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Accounting Conservatism and the Efficiency of Debt Contracts

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ABSTRACT

In this paper we examine how accounting conservatism affects the efficiency of debt contracting. We develop the statistical and informational properties of accounting reports under varying degrees of conditional and unconditional accounting conservatism, consistent with Basu's [1997] description of differential verifiability standards. Optimal debt covenants and interest rates on debt are derived from a natural tension between debt holders and equity claimants. We show how optimal covenants vary with the degree of conservatism and derive an efficiency metric that depends on the degree of conservatism. We find that accounting conservatism actually *decreases* the efficiency of debt contracts, contrary to the suggestions of Watts [2003] and contrary to the hypothesis in numerous empirical studies.

1. *Introduction*

In this paper, we examine whether accounting conservatism facilitates or detracts from the efficiency of debt contracting. We consider both "unconditional" and "conditional" conservatism as discussed in the literature. In both cases, our analysis does not support the positive relationship between accounting conservatism and the efficiency of debt contracting, as suggested by Watts [2003], and as hypothesized in numerous empirical studies.[1] In fact, we find the opposite can be true. Under very plausible conditions, we

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[1] See for example Ball and Shivakumar [2005], Ball, Robin, and Sadka [2008], Wittenberg [2008], and Zhang [2008].

find that accounting conservatism, which affects the information content of accounting reports, actually *decreases* the efficiency of debt contracts. Our notion of efficiency is derived endogenously from the joint optimality of the debt covenant and the corresponding interest rate on debt, but differs from the usual efficiency notion assumed in empirical studies. We also develop and use a statistical characterization of conservatism that is new in the literature but that, we believe, is consistent with the widely accepted definition of accounting conservatism originally proposed by Basu [1997].

The argument in favor of conservatism, as enunciated by Watts [2003] and Ball, Robin, and Sadka [2008] is as follows. Conservative accounting principles anticipate potential decreases in income or assets well before they are realized, but postpone the recognition of income or asset increasing events until they are sufficiently locked in. Thus, conservatism results in timely loss recognition at the expense of timely gain recognition. Given the asymmetric payoff to debt holders, timely loss recognition is of much greater importance to them than timely gain recognition. Timely loss recognition results in earlier violation of debt covenants, allowing debt holders to more quickly exercise their contractual rights and restrict the actions of managers. Hence, accounting conservatism enhances the efficiency of debt contracts.

Though the above argument is intuitively appealing, there are at least three components that have not been fully explored. These components are *essential* to understanding the relationship between accounting conservatism and the efficiency of debt contracting: First, conservative measurement principles not only increase the frequency of low accounting reports, but also change the information content of such reports. Second, optimal debt covenants will change with the degree of conservatism in accounting reports. Third, the interest rate on debt is not a measure of efficiency. The appropriate notion of efficiency is determined by the same economic tradeoffs that drive the optimality of the debt covenant. We elaborate on each of these elements below.

1.1 CHANGE IN INFORMATION CONTENT

An analogy will help provide intuition into how the information content of reports changes with the degree of conservatism. Consider exam/grading policies that report on student performance and communicate student ability. An instructor reads the detailed answers provided by students and translates each student's answer into a numerical score/letter grade. Outsiders, who are concerned with assessing student abilities, do not have access to the detailed answers provided by students and must rely on the grades assigned by the instructor. The instructor may adopt a stringent (conservative) scoring policy or a more liberal scoring policy. How does the information content of exam scores change with the stringency of the scoring policy? A very stringent scoring policy would make it almost impossible for low-ability students to score a high grade of A, but it inevitably results in some high-ability students also scoring a low grade of B. Thus, a high grade is very informative; students scoring an A are very likely to be high-ability/high-knowledge students. But a low grade of B contains a mixed signal since some high-ability students in addition to most low-ability students are awarded a B grade. Conversely, a liberal grading policy will result in some low-ability students in addition to most high-ability students scoring an A grade, thus diluting the information content of the A grade but enhancing the information content of a B grade. An instructor choosing between a stringent grading policy and a liberal grading policy, or equivalently between a tough exam and a more lenient exam, must therefore consider whether it is more desirable to precisely identify high-ability students or to precisely identify low-ability students. This choice is different from the choice of a more *accurate* testing procedure that increases the information content of *both* A and B grades, but that may be infeasible or much more costly to design and implement.

Basu [1997] defines accounting conservatism in terms of the verifiability standards that must be met for reporting income/asset increasing events and for reporting income/asset decreasing events: The greater the difference in the verifiability standards for reporting potentially income increasing events than for reporting potentially income decreasing events, the more conservative the accounting. In a more conservative regime, the disclosure of income increasing events will occur less frequently, but when they do occur, such reports will have high information content because the strict verifiability standards for making such a disclosure conveys that the probability of occurrence of the increased income is very high. Reports of income decreasing events would occur more frequently, but such reports would have lower information content because the lax verifiability standards for making such a disclosure means that it conveys less information about the probability of the loss actually occurring.

1.2 SHIFT IN DEBT COVENANTS

Optimal debt covenants transfer decision rights from equity holders to debt holders *only* when the future prospects of the firm appear to be sufficiently bad—otherwise the decision rights would *always* be vested with the debt holders and there would be no need for a covenant. Since the relationship between observed reports and future prospects is altered by accounting conservatism, debt covenants will shift as accounting becomes more conservative. This shift in debt covenants is obvious when conservatism takes the form of a downward monotone transformation of accounting signals. This form of conservatism is benign since it preserves information content and the resultant shift in the debt covenant perfectly offsets the effect of conservatism. However, when the information content of high and low signals change as accounting becomes more conservative the shift in the debt covenant cannot perfectly offset the effect of conservatism. Whether or not the new arrangement with higher conservatism is more "efficient" than the arrangement with less conservatism is an open question that we explore in this paper.

1.3 EFFICIENCY OF DEBT CONTRACTING

Empirical studies of conservatism usually measure the "efficiency" of debt contracts in terms of the implicit interest rate on the firm's debt. The claim is that the lower the interest rate, the more efficient the debt arrangement. However, we find that, regardless of efficiency issues, debt holders would *always* be willing to accept a lower interest rate in return for more frequent transfer of decision rights to them. Therefore, if lower interest rates truly represent increased efficiency, the most efficient debt contract would give decision rights to debt holders regardless of whether or not covenants are violated, thereby making debt covenants redundant. Needless to say, such an arrangement is rarely observed.

A more meaningful notion of efficiency is obtained by explicitly examining the tradeoffs that determine the simultaneous optimality of the implicit interest rate and the debt covenant. We show that, rather than minimizing the interest rate on debt, the optimal debt arrangement minimizes the sum of the expected opportunity costs arising from two kinds of decision errors: errors due to false alarms and errors due to undue optimism. These errors are analogous to the Type I and Type II decision errors that arise in any binary decision setting. Thus, the appropriate notion of efficiency is *social* efficiency. In fact, we show that any debt arrangement with a covenant that allows more frequent passage of decision rights to debt holders than is socially optimal, and a correspondingly lower interest rate, would be renegotiated upon violation of the debt covenant by raising the interest rate in exchange for a waiver of the decision rights of debt holders. Thus, in our analysis, increased accounting conservatism enhances the efficiency of debt contracting only if such conservatism decreases the minimized sum of the two opportunity costs described above.

In this paper, we explicitly take into account the informational properties of conservative accounting, the endogenous determination of the debt covenant, and the endogenous notion of efficiency to examine whether accounting conservatism facilitates or detracts from the efficiency of debt contracting. In our setting, accounting provides a report that is informative with respect to the eventual cash flows from a debt-financed project that was initiated at an earlier date. In the light of information provided by the report, a decision is made whether to continue the project or liquidate the firm's assets and discontinue the project. We show that because of the asymmetric payoff to debt holders, their preferences over the liquidation/continuation decision are different from those of residual claimants. This tension, arising naturally from the very form of the debt instrument, optimally results in the specification of both a covenant and an interest rate in the debt contract that is ex ante negotiated between the two parties. The debt covenant specifies that the right to make the liquidation/continuation decision switches from equity holders to debt holders if the report produces a sufficiently low signal. The efficiency properties of the optimal debt contract are studied and a simple efficiency metric is derived that can be compared across accounting regimes that differ only in the degree of conservatism. We characterize how the optimal debt contract changes as the degree of conservatism is varied. Given these characterizations, we examine how the efficiency of debt contracting is affected by the degree of conservatism in the accounting report.

The rest of the paper is organized as follows. In section 2 we develop a parsimonious model of debt covenants that incorporates the asymmetric payoff of debt holders and results in the natural tension between debt holders and equity holders. In section 3 we derive equilibrium debt contracts, consisting of an implicit interest rate and a debt covenant, for *any* arbitrary accounting system. We then establish the efficiency properties and the renegotiation properties of optimal debt contracts, and we show that equilibrium debt contracts do not minimize the interest rate on debt. In section 4, we construct a statistical characterization of accounting conservatism. In section 5, we compare debt-contracting efficiency across accounting regimes that vary in their degree of conservatism. Section 6 concludes with a discussion of possible extensions and avenues for additional research.

2. *A Model of Debt Covenants*

Consider a firm that has exclusive rights to a project that requires investment of K at date 0. At date 1, after receiving additional information, the firm has the option to either continue the project or liquidate the project. If the project is liquidated it pays a known deterministic liquidation value of M at date 1. If the project is continued, it produces an uncertain cash flow of $\tilde{x}$ at date 2. We assume that the entire investment of K is financed by debt issued at date 0, to be repaid with interest at date 2 upon realization of cash flows from the project.[2] Lenders, and residual claimants to the firm's cash flows are risk neutral.[3] The risk free rate of return is $R > 0$, so lenders will lend K to the firm if their expected repayment is at least $K(1 + R)$. We assume that at the time the project is initiated,

$$E(\tilde{x}) > K(1 + R) > M. \tag{1}$$

The first inequality merely states that, at the time of initiation, the project has a positive net present value, and the second inequality implies that neither lenders nor residual claimants have an interest in liquidating the project unless there is a deterioration in their expectations about the future cash flows from the project.

After the project is initiated, but prior to making the liquidate/continue decision at date 1, an accounting system provides a public report y that is correlated with the date 2 cash flow $\tilde{x}$. Since the relationship between accounting reports and future cash flows is stochastic, we represent the accounting system by a conditional probability density $\varphi(y \mid x)$ that produces the accounting signal y. We assume that $\tilde{x}$ has support $[0, \infty)$ and the report $\tilde{y}$ has fixed support $[0, \bar{y}]$. Let $F(x \mid y)$, with density $f(x \mid y)$, denote the Bayesian posterior distribution of cash flows from the project given the accounting signal y. We assume that higher values of the signal y constitute

[2] Since capital structure decisions are not the object of study here, we assume debt rather than equity financing for unspecified reasons.

[3] We make this assumption only to simplify the algebra. The incorporation of risk aversion would not qualitatively affect our results.

"good news" so that higher values of y shift the conditional distribution of x to the right in the sense of first-order stochastic dominance (Milgrom [1981]). We additionally assume that for each accounting system, there exists a signal y^* (whose value will, in general, depend on the degree of conservatism in the accounting system) satisfying

$$E(\tilde{x} \mid y^*) = M. \tag{2}$$

Because $E(\tilde{x} \mid y)$ is strictly increasing in y, assumption (2) implies that signal values below y^* induce a sufficient deterioration in expectations so as to make project liquidation the socially efficient decision and values above y^* make project continuation the socially efficient course of action.

We now derive the tension between debt and residual claimants (equity holders). Let D denote the chosen face value of the debt, so that if the project is continued, debt holders receive the amount D if $x > D$ is realized, but receive x if $x \leq D$. Given these payoffs, the value to debt holders of continuing the project, conditional on observing y at date 1, is

$$V(D, y) = \int_0^D x f(x \mid y)\, dx + \int_D^\infty D f(x \mid y)\, dx. \tag{3}$$

Clearly, $V(D, y) < D, \forall y$. Additionally, $V(D, y)$ is strictly increasing in y and strictly increasing in D. To see this latter claim, integrate the right-hand side of (3) by parts to obtain the simpler form:

$$V(D, y) = D - \int_0^D F(x \mid y)\, dx. \tag{4}$$

First-order stochastic dominance implies $F(x \mid y)$ is strictly decreasing in y, from which it follows that V is strictly increasing in y. Differentiating (4) with respect to D yields, $\frac{\partial V}{\partial D} = 1 - F(D \mid y) > 0$, implying that V is strictly increasing in D.

The face value of debt D is determined at date 0 when the debt contract is chosen, and market conditions require that D must be such that the date 0 expectation of payments to debt holders is at least $K(1 + R)$. Let $h(y)$ be the marginal density of the accounting signal provided at date 1. As a useful preliminary result, we establish:

LEMMA 1. *Given the assumptions described in* (1), $D > M$.

Proof. Let $y^0 \in [0, \bar{y}]$ be an arbitrary value of y such that observation of $y \leq y^0$ results in liquidation of the project and $y > y^0$ results in continuation of the project. Let $w \leq M$ be the amount paid to debt holders when the project is liquidated. Then lender participation requires that

$$\int_0^{y^0} w h(y)\, dy + \int_{y^0}^{\bar{y}} V(D, y) h(y)\, dy \geq K(1 + R).$$

Since $w \leq M$ and $V(D, y) < D, \forall y$,

$$\int_0^{y^0} M h(y)\, dy + \int_{y^0}^{\bar{y}} D h(y)\, dy \geq K(1 + R), \forall y^0 \in [0, \bar{y}].$$

Because $M < K(1 + R)$, the above inequality implies that $D > K(1 + R)$. The latter inequality, in turn, implies $D > M, \forall y^0 \in [0, \bar{y}]$. ■

We now develop the tension that exists between debt holders and equity holders over the liquidation/continuation decision.

PROPOSITION 1. *For each D there exists a value of the accounting signal $\hat{y}(D) > y^*$ such that debt holders would like to liquidate the project conditional on any signal $y \leq \hat{y}(D)$ and continue the project only when $y > \hat{y}(D)$. The signal $\hat{y}(D)$ is strictly decreasing in D and $Lim_{D\to\infty}\hat{y}(D) = y^*$.*

Proof. Debt holders are entitled to a payment of D provided there are enough funds to pay D. By Lemma 1, $M < D$, implying that debt holders receive the entire liquidation value of M when the project is liquidated. Therefore, since $V(D, y)$ is increasing in y, $\hat{y}(D)$ must satisfy the indifference condition

$$V(D, \hat{y}(D)) = M.$$

From (3),

$$V(D, y) < E(\tilde{x} \mid y), \forall y, \forall D < \infty.$$

Therefore, $E(\tilde{x} \mid y^*) = M \Rightarrow V(D, y^*) < M$, so $V(D, \hat{y}(D)) = M \Rightarrow \hat{y}(D) > y^*$. The claim that $\hat{y}(D)$is strictly decreasing in D follows from the observation that $V(D, y)$ is strictly increasing in both arguments and the limiting claim follows from the observation that $V(D, y) \to E(\tilde{x} \mid y)$ *as* $D \to \infty$. ■

The result $\hat{y}(D) > y^*$ implies that debt holders have an incentive to liquidate the project even when continuation is the efficient decision. This result is due to the fact that debt holders do not benefit from project payoffs that exceed D, that is, it is a direct consequence of the asymmetric payoff to debt holders. We now examine the preferences of the equity holders. Their expected payoff from continuing the project, conditional on any signal y, is

$$U(D, y) \equiv \int_D^\infty (x - D) f(x \mid y)\, dx. \tag{5}$$

Notice that $U(D, y) > 0, \forall y$, because there is always some chance, no matter how small, that the project's cash flow will exceed the face value of the debt. On the other hand, when the project is liquidated the payoff to equity holders is zero, as established in Lemma 1. Thus, equity holders want to continue the project no matter how dismal the future looks.

We have shown that there is a well-defined conflict between debt holders and equity holders caused by their asymmetric payoffs, which, in turn, is induced by the very nature of a debt instrument. Debt holders are too eager to liquidate the project, while residual claimants are too eager to continue the project. Clearly, there is scope for contractually resolving this conflict by regulating the liquidation/continuation decision. A debt-covenant, taking the form of a threshold signal y^C, is such a contract. The covenant assigns the decision right to liquidate or continue the project to debt holders whenever $y < y^C$ and leaves the decision right with equity holders whenever $y \geq y^C$. We next derive the optimal covenant and other features of the optimal debt contract.

3. Properties of the Optimal Debt Contract

A debt contract is a triple $\{K, D, y^C\}$, where K is the amount borrowed, D is the face value of debt defining the upper bound on debt holders' claims, and y^C defines the debt covenant, the violation of which transfers decision making rights to the debt holders. Because K is exogenously fixed by the investment needs of the project, we only need to determine the face value of the debt, D, and the covenant y^C in specifying the debt contract. The face value D, in turn, defines the implicit interest rate on the debt, with higher D indicating higher implicit interest rates.

Recall that the preferences of debt holders and residual claimants coincide when a signal $y > \hat{y}(D)$ is observed. Therefore, any covenant $y^C > \hat{y}(D)$ is equivalent to the covenant $y^C = \hat{y}(D)$, because it will result in exactly the same payoffs to all parties. Given $y^C \leq \hat{y}(D)$, debt holders will liquidate the project whenever the covenant is violated, in which case debt holders receive M and residual claimants receive zero. Thus, from the perspective of date 0, the expected payment to debt holders from a debt contract $\{D, y^C\}, y^C \leq \hat{y}(D)$, is

$$\hat{V}(D, y^C) \equiv \int_0^{y^C} Mh(y)\,dy + \int_{y^C}^{\bar{y}} V(D, y)h(y)\,dy,$$

and the expected payoff of the residual claimants is

$$\hat{U}(D, y^C) \equiv \int_{y^C}^{\bar{y}} U(D, y)h(y)\,dy,$$

where $h(y)$ denotes the marginal density of the accounting signal y.

We construct the optimal debt contract by maximizing the expected payoff to residual claimants subject to the participation constraint that debt holders are willing to accept the contract. Thus, the optimal debt contract $\{D, y^C\}$ is the solution to

$$\begin{aligned} &\text{Max}\ \hat{U}(D, y^C),\\ &\text{subject to: } \hat{V}(D, y^C) \geq K(1+R). \end{aligned} \tag{6}$$

PROPOSITION 2. *The optimal debt contract $\{D^*, y^C\}$ is characterized by*

$$y^C = y^*, \tag{7}$$

$$\int_{y^*}^{\bar{y}} V(D^*, y)h(y)\,dy = K(1+R) - \int_0^{y^*} Mh(y)\,dy. \tag{8}$$

Proof. From (4) and (5) it follows that,

$$U(D, y) = E(\tilde{x} \mid y) - V(D, y).$$

Substituting this into the objective function gives

$$\hat{U}(D, y^C) \equiv \int_{y^C}^{\bar{y}} U(D, y)h(y)\,dy = \int_{y^C}^{\bar{y}} [E(\tilde{x} \mid y) - V(D, y)]h(y)\,dy. \tag{9}$$

Now, because $V(D, y)$ is strictly increasing in D, $\hat{V}(D, y^C)$ is strictly increasing in D, and $\hat{U}(D, y^C)$ is strictly decreasing in D. Therefore the market constraint (6) must bind, and

$$\int_{y^C}^{\bar{y}} V(D, y) h(y) dy = K(1+R) - \int_0^{y^C} Mh(y) dy. \tag{10}$$

Substituting (10) into (9) results in the following unconstrained problem whose solution yields the optimal covenant,

$$\underset{y^C}{\text{Max}} \int_{y^C}^{\bar{y}} E(\tilde{x} \mid y) h(y) dy - K(1+R) + \int_0^{y^C} Mh(y) dy.$$

The first-order condition with respect to y^C is

$$-E(\tilde{x} \mid y^C) h(y^C) + Mh(y^C) = 0,$$

which implies that $y^C = y^*$. Substituting this equality into (10) yields (8). ■

Several properties of the optimal debt contract are worth noting. First, the optimal debt covenant protects *both* lenders and residual claimants, not just the former. Lenders are protected over the interval $[0, y^*]$ in that residual claimants would continue the project when y lies in this interval, but the project is liquidated because decision rights are transferred to debt holders. Residual claimants are protected over the interval $[y^*, \hat{y}(D^*)]$, because debt holders would liquidate the project if they had the right to do so, but the debt covenant prevents such liquidation. Second, the debt covenant results in *socially efficient* liquidation, in the sense that the project is liquidated whenever $E(\tilde{x} \mid y) < M$ and continued whenever $E(\tilde{x} \mid y) > M$. Third, because $\hat{y}(D^*) > y^*$, lenders would be willing to accept lower implicit interest rates on the debt in exchange for more stringent debt covenants. However, a more stringent debt covenant would result in inefficient liquidation, implying that lower interest rates are not necessarily indicative of contractual efficiency.

The efficiency property described above will hold for *any* degree of accounting conservatism, so long as the covenant is optimal relative to that degree of conservatism. This does not mean that accounting conservatism is innocuous. Below, we develop a simple metric that facilitates the comparison of efficiency across differing degrees of conservatism. Any binary decision, such as the continue/liquidate decision we are considering, is prone to Type I and Type II errors. In our setting, a Type I error occurs when a viable project is liquidated because the noisy accounting system sends a false alarm, that is, when the accounting measure indicates that the covenant has been violated but, unknown to the decision maker, $x > M$. For any given covenant $y^C \leq \hat{y}(D)$, the expected cost of such false alarms is

$$L_I(y^C) = \int_0^{y^C} \left[\int_M^{\infty} (x - M) f(x \mid y) dx \right] h(y)\, dy.$$

A Type II error occurs when the accounting measure fails to send an alarm, that is, $y > y^C$, even though $x < M$. The expected cost of such undue optimism is

$$L_{II}(y^C) = \int_{y^C}^{\bar{y}} \left[\int_0^M (M - x) f(x \mid y) dx \right] h(y)\, dy.$$

PROPOSITION 3. *The optimal debt-covenant $y^{C^*} = y^*$ is socially efficient in the sense that the decisions resulting from such a covenant minimize the sum of the expected cost of false alarms and undue optimism.*

Proof. Consider the programming problem:

$$\underset{y^C}{\text{Min}} \int_0^{y^C} \left[\int_M^\infty (x - M) f(x \mid y)\, dx \right] h(y)\, dy + \int_{y^C}^{\bar{y}} \left[\int_0^M (M - x) f(x \mid y)\, dx \right] h(y)\, dy.$$

The first-order condition with respect to y^C is

$$\int_M^\infty (x - M) f(x \mid y^C) h(y^C)\, dx - \int_0^M (M - x) f(x \mid y^C) h(y^C)\, dx = 0$$

$$\Rightarrow \int_M^\infty x f(x \mid y^C) h(y^C)\, dx - \int_M^\infty M f(x \mid y^C) h(y^C)\, dx - \int_0^M M f(x \mid y^C) h(y^C)\, dx + \int_0^M x f(x \mid y^C) h(y^C)\, dx = 0$$

$$\Rightarrow \int_0^\infty x f(x \mid y^C) h(y^C)\, dx = M \int_0^\infty f(x \mid y^C) h(y^C)\, dx$$

$$\Leftrightarrow E(\tilde{x} \mid y^C) = M, \text{ implying } y^C = y^*.$$ ■

Proposition 3 establishes that the efficiency properties of accounting conservatism, vis-à-vis debt contracting, should be examined in terms of the effect of conservatism on the minimized sum of the expected cost of false alarms and the expected cost of undue optimism. Given that conservatism increases the frequency of low signals, one would expect that if the covenant was held fixed while the accounting measure was made more conservative, the expected cost of false alarms would increase. This upsets the balance between false alarms and undue optimism, causing the covenant to be revised downwards. However, when conservatism changes the information content of low and high signals, a shift in the covenant does not generally restore the previous equilibrium. The minimized sum of expected costs of the two kinds of errors could become larger or smaller as accounting becomes more conservative. If this sum becomes smaller, then the hypothesis that accounting conservatism enhances the efficiency of debt contracts is confirmed. If not, the hypothesis is not supported.

The next proposition strengthens our claim that the metric $L_I(y^*) + L_{II}(y^*)$ is a robust indicator of the efficiency properties of accounting conservatism.

PROPOSITION 4. *Let $\{D, y^C\}$ be any arbitrary initial debt contract, with $y^C \neq y^*$.*

(i) If $y > y^*$ is observed, and the initial debt contract is such that debt holders want to liquidate the project and have the right to do so, the debt contract will be renegotiated and the project will be continued.
(ii) If $y < y^*$ is observed, and the initial debt contract is such that the residual claimants have the right to continue the project, the debt contract will be renegotiated and the project will be terminated.
(iii) Any renegotiation proof debt contract must have the covenant $y^C = y^*$.

Proof. Consider any arbitrary initial debt contract $\{D, y^C\}$ with $y^C \neq y^*$ and $D < \infty$. Let $\hat{y}(D)$ satisfy $V(D, \hat{y}(D)) = M$. First, consider the case where $y > y^*$. From Proposition 2, $\hat{y}(D) > y^*$. If $y > \hat{y}(D)$ is observed, there is no need for renegotiation and the project is continued regardless of who has the decision rights since the preferences of the two parties coincide. If $y^C < y < \hat{y}(D)$, then also the project is continued without renegotiation since residual claimants have the decision rights. Now consider the nonempty interval of signals satisfying $y^* < y \leq y^C \leq \hat{y}(D)$. This is the interval where debt holders prefer to liquidate the project and have the right to do so. If there is no renegotiation, the project will be liquidated resulting in a payoff of M to debt holders and a payoff of zero to residual claimants. We show that there exists a renegotiated face value $D^N > D$ that if proposed by residual claimants will be accepted by debt holders in exchange for a waiver of the covenant and this renegotiated arrangement will make both parties better off. Since $y > y^*$, $E(\tilde{x} \mid y) > M$, and since $y < \hat{y}(D)$, $V(D, y) < M$. Therefore, there exists a $D^N > D$ such that:

$$V(D^N, y) = M \text{ and } U(D^N, y) = E(\tilde{x} \mid y) - V(D^N, y) = E(\tilde{x} \mid y) - M > 0.$$

This proves claim (i) of the proposition.

Now consider $y < y^*$. Since $\hat{y}(D) > y^*$, it must be the case that $y < \hat{y}(D)$, so debt holders would like to liquidate while residual claimants would like to continue the project. Suppose debt holders have the decision rights. Liquidation yields them the payoff M. Since $E(\tilde{x} \mid y) < M$, there exists no offer that can be made by residual claimants that would yield a payoff greater than M to debt holders and provides a nonnegative expected payoff to residual claimants. Therefore, there is no scope for renegotiation and the project will be liquidated. Finally, suppose that residual claimants have the decision rights. If the project is continued the expected payoff is strictly positive to both parties, but the sum of these expected payoffs $V(D, y) + U(D, y) = E(\tilde{x} \mid y) < M$. Since liquidation results in a larger aggregate payoff M, this larger amount can be divided between the two parties so as to make both parties better off from liquidation than from continuation of the project. Therefore, Pareto improving renegotiation is feasible and will occur, resulting in liquidation of the project. This proves Claim (ii) of the proposition. Claim (iii) of the proposition is obvious from the preceding analysis. ■

In deriving the optimal debt contract, characterized in Proposition 2, we assumed that residual claimants had all the bargaining power and were restricted only by the risk free interest rate prevailing in the market. Proposition 4 indicates that regardless of how the bargaining power is distributed between the two parties, and regardless of the procedure for choosing the original debt contract, ex post renegotiation between the two parties will *effectively* result in the covenant $y^C = y^*$. Therefore, in any equilibrium that does not prohibit renegotiation, the efficiency of debt contracting is equivalent to the efficiency of the covenant $y^C = y^*$. Proposition 3 implies that such efficiency is measured by the sum of opportunity costs $L_I(y^*) + L_{II}(y^*)$. Therefore, our investigation of the efficiency properties of accounting conservatism will next focus on how this sum varies with the degree of accounting conservatism.

4. *A Statistical Characterization of Unconditional and Conditional Accounting Conservatism*

Basu [1997] and Watts [2003] defined accounting conservatism in terms of differential verifiability standards that must be met for measuring and incorporating good and bad news in accounting reports. Even though such a view of conservatism is without controversy, formal models of financial reporting have incorporated conservatism in different ways. Guay and Verrecchia (G&V) [2006] consider a situation where a firm's manager privately knows a difficult to verify component of the firm's "true" earnings and is required to publicly disclose it. They view conservatism as consisting of a legal regime that penalizes upward biasing of disclosures together with a restriction on the message space. They assume that the legal regime is sufficient to deter all upward biasing and the restriction on the message space is that the manager is forbidden from reporting any realization of the unverifiable income component that is greater than its prior mean. Thus, bad news is fully disclosed while all good news is pooled and reported equal to the prior mean. This implies that relative to a reporting regime where there is no legal liability and thus no information content to managerial disclosures, accounting conservatism increases (in the Blackwell sense) the information contained in managerial reports. The gain in information content is much greater when true earnings are low than when true earnings are high. This implies that the relationship between reported earnings and assessed true earnings (equivalently, stock returns) would display a kink at the point where reported earnings equal prior expectations of true income, with a larger slope coefficient when reported earnings are below prior expectations of true income.

Thus, the G&V characterization of conservatism is consistent with the empirical regularity described by Basu [1997]. But, since there is usually more than one way to explain an empirical regularity, consistency with empirical data is hardly sufficient to assert the realism of an ad hoc model of financial reporting that is designed to fit the data, but has no other economic justification.[4] Given the existence of a legal regime that deters all upward biasing of reports there is no justification for the imposition of a message space restriction, and G&V offer none. As G&V note, such a restriction, by itself, is inefficient because it *decreases* the information contained in managerial reports. A legal regime that deters misrepresentation will obviously add value by increasing the information content of managerial disclosures, but the prohibition on good news disclosures, which is the key characteristic of conservatism in the G&V model, serves no purpose and is actually dysfunctional. We doubt that this kind of conservatism would survive the test of time.

Our view of accounting conservatism is radically different from that of G&V. We think of conservatism as a principle of *measurement* used by accountants and auditors, rather than a restriction on disclosure of information privately known to a manager. A firm's economic transactions and events over a period of time are complex and myriad, and the details of all these transactions are unobservable to outsiders. Accountants and auditors translate such data into summary financial statistics that are incorporated in income statements and balance sheets that are publicly disseminated and that can be contracted upon. By applying differential verifiability standards to transactions that have the potential to decrease versus increase income, this translation can be done with greater or lesser degrees of conservatism. Conservatism is usually incorporated into accounting measurement in the form of judgments that cannot be unraveled by outside observers. For example, conservative measurement principles are imbedded in revenue recognition principles, anticipation of future operating expenses, judgments about whether to capitalize or expense observable cash outflows, recognition of asset impairments, etc. As illustrated earlier, these accounting judgments are analogous to the judgments made by an instructor who translates detailed student answers into numerical scores and letter grades.

Even though we view conservatism as a measurement principle, we do not seek to characterize conservatism by modeling the actual measurement process. Such a task would be difficult given the enormous complexity and variety of accounting judgments in which conservatism is imbedded. Instead, we develop a *reduced form* statistical representation of conservatism. The true relationship between past economic transactions/events and a firm's future cash flows is inherently stochastic. Therefore, any translation of these events into summary financial statistics must produce signals (reports) that are also

[4] We later argue that, appropriately interpreted, our model of conservatism is also consistent with the empirical regularity documented by Basu [1997].

stochastically related to the firm's future cash flows. Different measurement principles affect this stochastic relationship in different ways, hence altering the information content of accounting reports in ways that are often Blackwell incomparable. We postulate that conservatism is one such measurement principle, and variations in the degree of conservatism can be characterized in terms of how the information content of financial statistics changes with the degree of conservatism. Our goal here is to motivate and capture these *statistical* effects of conservatism, without formulating an explicit model of the measurement process.

We have previously specified the stochastic relationship between accounting signals y and the firm's future cash flow x by the conditional probability density $\varphi(y \mid x)$. We now consider a family of probability densities indexed by a parameter δ that represents the degree of conservatism. Henceforth, the conditional probability density $\varphi(y \mid x, \delta)$ describes an accounting system with degree of conservatism δ. Decreases in δ are to be interpreted as increases in the degree of accounting conservatism (and increases in δ represent increasing accounting liberalism), in the precise sense to be described below.

It is easiest to understand the effect of conservatism in settings where the future wealth of the firm is binary.[5] With this goal of expositional clarity, and without loss of generality, we now specialize the model to a setting where the outcome of the project is binary, that is, $x \in \{x_L, x_H\}$, $x_L < x_H$, with nonzero prior probabilities p_L, p_H. We continue to maintain the assumption that the accounting signal y is a continuous random variable with fixed support, $[0, \bar{y}]$. Consistent with earlier assumptions, we now assume

$$x_L < M < x_H \tag{11}$$

and

$$E[\tilde{x}] \equiv p_H x_H + p_L x_L > K(1 + R) > M. \tag{12}$$

Below, we specify conditions on the family of densities $\{\varphi\}$ that describe how the distribution and information content of accounting signals change as accounting becomes more conservative.

CONDITION (A1). *For any given* δ, $\frac{\varphi(y \mid x_H, \delta)}{\varphi(y \mid x_L, \delta)}$ *is strictly increasing in* y.

As shown in Milgrom [1981], this maximum likelihood ratio property (MLRP) condition guarantees that higher values of y move the posterior distribution of x to the right, for every non-degenerate prior distribution on x.[6] In this sense higher values of y constitute good news. In our binary

[5] The extension to a continuum of outcomes and a continuum of signals is not difficult, but the intuitive development that follows is much more transparent in the case of binary outcomes. We indicate the continuous analog in a series of footnotes. None of the results are qualitatively altered in settings with continuous outcomes.

[6] The analogous condition for continuous x is φ_x/φ strictly increasing in y at each δ.

setting, MLRP implies that the posterior probability assessment Prob$(x_H \mid y, \delta)$ is strictly increasing in y for every value of δ. By itself, condition (A1) is not a characteristic of conservatism. However, there seems to be a natural ordering of accounting signals such as earnings reports whereby higher reports are interpreted more favorably, and we see no reason why this natural *order* would be altered by accounting conservatism. Condition (A1) says just that.

Condition (A1) also guarantees that, regardless of the degree of conservatism, increases in x shift the distribution of accounting signals to the right, that is, for any $a > 0$ and any δ,

$$\int_a^{\bar{y}} \varphi(y \mid x_H, \delta)\, dy > \int_a^{\bar{y}} \varphi(y \mid x_L, \delta)\, dy. \tag{13}$$

CONDITION (A2). *For every $a > 0$ and for every $x \in \{x_L, x_H\}$, $\int_a^{\bar{y}} \varphi(y \mid x, \delta)\, dy$ is strictly increasing in δ.*[7]

CONDITION (A3). *For any given y, $\frac{\varphi(y \mid x_H, \delta)}{\varphi(y \mid x_L, \delta)}$ is strictly decreasing in δ.*[8]

In our view, conditions (A2) and (A3) are quintessential properties of accounting conservatism. Condition (A2) says that when the degree of conservatism is increased the distribution of accounting signals shifts to the left, conditional on each value of the future cash flow. This is consistent with the intuitive feeling that conservatism imparts a downward bias to accounting reports.

However, it is unclear how the information content of accounting signals is affected by this downward shift. Condition (A3), which is a variation on the standard MLRP assumption (A1), is an informational condition. It describes how the likelihood ratio at each fixed value of y changes as the degree of accounting conservatism is varied. (A3) implies that, for each observable value of the accounting signal y, the posterior probability assessment Prob$(x_H \mid y, \delta)$ is strictly decreasing in δ. In other words, the assessed probability of high future cash flows given the observation of a signal y is greater when that signal is observed from a conservative accounting regime than when the *same* signal value is observed from a liberal accounting regime.[9]

Our earlier analogy of tough and lenient exams, or stringent versus liberal scoring of exam answers, provides the intuition for (A3). Suppose that a student is observed to score 70 out of 100 points on an exam. Intuition suggests that the score of 70 points is more impressive if it was earned on a tough exam than if it was earned on a more lenient exam. This implies that the probability the student is of high ability, given that she scored

[7] For continuous x, simply replace $x \in \{x_L, x_H\}$ with $x \in (0, \infty)$.

[8] For continuous x, (A3) implies that φ_x/φ strictly decreasing in δ.

[9] In the case where x is a continuous random variable, the posterior distribution of x conditional on a signal y generated by a more conservative accounting regime lies to the right of the posterior distribution conditional on the same signal y when it is generated by a less conservative accounting regime.

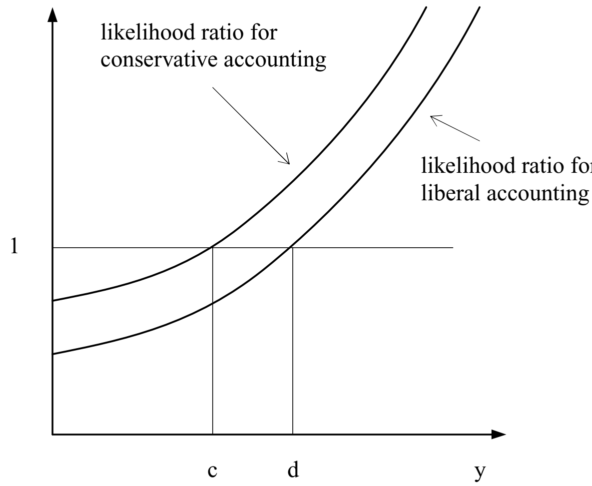

FIG. 1.—Informational implications of accounting conservatism.

70 points on the exam, is higher if the exam was tough than if the exam was lenient.

Condition (A3) also implies that when the accounting regime becomes more conservative the information content of sufficiently high signals is enhanced and the information content of sufficiently low signals is diminished.[10] We illustrate this in figure 1 by comparing the likelihood ratios for liberal (less conservative) and conservative accounting systems, plotted as functions of y. Consistent with condition (A1), the likelihood ratios in figure 1 are increasing in y and, consistent with condition (A3), the likelihood ratios for the liberal accounting regime are everywhere below the corresponding likelihood ratios for the conservative accounting regime.

To see the informational implications of the likelihood ratio ordering described in (A3) and figure 1, note that the likelihood ratio at each value of y is equivalent to the ratio of posterior probabilities divided by the corresponding ratio of prior probabilities

$$\frac{\varphi(y \mid x_H, \delta)}{\varphi(y \mid x_L, \delta)} = \frac{\text{Prob}(x_H \mid y, \delta)/\text{Prob}(x_L \mid y, \delta)}{p_H/p_L}. \tag{14}$$

The equivalence can be established by calculating the posterior probabilities on the right-hand side of (14), via Bayes's rule, and canceling common

[10] This feature of our characterization of conservatism is in strong contrast to that in Guay and Verrecchia [2006]. In the G&V model, conservatism makes low signals more informative than high signals because all low signals reveal the exact truth while high signals are prohibited and therefore pooled into a single signal.

terms. Since the likelihood ratio is equivalent to the extent of probability revision, the likelihood ratio at any signal value y measures the amount of information contained in that signal realization. The observation of a y value at which the likelihood ratio equals 1 conveys no information, because it causes no probability revision. Values of y at which the likelihood ratio is greater than 1 cause upward revisions in the probability of high cash flows, while values of y at which the likelihood ratio is less than 1 cause downward revisions.[11] The greater the deviation from 1 of the likelihood ratio at some signal realization y, the greater the extent of probability revision caused by observation of that signal realization and, therefore, the greater its information content. It is immediate from figure 1 that Assumption (A3) implies that there exist signal values, c and d, $d > c$, such that at each $y > d$ there is a greater upward probability revision when the *same* signal is drawn from a more conservative accounting regime than when it is drawn from a liberal accounting regime. Conversely, at each $y < c$ there is a greater downward probability revision when the signal is drawn from a liberal accounting regime than when the same signal is drawn from a conservative accounting regime. It is additionally clear from figure 1 that liberal accounting regimes can attain low values of the likelihood ratio that cannot be attained by conservative accounting regimes, while conservative accounting regimes can attain high values of the likelihood ratio that cannot be attained by liberal accounting regimes. Thus, (A3) implies that a movement towards accounting conservatism enhances the information content of high signals and diminishes the information content of low signals.

Condition (A3) explicitly rules out a characterization of conservatism as a one-to-one transformation of accounting signals. Such a transformation, say $\Omega = T(Y)$, preserves information content, in the sense that the likelihood ratio at any signal realization ω of the transformed variable would exactly equal the likelihood ratio at $T^{-1}(\omega)$ of the untransformed variable. Condition (A3) precludes such a one-to-one mapping of likelihood ratios from liberal to conservative accounting systems. Additionally, (A3) implies that liberal and conservative accounting regimes cannot be ordered in the sense of Blackwell. While the information content of *some* signal realizations can be ordered across liberal and conservative accounting regimes, it is not the case that the *overall* information content of a conservative accounting regime is greater or less than the overall information content of a liberal accounting regime.

Our representation of conservatism does not permit an unequivocal identification of whether a *given* accounting regime is conservative or not. This would require an explicit model of the measurement process, which we do not undertake. We are only interested in capturing an ordinal ranking of accounting regimes, so that we can identify what it means to increase or decrease the degree of conservatism. Such an ordinal ranking will prove

[11] Every likelihood ratio must equal 1 for some value of y by the law of iterated expectations.

sufficient to examine whether conservatism enhances debt-contracting efficiency. In a similar spirit, the empirical literature ranks accounting regimes in terms of the degree of conservatism by cross-country and time-series comparisons of the Basu coefficients.[12]

4.1 CONSISTENCY WITH BASU'S EMPIRICAL FINDINGS

It may appear that our characterization of the informational properties of accounting conservatism contradicts the empirical regularities documented by Basu [1997]. We argue that such is not the case. Stated in purely statistical terms, Basu's finding is that the contemporaneous correlation between accounting earnings and stock returns is higher when stock returns are negative than when they are positive. Basu interprets this result under the *assumption* that all value relevant events, good or bad, firm specific or macroeconomic, are immediately impounded in stock prices *regardless* of how and when they are incorporated into accounting reports, that is, under the assumption that accounting conveys no incremental information to the capital market. Thus, a high contemporaneous correlation between stock returns and accounting reports indicates that the news that drove stock returns was incorporated into accounting reports at about the same time that the news reached the market through independent sources. Conversely, a low contemporaneous correlation indicates that the news reached the market earlier than its incorporation into accounting reports. This interpretation has become standard in the literature. Hence, the belief that conservatism is equivalent to the timely reporting of bad news and delayed reporting of good news.

However, Basu's statistical regularity is amenable to more than one interpretation. Suppose that, contrary to Basu's assumption, accounting reports do provide incremental information to the capital market. Then if stock prices are an increasing strictly convex function of reported accounting earnings, a *reverse regression* of accounting earnings on stock returns, as in Basu [1997], would yield a piecewise linear approximation of a strictly *concave* relationship, having the differential regression coefficients recorded by Basu. An accounting system with the property that favorable earnings reports (those producing increased expectations of future earnings) have much greater information content than unfavorable earnings reports (those producing downgraded expectations of future earnings) would produce such a convex pricing function. Since accounting conservatism, as we have characterized it, decreases the information content of low reports and enhances the information content of high reports, such conservatism could be consistent with Basu's statistical results. In the appendix, we provide two numerical examples to illustrate this claim.

[12] See for example Ball, Kothari, and Robin [2000] and Bushman and Piotroski [2006].

4.2 UNCONDITIONAL CONSERVATISM

So far, we have not distinguished between unconditional and conditional conservatism, as is often done in the accounting literature.[13] Unconditional conservatism, sometimes called "ex ante" or "news independent" conservatism, is an accounting measurement bias that is unaffected by the characteristics of the event that is measured. A commonly cited example of unconditional conservatism is the immediate expensing of all R&D *irrespective of the probabilities of success of the underlying R&D projects.* Conditional conservatism (or "ex post" or "news dependant" conservatism) means that the extent of conservatism in the accounting measurement depends on the characteristics of the event being measured. Examples usually have a "lower of cost or market" feature in accounting for inventory and asset impairments. Translating these different types of measurement bias to our way of characterizing conservatism requires the specification of how each type of conservatism affects the probability distribution of accounting signals *conditional* on the future cash flows of the firm.

Condition (A2), which we feel is an essential property of accounting conservatism of any form, already requires that accounting signals are stochastically lower when accounting is more conservative. Unconditional conservatism must mean that such a downward shift in the distribution of accounting signals is *independent* of the current events being measured and therefore independent of the future cash flow of the firm. This motivates the following definition of unconditional conservatism for the setting under study.

DEFINITION OF UNCONDITIONAL CONSERVATISM. *The parameter δ is an index of unconditional conservatism if in addition to conditions (A1), (A2), and (A3) the following condition is satisfied:*

CONDITION (A4). *For each $a > 0$ and for each δ,*

$$\frac{\partial}{\partial \delta}\left(\int_a^{\bar{y}} \varphi(y \mid x_H, \delta)\, dy\right) = \frac{\partial}{\partial \delta}\left(\int_a^{\bar{y}} \varphi(y \mid x_L, \delta)\, dy\right).$$

Since, (A4) must be satisfied for every $a > 0$, it is equivalent to

$$\varphi_\delta(y \mid x_H, \delta) = \varphi_\delta(y \mid x_L, \delta), \forall \delta, \text{ and almost all values of } y.^{14} \qquad (15)$$

It is tempting to think that unconditional conservatism has no information effect on the accounting system because any unconditional bias can simply be "unraveled." Such unraveling is true only for monotone transformations of accounting measurements. In our view, such monotone transformations do not constitute conservatism; they are merely inconsequential

[13] See for example Ball, Kothari, and Robin [2000], Ball and Shivakumar [2005], and Beaver and Ryan [2005].

[14] Equation (15), and therefore condition (A4), has an obvious counterpart when x is continuous, i.e., $\varphi_{\delta x}(y \mid x, \delta) \equiv 0$.

transformations of the signal space. We have shown that condition (A3) precludes such monotone transformations as representations of conservatism. Since (A3) is required to hold in addition to (A4), unconditional conservatism, as we have defined it, is not benign. To see how unconditional conservatism (A4) interacts with (A3), differentiate the likelihood ratio with respect to δ so that (A3) is equivalent to

$$\varphi_\delta(y \mid x_H, \delta) < \varphi_\delta(y \mid x_L, \delta)\left(\frac{\varphi(y \mid x_H, \delta)}{\varphi(y \mid x_L, \delta)}\right). \tag{16}$$

Next, define $y^0(\delta)$ by

$$\frac{\varphi(y^0(\delta) \mid x_H, \delta)}{\varphi(y^0(\delta) \mid x_L, \delta)} \equiv 1.^{15} \tag{17}$$

Then since (A1) requires that the likelihood ratio is strictly increasing in y, (15), (16), and (17) imply that (A3) and (A4) are simultaneously satisfied if and only if

$$\varphi_\delta(y \mid x_H, \delta) = \varphi_\delta(y \mid x_L, \delta) < 0, \forall\, y < y^0(\delta),$$

and

$$\varphi_\delta(y \mid x_H, \delta) = \varphi_\delta(y \mid x_L, \delta) > 0, \forall y > y^0(\delta).$$

When accounting is made more liberal in the unconditional sense of (A4), (A3) is also satisfied if the probabilities of all signals above the uninformative signal $y^0(\delta)$ increase and the probabilities of all signals below $y^0(\delta)$ decrease. In this case unconditional accounting conservatism changes the information content of accounting signals and so may have implications for efficient debt contracting.

4.3 CONDITIONAL CONSERVATISM

A change in conditional conservatism implies that the shift in the distribution of accounting signals is *conditional* on the characteristics of the events being measured and is therefore conditional on the future cash flow of the firm, that is, $\varphi_\delta(y \mid x, \delta)$ is *not* independent of x. We use Basu's [1997] verifiability criteria to specify how changes in the degree of conditional conservatism interact with the future cash flow x to affect the distribution of accounting signals. In terms of this interaction, we describe both conditional conservatism and "conditional liberalism." The more stringent verifiability standards for reporting good news than for reporting bad news implies that the effect of conditional conservatism on the distribution of accounting signals is stronger when the future cash flow is high (x_H) than when it is low (x_L). The converse must be true when accounting is conditionally liberal. This motivates the following definition:

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[15] When x is continuous, define y^0 as the value of y where $\varphi_x/\varphi = 0$.

DEFINITION OF CONDITIONAL CONSERVATISM. *The parameter δ is an index of conditional conservatism (or conditional liberalism) if the following conditions are satisfied:*

CONDITION (A5). *There exists δ^0 such that for each $a > 0$:*

$$(A5i) \quad \frac{\partial}{\partial \delta}\left(\int_a^{\bar{y}} \varphi(y \mid x_H, \delta)\, dy\right) > \frac{\partial}{\partial \delta}\left(\int_a^{\bar{y}} \varphi(y \mid x_L, \delta)\, dy\right), \forall \delta < \delta^0,$$

and

$$(A5ii) \quad \frac{\partial}{\partial \delta}\left(\int_a^{\bar{y}} \varphi(y \mid x_H, \delta)\, dy\right) < \frac{\partial}{\partial \delta}\left(\int_a^{\bar{y}} \varphi(y \mid x_L, \delta)\, dy\right), \forall \delta > \delta^0.$$

Additionally, conditions (A1) and (A2) must be satisfied and (A3) must be satisfied in the region $\delta < \delta^0$.

In the region $\delta < \delta^0$, accounting is conditionally conservative, and in the region $\delta > \delta^0$, it is conditionally liberal. In both regions, increases in δ represent a movement towards more liberal accounting.

Again, we use the analogy of tough and lenient exams to lend intuition to (A5). Suppose initially that the exam is so tough (or that the scoring of student answers is so stringent) that all students, regardless of ability, almost certainly fail the exam. Now suppose the exam is made progressively easier. As the exam becomes easier, we expect the distribution of scores, conditional on student ability, to move upward for students of all abilities. However, if the effect of relaxing the exam falls unevenly on students of different ability, we would expect that initially high-ability students would benefit more than low-ability students by moving the former students' distribution of scores more rapidly to the right, as described in (A5i). But once the exam has become sufficiently easy, the distribution of scores for the high-ability students has already moved so much to the right that there is not much "room" for it to move further. The distribution of scores for the low-ability students then begins to "catch up," as described in (A5ii). In the limit, the exam becomes so easy that all students, regardless of ability, almost certainly score the highest number of points.

Mathematically, the difference between unconditional and conditional conservatism is as follows. Fix a in the interior of the common support of the two distributions, that is, $0 < a < \bar{y}$. Now consider the quantity

$$\text{Prob}(y \geq a \mid x_H, \delta) - \text{Prob}(y \geq a \mid x_L, \delta)$$
$$= \int_a^{\bar{y}} (\varphi(y \mid x_H, \delta) - \varphi(y \mid x_L, \delta))\, dy. \quad (18)$$

By (A1) the right hand side of (18) is positive at all values of δ. The issue is: How does this positive quantity vary with δ, that is, how does it change as accounting is made less conservative? If δ is an index of unconditional conservatism, the difference between the two probabilities remains the same at every δ. But if δ is an index of conditional conservatism, the difference increases at a decreasing rate in δ, reaches a maximum at δ^0, then declines in δ.

Our characterization of accounting conservatism is consistent with the binary signal settings in Gigler and Hemmer [2001], Venugopalan [2001], and Chen, Hemmer, and Zhang [2007]. They reason that conservative accounting practices have a high likelihood of reporting a low signal given unfavorable fundamentals, and a low likelihood of reporting a high signal given favorable fundamentals. Demski and Sappington [1990] define a conservative transformation as one that places more weight on unfavorable outcomes and less weight on favorable outcomes. In contrast to previous models of conservatism, our characterization allows for continuous variation in the degree of conservatism, allows for continuous adjustment to debt covenants in response to increased conservatism, and allows a distinction between conditional and unconditional conservatism.

5. *How the Efficiency of Debt Contracts Varies with Accounting Conservatism*

Having developed a formalization of accounting conservatism, we now return to the problem of debt contracting and analyze how changes in the degree of accounting conservatism affect the efficiency of optimal debt contracts. Recall that for any degree of conservatism δ, the optimal debt covenant y^* is described by $E(\tilde{x} \mid y^*, \delta) = M$. Since $E(\tilde{x} \mid y, \delta)$is strictly increasing in y (condition (A1)) and strictly decreasing in δ (condition (A3)), it must be the case that $y^*(\delta)$ is strictly increasing in δ. This is consistent with the intuition that optimal covenants, stated in terms of accounting reports, will adjust to the degree of conservatism built into the accounting system. The optimal covenant must move downward as the degree of conservatism is increased. This result holds regardless of whether the conservatism is unconditional or conditional, since in both cases conditions (A1) and (A3) are satisfied. Also recall that for any degree of conservatism the optimal debt covenant $y^*(\delta)$ minimizes the sum of two opportunity costs, the expected cost of false alarms and the expected cost of undue optimism. Below, we analyze how this minimized sum of opportunity costs, and thereby the efficiency of debt contracting, varies with the degree of accounting conservatism.

Given that $x_L < M < x_H$ the potential opportunity cost of liquidating the project is $x_H - M$, and since the project is optimally liquidated only when signals below $y^*(\delta)$ are observed, the probability of incurring such an opportunity cost is $p_H \int_0^{y^*(\delta)} \varphi(y \mid x_H, \delta)\, dy$. Therefore the optimized expected cost of false alarms is

$$L_I(\delta) = p_H(x_H - M) \int_0^{y^*(\delta)} \varphi(y \mid x_H, \delta)\, dy.$$

The potential opportunity cost of continuing the project is $M - x_L$ and, under the optimal covenant, the probability of incurring this loss is

$p_L \int_{y^*(\delta)}^{\bar{y}} \varphi(y \mid x_L, \delta)\, dy$. Therefore the optimized expected cost of undue optimism is

$$L_{II}(\delta) = p_L(M - x_L)\int_{y^*(\delta)}^{\bar{y}} \varphi(y \mid x_L, \delta)\, dy.$$

In order to examine how the sum of these opportunity costs varies with accounting conservatism, we need to determine the sign of the derivative $\frac{d}{d\delta}[L_I(\delta) + L_{II}(\delta)]$, taking into account the change in the optimal covenant $y^*(\delta)$ as δ is varied. But, since y^* minimizes the sum of these opportunity costs, the Envelope Theorem implies

$$\frac{d}{d\delta}[L_I(\delta) + L_{II}(\delta)]$$
$$= p_H(x_H - M)\int_0^{y^*(\delta)} \varphi_\delta(y \mid x_H, \delta)\, dy + p_L(M - x_L)\int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_L, \delta)\, dy. \tag{19}$$

Now, because $\int_0^{\bar{y}} \varphi_\delta(y \mid x, \delta)\, dy = 0, \forall x, \delta$,

$$\int_0^{y^*} \varphi_\delta(y \mid x_H, \delta)\, dy = -\int_{y^*}^{\bar{y}} \varphi_\delta(y \mid x_H, \delta)\, dy < 0, \tag{20}$$

where the last inequality follows from condition (A2). Thus, the first term in (19) is negative and the second term is positive, regardless of whether δ is an index of conditional or unconditional conservatism. This indicates that every increase in conservatism (decrease in δ), conditional or unconditional, will increase the expected cost of false alarms and decrease the expected cost of undue optimism, even after taking into account the adjustment to the optimal debt covenant. Accounting conservatism enhances the efficiency of debt contracting only if the latter effect dominates the former.

We argue that the opposite is true: The increase in the expected cost of false alarms more than offsets the decrease in the expected cost of undue optimism. From (19) and (20) it follows that $\frac{d}{d\delta}[L_I(\delta) + L_{II}(\delta)] < 0$ if,

$$p_H(x_H - M)\int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_H, \delta)\, dy > p_L(M - x_L)\int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_L, \delta)\, dy. \tag{21}$$

Now,

$$E(\tilde{x}) > M \Rightarrow p_H(x_H - M) > p_L(M - x_L). \tag{22}$$

Because unconditional conservatism (A4) implies that at every δ

$$\int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_H, \delta)\, dy = \int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_L, \delta)\, dy > 0,$$

it must be true that $\frac{d}{d\delta}[L_I(\delta) + L_{II}(\delta)] < 0$, at every δ. Thus, we have established:

PROPOSITION 5. *The efficiency of debt contracting declines monotonically as accounting becomes more conservative in an unconditional sense.*

The extension of this result to the case of conditional conservatism is straightforward. Recall that in our discussion of (A5) we argued that in the region where accounting is conditionally conservative ($\delta < \delta^0$)

$$\int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_H, \delta)\, dy > \int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_L, \delta)\, dy > 0,$$

which implies that (21) continues to hold when δ is an index of conditional conservatism. It is clear from (21) and (22) that

$$\int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_H, \delta)\, dy < \int_{y^*(\delta)}^{\bar{y}} \varphi_\delta(y \mid x_L, \delta)\, dy$$

is a necessary condition for an interior optimal degree of conservatism. Condition (A5ii) asserts that this inequality can only be satisfied in the region where accounting is conditionally *liberal*($\delta > \delta^0$). Thus, we have established:

PROPOSITION 6. *The efficiency of debt contracting declines monotonically as accounting becomes more conservative in a conditional sense. An accounting system that maximizes the efficiency of debt contracting must be conditionally liberal.*

The intuition underlying Propositions 5 and 6 is as follows. Because the ex ante belief at the time the project was initiated is that the returns to the project would exceed its liquidation value, that is, $E(\tilde{x}) > M$, it is optimal to liquidate the project only if beliefs are sufficiently downgraded. This implies that the likelihood ratio at all values of $y \leq y^*$ must be sufficiently smaller than 1. As illustrated in figure 1, condition (A3) implies that any increase in conservatism, conditional, or unconditional, results in a loss of information at signal values where the likelihood ratio is smaller than 1. Thus, the downward adjustment to the debt covenant caused by increased conservatism cannot fully undo the effect of conservatism causing the probability of false alarms to necessarily increase and the probability of undue optimism to necessarily decrease. In the case of unconditional conservatism, the increase in the probability of false alarms exactly equals the decrease in the probability of undue optimism, that is, $\int_0^{y^*} \varphi_\delta(y \mid x_H, \delta)\, dy = -\int_{y^*}^{\bar{y}} \varphi_\delta(y \mid x_H, \delta)\, dy = -\int_{y^*}^{\bar{y}} \varphi_\delta(y \mid x_L, \delta)\, dy$. But, because $p_H(x_H - M) > p_L(M - x_L)$, the ex ante opportunity cost of false alarms is much larger than the ex ante opportunity cost of undue optimism. Therefore, an increase in the probability of false alarms is much more costly than the gain from a corresponding decrease in the probability of undue optimism. Conditional conservatism makes the situation even worse, since the increase in the probability of false alarms exceeds the decrease in the probability of undue optimism. Clearly, the assumption that $E(\tilde{x}) > M$ is crucial to our results, so it is important to ask how realistic it is. Violation of this assumption would mean that firms would start projects with the prior *intention* of liquidating them before the returns to the project are realized! It would be quite surprising if real world data were consistent with such perverse investment strategies.

6. Conclusion

The Basu [1997] description of accounting conservatism (higher verifiability standards for reporting potentially income increasing events and lower verifiability standards for reporting potentially income decreasing events) is widely accepted in the literature and seems to accord well with popular intuition. We believe our statistical characterization of conservatism is faithful to such a description. Yet our analysis yields the result that accounting conservatism actually *detracts* from the efficiency of debt contracts, a result that is strikingly different from that suggested by Watts [2003], Ball and Shivakumar [2005], and Ball, Robin, and Sadka [2008]. Our analysis underscores the importance of explicitly considering how the information content of accounting is changed by accounting conservatism. The intuition in the literature is that conservatism is beneficial because it provides "timely loss recognition." In the terminology of our characterization, this simply means that conservatism increases the probability of low signals when the future is gloomy. However, one also needs to ask whether conservatism increases the probability of low signals when the future is bright. If the answer is in the affirmative, as Basu's notion of conservatism would seem to suggest, then conservatism could increase the probability of false alarms, and this by itself would detract from the efficiency of debt contracts.

It is also important to empirically distinguish conservatism from other forces that result in a strict increase in the informativeness of the accounting regime. If, due to a tightening of the legal regime, bad news events that were previously suppressed begin to be reported in a more timely fashion, then clearly accounting reports would become more informative in the Blackwell sense. In this case, we have no doubt that contractual efficiency would improve. But, such a tightening of the legal regime does not, by itself, constitute accounting conservatism.

Our analysis also underscores the importance of explicitly understanding the tensions between debt holders and residual claimants that create the need for debt covenants. Without explicit consideration of these tensions, it is not clear what is meant by the "efficiency" of debt contracts. Empirical studies indicate that accounting conservatism is negatively correlated with implicit interest rates on debt (Zhang [2008]). It has become commonplace in the literature to equate this empirical finding to higher contractual efficiency. Our analysis does not contradict this empirical finding, but it does indicate that the *interpretation* of such empirical findings is incorrect.[16] More importantly, our findings call into question the *policy* prescription suggested

[16] We have investigated whether $D^*(\delta)$ is increasing or decreasing in δ. In general, this comparative static is non-monotone and therefore there is nothing systematic about the behavior of implicit interest rates as the degree of conservatism is varied. Interest rates could decrease

by Watts [2003] that standard setters should maintain the conservatism that exists in current accounting practice because such conservatism facilitates debt contracting. We do not claim that accounting conservatism is unjustified. But, it is unlikely that the demand for accounting conservatism arises due to debt contracting considerations.

Perhaps the analytical results obtained here are specific to the particular conflict between debt holders and residual claimants that we have modeled. It would be useful to examine other tensions that may arise between the two parties. Debt covenants are also written to prevent residual claimants from "running away with the money" by paying out excess dividends, etc. The role of accounting conservatism in such settings merits investigation. However, we think that, regardless of the setting considered, if the action that is regulated by the covenant requires an assessment of future cash flows, errors of false alarms and errors of undue optimism will play an important role in determining efficiency and the desirability of accounting conservatism will rest on a balancing of these forces.

Another setting that clearly merits investigation is the case where accounting provides only hard contractible information, but there are other sources of information that provide soft, mutually observed, but noncontractible information about future cash flows. The issue here is whether the presence of supplementary noncontractible information alleviates the informational aspects of accounting conservatism in such a way that accounting conservatism actually becomes desirable. The answer is far from obvious. Much would depend on the correlations between hard and soft information and on the outcome of renegotiations that would become inevitable in such settings.

Kwon, Newman, and Suh [2001] found that conservatism has value in moral hazard settings with binary actions, binary signals, and limited liability constraints on the agent's compensation. In their setting, the optimal compensation contract is unaffected by conservatism, the individual rationality constraint does not bind, and the only effect of conservatism is to decrease the probability with which the high wage is paid.Venugopalan [2001] similarly found that conservatism is beneficial in adverse selection settings with limited liability. In these models, conservatism helps in squeezing out rents that arise from limitations on contractual transfer payments between asymmetrically informed parties. Unlike our setting, the accounting signal does not inform a sequentially rational decision, so there is no possibility of Type I and Type II decision errors. Chen, Hemmer, and Zhang [2007] studied "unbiased" and conservative accounting systems in a setting where a binary accounting signal is used both for contractually motivating

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or increase with conservatism depending upon parameter values, depending upon the initial degree of conservatism, and depending on the relative magnitudes of change in the likelihood ratio with respect to variations in δ and variations in the signal y. Thus, for some firms an increase in conservatism could decrease interest rates on debt while for other firms the interest rate could increase.

the hidden effort of an agent and for informing an outside buyer who purchases the firm. The principal, in their setting, has the opportunity and the incentive to manipulate the earnings report to influence the price paid by the outside buyer, but such manipulation also affects the cost of eliciting the high action from the agent since the agent's compensation contract must also be written on the manipulated reports. They view "unbiased" accounting as providing a noiseless report of true earnings, and conservatism as a decrease in the information content of the low report without affecting the information content of the high report. Earnings manipulation in the presence of unbiased accounting decreases the information content of the high report while preserving the information content of the low report, while earnings manipulation in the presence of conservatism decreases the information content of both the high and the low report. Hence, in terms of the cost of eliciting the high action from the agent, earnings manipulation is more costly in the presence of conservative accounting than in the presence of unbiased accounting. Thus, in such settings, conservatism adds value because it increases the cost of earnings manipulation.

The above findings suggest it would be fruitful to study the effect of conservatism when residual claimants acquire private information that is not observed by debt holders about the continuation cash flows from the project after the debt contract has been signed. In such settings, violation of the debt covenant would trigger renegotiations between residual claimants and debt holders. The former have the natural incentive to bias their information upwards in order to persuade debt holders to allow continuation of the project. Such incentives for misrepresentation would need to be disciplined by the renegotiation process itself, and informational rents will likely be an issue. Perhaps, conservatism and the initial choice of the debt covenant could be used to squeeze informational rents.

APPENDIX

In this appendix, we provide two numerical examples to illustrate how our representation of conservatism could produce regression results consistent with the empirical findings of Basu [1997].

EXAMPLE 1. Assume the firm's future earnings are binary, $x_L = 20$, $x_H = 80$, while currently reported accounting signals are tertiary, $y_L = 20$, $y_M = 50$, $y_H = 80$.[17] The probabilities of each signal conditional on each value of future earnings, $P(y \mid x)$, are described in figure A1.

Because of the stringent verifiability standards that must be met for reporting the high signal of y_H the probability of such a report conditional on high future earnings is only 0.15, while the probability of reporting the low signal of y_L conditional on low future earnings is much larger at 0.8 due to the

[17] A minimum of three signals are necessary to characterize a kink in the reports-returns space.

$P(y/x)$	x_L	x_H
y_L	0.8	0.6
y_M	0.198	0.25
y_H	0.002	0.15

FIG. A1.—Matrix of the probabilities of signal y conditional on earnings x.

$P(x/y)$	y_L	y_M	y_H
x_H	0.4286	0.5580	0.9868
x_L	0.5714	0.4420	0.0132

FIG. A2.—Matrix of the posterior probabilities of earnings x conditional on signal y.

lower verifiability standards that must be satisfied for reporting the low signal. The likelihood ratios $\frac{P(y_L \mid x_H)}{P(y_L \mid x_L)} = 0.75$, $\frac{P(y_M \mid x_H)}{P(y_M \mid x_L)} = 1.26$, $\frac{P(y_H \mid x_H)}{P(y_H \mid x_L)} = 75$, indicate that the MLRP condition (A1) is satisfied, and that the low and medium signals have much lower information content than the high signal. The Bayesian posterior probabilities, $P(x \mid y)$, are calculated assuming equal priors and presented in figure A2.

The assumed equal priors imply that the ex ante price of the firm is $v_0 = 50$, and using the Bayesian posteriors calculated above, the prices contingent on each report are $v_1(y_H) = 79.208$, $v_1(y_M) = 53.48$, $v_1(y_L) = 45.716$. Thus the stock market return, v_1 to v_0, associated with y_H is 29.208, the return associated with y_M is 3.48, and the return associated with y_L is –4.284. A Basu-type plot of accounting reports against stock returns would produce the graph displayed in figure A3, with a kink separating low returns from high returns. The slope of the line segment A–B is 3.864, while the slope of the line segment B–C is a much lower 1.166.

EXAMPLE 2. The results illustrated in example 1 are not an artifact of the assumptions that future earnings are binary and accounting reports are tertiary. In this second example, we show that similar results obtain when the number and value of accounting signals equal those of possible future earnings. Assume $x \in \{x_L = 20, x_M = 50, x_H = 80\}$ and $y \in \{y_L = 20, y_M = 50, y_H = 80\}$. Figure A4, motivated in the same way as figure A1, describes the probabilities, $P(y \mid x)$, of each signal conditional on each value of future earnings.

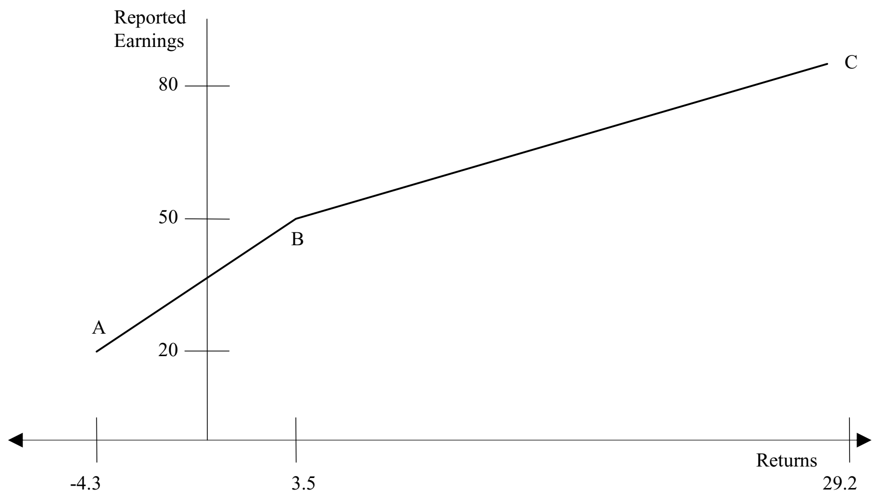

FIG. A3.—Regression of earnings on returns example 1.

$P(y/x)$	x_L	x_M	x_H
y_L	0.7	0.6	0.3
y_M	0.3	0.4	0.5
y_H	0	0	0.2

FIG. A4.—Matrix of the probabilities of signal y conditional on earnings.

$P(x/y)$	y_L	y_M	y_H
x_H	0.1875	0.4167	1
x_M	0.3750	0.3334	0
x_L	0.4375	0.2499	0

FIG. A5.—Matrix of the posterior probabilities of earnings x conditional on signal y.

Assuming equal priors, the Bayesian posteriors, $P(x \mid y)$ are presented in figure A5.

As in the previous example, the ex ante price is $v_0 = 50$, and using the Bayesian posteriors calculated above, the prices contingent on each report

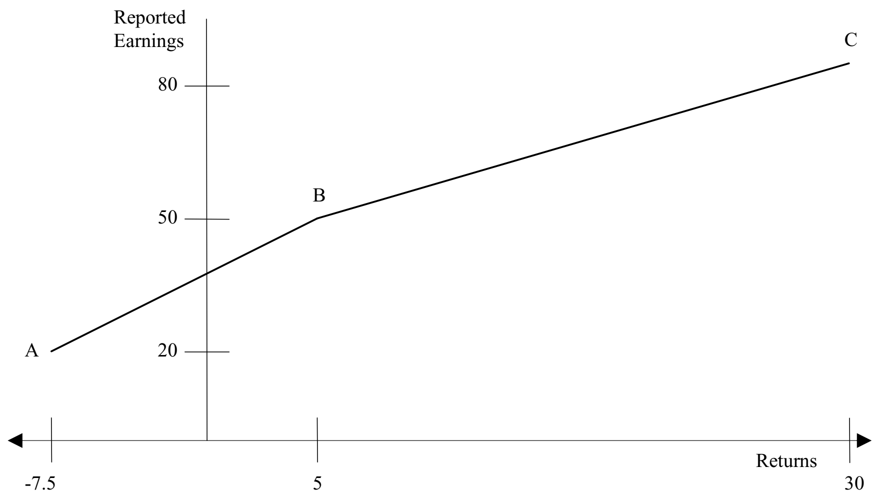

FIG. A6.—Regression of earnings on returns example 2.

are $v_1(y_H) = 80$, $v_1(y_M) = 55$, and $v_1(y_L) = 42.5$. Thus, the stock market return associated with y_H is 30, the return associated with y_M is 5, and the return associated with y_L is -7.5. Figure A6 is a Basu-type plot of accounting reports against stock returns. As in example 1, there is a kink in the graph separating low returns from high returns. The slope of the line segment A–B is 2.4, while the slope of the line segment B–C is a much lower 1.2.

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