p_{BSL})C_B + (p_{BFH} + p_{BFL})A - (p_{GL} + p_{BSL} + p_{BFH})R - k(1+r).$$

Differentiating the expected payoff with respect to c and solving in terms of g yields $g = 1 - \frac{1}{2d} = g_3^+$. Unlike g^+ in the earlier settings, the renegotiation version does not depend on the cash flows or cost of capital. In that the threshold is decreasing in the

18. The probabilities are $p_{BSH} = (1-g)(1-d)(1-c+q)$, $P_{BSL} = (1-g)(1-d)(c-q)$, $p_{BFL} = (1-g)dc$, and $p_{BFH} = (1-g)d(1-c)$.

default rate, optimal conservatism is likely to be associated with lower-value projects, but the threshold imposes no restriction on C_G. Because of the observability of the realized state and the ability to renegotiate, the parties always make the efficient continuation decision, albeit at cost R. Conservatism changes the expected profit only by affecting the expected renegotiation cost, which is $[(c - q)[g + (1 - g)(1 - d] + (1 - g)d(1 - c)]R$ The average firm's expected profit is increasing in conservatism as long as g is below g_3^+.

PROPOSITION 5. *In the post-investment setting with renegotiation and no private information, if $g < g_3^+$ the firm receives financing if $q > q_{3n}^q$ regardless of conservatism. The expected surplus is strictly increasing in conservatism in this region. The firm also receives financing for $q_{3n}^1 \leq q \leq q_{3n}^q$ as long as the accounting is conservative enough ($c > c_{3n}^*$). The expected surplus is weakly increasing in conservatism in this region.*

The creditor and firm always make the efficient continuation decision in this setting. If expected renegotiation costs are too high, however, the return from investment is less than the cost of capital, and no investment occurs. When g is low ($g < g_3^+$), the pool of unsuccessful projects is relatively large. Renegotiation is necessary if these projects generate a high signal. This can be prevented either by improving the classification accuracy or increasing conservatism. If q is too low, then no amount of conservatism will lower the renegotiation costs enough to allow profitable investment. If q is higher, then investment occurs as long as conservatism is high enough. If q is higher still, then investment occurs regardless of c, though the expected surplus is still increasing in c. When g is high, conservatism increases the renegotiation costs associated with the large pool of successful projects receiving low signals and therefore decreases the expected surplus. As in the previous no private information settings, the degree of conservatism that maximizes the unconstrained expected surplus ($c = 1$ for relatively low g projects, $c = q$ for relatively high g projects) also maximizes the parameter space over which a financing equilibrium is possible.

The ability to renegotiate renders the project more valuable by avoiding inefficient continuation decisions. For the same set of parameters as in Figures 2 and 3, financing occurs for all (g, q) combinations, as illustrated in Figure 4, panel A.[19] In region 1, the surplus is strictly increasing in c; in region 2, it is strictly decreasing in c.

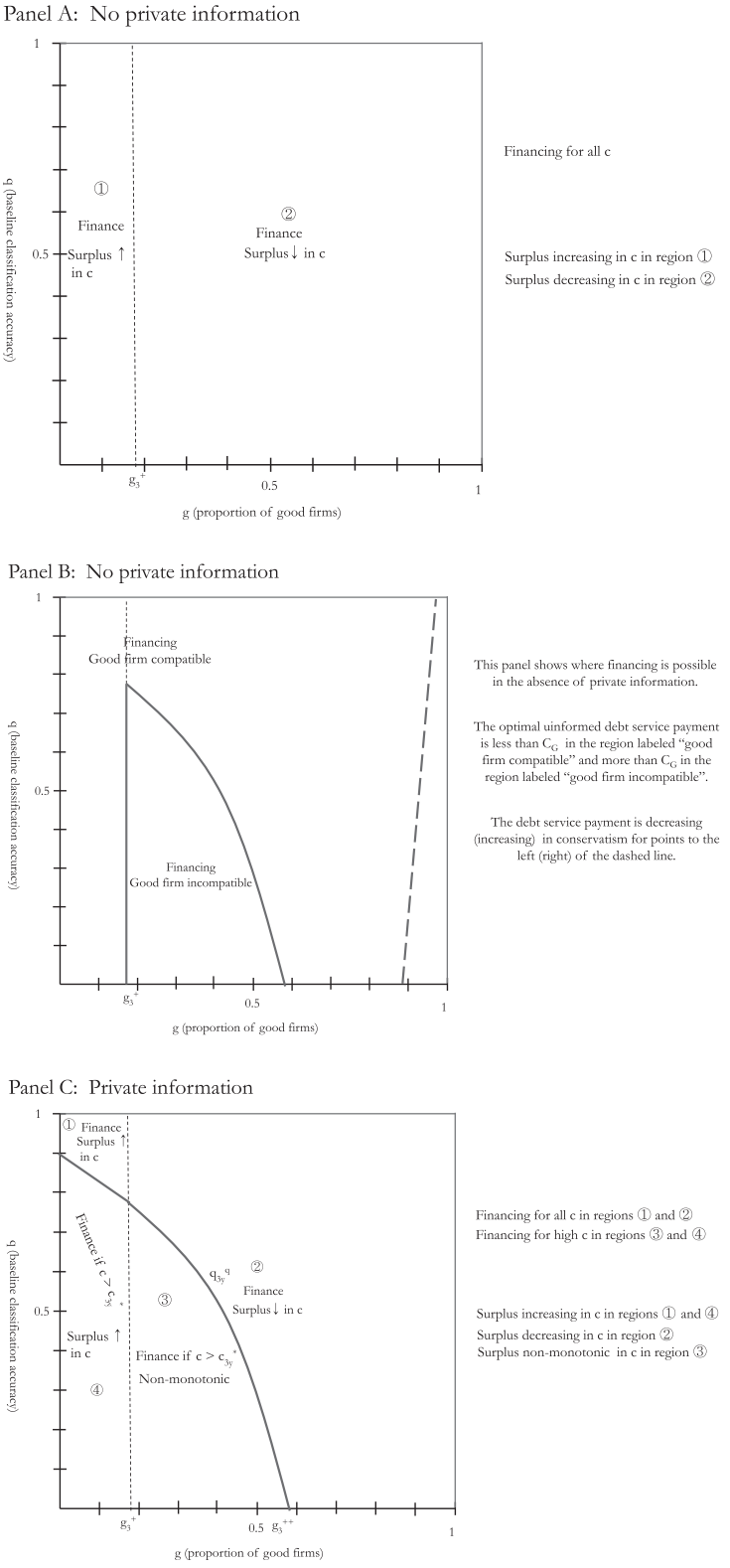
Private information

If the firm has private information about type, then the pooled debt service payment must satisfy the participation constraint for the good firm or there cannot be a pooling equilibrium.[20] Define $g_3^{++} = \frac{k(1+r)-(1-d)C_G}{dC_G}$ The threshold g_3^{++} exceeds g_3^+ as long as the expected return to the good project is less than 100 percent ($C_G < 2k(1 + r)$), a reasonable parameter restriction.

PROPOSITION 6. *In the post-investment setting with renegotiation and private information, there are three cases:*[21]

19. The restriction on R guaranteeing that the bad project's expected cash flows are lower than the good one's does not preclude them from exceeding the cost of capital. In this parameterization, the q_{3n}^q curve above which an equilibrium exists for any level of conservatism is negative for $0 \leq g \leq 1$. For a less valuable project, the characterization of the equilibrium would be similar to Figure 3, panel A.
20. As in the no renegotiation setting, a bad-only separating equilibrium may be possible. It can be shown that it is dominated by the pooling equilibrium if feasible.
21. To reduce the enumeration of subcases, I assume that d is sufficiently low to rule out another subcase qualitatively similar to the other cases but less likely to occur because of parameter restrictions. Please see supporting information, "Appendix S1: Proofs" as an addition to the online article for details.

Figure 4 Post-investment signal/renegotiation



(i) If renegotiation costs are high ($R \geq C_B - C_G$), *the firm receives financing if* $q > q^q_{3y}$ *regardless of the level of conservatism, and for sufficiently high conservatism* ($c > c^*_{3y}$) *if* $q^1_{3y} \leq q \leq q^q_{3y}$. *The expected surplus is weakly increasing in c when* $g < g^+_3$ *and* $q^1_{3y} \leq q \leq q^q_{3y}$ *and nonmonotonic in c* when $g^+_3 \leq g \leq g^{++}_3$ and $q^1_{3y} \leq q \leq q^q_{3y}$.

(ii) If renegotiation costs are low ($R < C_B - C_G$) *and the alternative value is high* ($A \geq \frac{k(1+r)-C_G(1-d)}{d}$), *the firm receives financing regardless of the level of conservatism if* $q > q^q_{3y}$ *and for sufficiently high levels of conservatism* ($c > c^*_{3y}$) *for* $q \leq q^q_{3y}$. *The expected surplus is weakly increasing in c when* $g < g^+_3$ *and nonmonotonic in c* when $g^+_3 \leq g \leq g^{++}_3$ and $q \leq q^q_{3y}$.

(iii) If renegotiation costs are low ($R < C_B - C_G$) *and the alternative value is low*($A < \frac{k(1+r)-C_G(1-d)}{d}$), *the firm receives financing regardless of the level of conservatism if* $q > q^q_{3y}$ *and for sufficiently high levels of conservatism* ($c > c^*_{3y}$) *if* $q \leq \text{Min } \{q^q_{3y}, q^1_{3y}\}$. *The expected surplus is weakly increasing in c when* $g < g^+_3$ *and nonmonotonic in c* when $g^+_3 \leq g \leq g^{++}_3$ and $q \leq \text{Min } \{q^q_{3y}, q^1_{3y}\}$.

High renegotiation costs (part *i*) effectively nullify the value of renegotiation. As a result, the intuition underlying the financing equilibrium is similar to the no renegotiation setting, as efficiency with respect to the abandonment decision is of paramount importance. If renegotiation costs are low and the abandonment value high, as in part *(ii)*, renegotiation of the success/low state becomes an efficient way to provide the creditor with its return as the creditor gets $C_G - R$ ($C_B - R$) instead of A. This increases the value of conservatism sufficiently that there exists c such that an equilibrium is feasible for the entire parameter space. If both renegotiation costs and abandonment value are low, as in part *(iii)*, allowing the creditor to capture the surplus from inaccurate low signals more often may be necessary to provide it with its required rate of return. In this case, increasing the baseline level of signal accuracy increases the debt service payment. The intuition is that because renegotiation of the success/low states occurs less frequently for high q, the debt service payment must carry more of the burden of providing the creditor its return. The outcome of these forces is that there is a region for low g such that an equilibrium exists for $q \leq q^1_{3y}$ if c is high enough, but not for values of baseline accuracy higher than q^1_{3y}.

Figure 4, panels B and C illustrate the equilibrium for the same set of parameters as Figures 2 and 3, which correspond to part *(ii)* of the Proposition. Figure 4, panel B shows the parameter values for which the uninformed equilibrium entails good firm losses. Because the creditor extracts the surplus from the renegotiation of inaccurate low signals, conservatism is relatively more valuable than in the no renegotiation setting. As a result, the debt service payment is decreasing in conservatism over the entire range for which the uninformed equilibrium entails good firm losses. The expected surplus is nonmonotonic in this range. Minimum conservatism maximizes the expected cash flows, assuming investment, but some conservatism is necessary to secure the investment of the good firm.

Figure 4, panel C illustrates the full results. The surplus is strictly increasing in c in region 1, weakly increasing in region 2, and nonmonotonic in region 3. In region 3, the level of conservatism does not minimize the expected renegotiation costs. In particular, the success/low state occurs too often. While inefficient in terms of costs, inducing frequent renegotiation in these states is necessary to provide the creditor enough return that the zero-profit debt service payment in success/high states can be lower. Once again, private information results in an optimal interior value for conservatism.

5. Concluding remarks

Because the theoretical conservatism literature is diffuse, it is difficult to compare results across models. Nonetheless, a commonality in some recent conservatism studies (see Smith

2007; Gigler et al. 2009; Gox and Wagenhofer 2009) is that a conservative accounting signal is useful only for relatively low-value investments. In Gigler et al. (2009), for example, a conservative signal is efficient only if the liquidation value of the investment exceeds its expected cash flows. That conservatism is optimal only for low ex ante expected value investments represents a limitation to the role of these models in explaining conservatism. In this study, I first derive a result echoing the previous results, and then show that the main effect of private information is to expand in some cases the range of investments for which conservatism is efficient to include higher ex ante expected value projects.

In the model, the firm seeks financing for an investment opportunity. There is an accounting signal that has two features. First, there is a baseline classification error that cannot be purged from the signal due to the underlying complexity of the classification task. Second, an unmodeled regulator can vary the verifiability standard for losses, thereby controlling the level of accounting conservatism. As the standard for losses becomes easier to satisfy, conservatism increases.

Because there is no uniformity in the existing literature as to the timing of the signal, I examine two scenarios. In the first, the signal arrives before the investment, allowing the creditor to condition its decision on the signal's realization. In the second, the signal arrives after the investment, but before a possible abandonment date for the asset. I consider the possibility of renegotiating the debt contract. Because the creditor anticipates the cash flow implications of the abandonment and renegotiation decisions, the post-investment signal bears indirectly on the investment decision. The basic results hold in both the pre- and post-investment settings, though the intuition is slightly different. The main difference in the equilibria is that only high-signal firms (or no firms) firms receive financing in the pre-investment setting, but all firms (or no firms) receive financing in the post-investment setting. This has subtle effects on the role of conservatism.

In the absence of private information, conservatism is valuable only for projects with lower expected returns. In the pre-investment signal setting, this corresponds to the cost of capital exceeding the return on an average project. In the post-investment signal setting without renegotiation, this corresponds to the abandonment value exceeding the expected value of the average project. In the renegotiation setting, it corresponds to a high probability of bad project failure. The intuition underlying the results is that conservatism enhances value only when the cost of financing a bad project or continuing an unsuccessful one exceeds the opportunity cost of failing to finance a good project or abandoning a successful one. For more profitable projects, that is, those in which the opportunity costs exceed the outlay costs, conservatism reduces expected surplus. This result is in the spirit of results in Smith (2007), Gigler et al. (2009), and the other aforementioned papers.

Conservatism plays a more general role if the firm has private information about its type. In this case, the financing terms must satisfy the participation constraint of the good firm. In the pre-investment setting, conservatism screens out bad firms from the high-signal pool, lowering the debt service payment demanded by creditors to a level acceptable to good firms. In the post-investment settings, conservatism protects the creditor from the downside risk of financing a bad project, also lowering the required debt service payment to a level securing participation. These results can occur in both settings even if the average project is profitable enough that aggressive accounting maximizes surplus in the absence of private information. Overall, the results suggest that private information significantly alters the conditions under which conservatism is useful. In particular, it can be useful for projects that have higher (though not too high) ex ante values, a class of projects ruled out by many models in the prior literature.

The modeling of conservatism in terms of verifiability standards is consistent with the institutional story motivating the empirical proxy for conservatism in Basu (1997). It is impossible to verify analytically that the modeling of conservatism is consistent with the

empirical proxy itself for two reasons. First, the proxy is essentially a comparison of the correlation between earnings and returns for positive and negative return samples. A binary model, therefore, does not generate enough data points to perform such a calculation. Second, and more important, there are no earnings in the model. That is, there is no mapping between the underlying signals and balance sheet amounts. This mapping is not necessary to demonstrate the main point of the study: higher conservatism (lower verification standards for losses) can be surplus maximizing under weaker parameter conditions if firms are privately informed.[22]

Finally, the theory has empirical implications, deriving two industry characteristics that are associated with conservatism. Specifically, one would expect to find conservatism in industries with a high degree of asymmetric information and in industries with relatively low ex ante profitability. A common empirical proxy for asymmetric information is the level of research and development (R&D) expenditures. In this sense, the theory is consistent with some aspects of the accounting for intellectual property embodied in current U.S. Generally Accepted Accounting Principles and also in International Financial Reporting Standards. While investment in tangible assets is typically capitalized under both regimes, the threshold for capitalization is higher for intellectual property, especially research and development. Under U.S. GAAP, capitalization occurs only for certain self-generated software assets and for purchased intellectual property. Under IFRS, research costs are typically expensed, but development costs can be capitalized contingent on satisfying certain technological and commercial feasibility tests. The results in Smith (2007) also support the optimal use of conservative accounting for R&D expenditures. Determining an empirical proxy for ex ante profitability is more difficult. One could argue that projects initiated by R&D intensive firms have a relatively low probability of success (g in the model), which is consistent with the optimality of conservatism for low g in the model. The profitability thresholds, however, are also functions of the payoffs, confounding straightforward interpretation. Large sample measures of observed industry profitability and measures of ex post returns are also subject to survivor bias with respect to the estimation of ex ante profitability. Thus, caution must be exercised in executing an empirical test of this aspect of the theoretical results.

Appendix

Glossary of notation

Symbol	Meaning
g	Probability that a firm is good
k	Investment
C_i	Cash realization for a successful project of type i
r	Required rate of return for creditors
c	Degree of conservatism
c^*	Threshold c above which equilibrium exists
q	Baseline level of classification accuracy
q^q	q above which equilibrium exists without conservatism
q^1	q below which no equilibrium exists even for max c

(The appendix is continued on the next page.)

22. Because there is no balance sheet, it is also impossible to verify analytically that the modeling is consistent with the proxy for unconditional conservatism in Penman and Zhang (2002). It is easy to devise a mapping that would generate the understatement of assets: write down the asset to market value for a low-signal realization and make no adjustment for a high-signal realization. I leave it to future research to explore the relations among the underlying information structure, the balance sheet mapping and the empirical proxies.

Appendix (continued)

Symbol	Meaning
d	Probability that a bad firm defaults on debt
D	Debt service payment
A	Value of asset in alternative use
R	Cost to renegotiate debt covenant

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:
Appendix S1. Proofs.