Earnings variance: information or noise?

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Abstract

We examine the relation between earnings variance and information. We extend the conventional model of earnings, in which variance is noise, to include forward-looking information. Increasing the variance of earnings by increasing the variance of forward-looking information can decrease the posterior variance (increase the precision of earnings) of the investors estimate of firm value. We show that a positive association between earnings variance and earnings precision confounds the interpretation of many commonly used empirical measures. We illustrate this with our empirical finding that loss firms have lower short-window earnings response coefficients than a sample of non-loss firms even though both samples have (by construction) the same average standardized absolute abnormal announcement return. Consistent with our theoretical argument, the variance of earnings is much lower for the non-loss firms.
1 Introduction

We address the relation between the variance of earnings and information. In the conventional model of earnings, the accounting signal is the sum of the firm’s liquidating dividend and a noise term. The modeling induces equivalence between the variance of earnings and the precision of the investors’ posterior estimate of firm value induced by earnings. In the conventional model, one can increase the variance of earnings only by increasing noise. The increase in noise obscures the information in earnings, thereby reducing the accuracy of investors’ inferences and resulting in a less precise estimate of firm value. Throughout the paper, we define the precision of earnings in terms of the statistical properties of the posterior estimate of firm value derived from earnings rather than in terms of the statistical properties of earnings: more precise earnings produce more accurate (equivalently more precise or lower variance) posterior estimates of firm value. The conventional wisdom that more variable earnings are less precise is pervasive in the accounting literature.

The first contribution of the paper is to show that earnings variance can represent information, not noise. The direct implication of this result is that the precision of earnings, measured as the inverse of the posterior variance of firm value, can be increasing in earnings variance. We model an accounting signal that has information both about the cash flow implications of current-period accrual transactions and forward-looking information about the cash flow implications of future accrual transactions. One can increase the variance of earnings in two ways in this model. First, as with the conventional model, one can increase the variance of noise. As in the conventional model, this reduces the accuracy of the posterior estimate of firm value. Second, one can increase the variance of the forward-looking information. This has two opposite effects. The forward-looking information is noise with respect to the current-period accrual transactions, reducing precision, but informative with respect to future accrual transactions, increasing precision. If the correlation between the forward-looking information and future accrual transactions is high enough, the information effect dominates the noise effect. Thus, higher variance earnings can produce more accurate inferences about firm value. We define the precision of earnings, therefore, in terms of
the statistical properties of the posterior estimate of firm value rather than in terms of the statistical properties of earnings.

We believe the characterization of earnings is timely. Generally Accepted Accounting Principles increasingly call for the replacement of historical cost measurement with fair value measurement for various asset and liability categories. It is plausible, then, that there is more forward-looking information in earnings now than in the past, and a need to understand the implications of the change in the nature of the information.

The second contribution of the paper is to demonstrate analytically that the fact that higher variance earnings can be more precise matters. There are many empirical measures of the underlying attributes of accounting earnings, including earnings response coefficients, earnings persistence, and earnings predictability. We view the attributes measured as secondary attributes indicating the usefulness of earnings in price formation. That is, investors do not care about earnings persistence, *per se*, but rather care about earnings persistence under the belief that more persistent earnings may lead to a more accurate estimate of firm value. The impossibility of observing the posterior variance of firm value creates the demand for measures of the secondary attributes. We can compute the posterior variance in our model, however. The main part of our theoretical analysis is to understand how well the common empirical measures align with posterior variance. The measures all entail deflation of a covariance term by a term including accounting earnings. Increasing the variance of earnings, ceteris paribus, reduces each of these measures. If earnings precision is increasing in earnings variance, then higher quality accounting may be associated with lower values of the measures. That is, the comparative statics for these empirical measures are ambiguous. This result also holds, for slightly different reasons, for the Dechow and Dichev (2002) measure of accrual quality.

Our third contribution is to show that our theoretical argument has practical implications. We identify samples of firms illustrating that higher variance earnings does not necessarily imply less information. Specifically, we compare loss firms to a sample of non-loss firms from 1978 to 2004. We compute the short-window earnings response coefficient on earnings an-
ouncement dates and the standardized absolute abnormal earnings announcement returns, both considered measures of the new information in earnings. Though the standardized absolute abnormal returns are (by construction) equal across the samples, the non-loss firm ERC is higher in 26 of the 27 years, significantly so at least at the 5% level for 17 years. Consistent with the theoretical argument, the loss firms have much higher earnings variance. The higher variance depresses the loss-firm ERC without an associated decline in the new information in earnings as measured by the returns measure. The lower short-window ERCs are an econometric phenomenon, not an economic one.

We also assess the earnings variance-information relation by regressing the firm-specific average standardized excess return for all firms in our sample on the firm-specific time-series variance of earnings and other explanatory variables. If earnings variance is noise, we would expect to see a negative association between the standardized excess return and earnings variance. Instead, we document a positive (but insignificant) association between the two variables.

We sketch the conventional model in Section 2 and our extended model in Section 3. We analyze the theoretical implications of our model in Section 4. In Section 5, we present the empirical analysis. Finally, we conclude in Section 6.

2 Conventional model: earnings variance is noise

Let \( \hat{u} \) be the liquidating value of the firm. In the conventional model of earnings in the accounting literature, the accounting signal, \( \hat{y} \), is the underlying liquidating value of the firm perturbed by a disturbance term, \( \hat{e} \), or \( \hat{y} = \hat{u} + \hat{e} \). The only parameter determining the quality of accounting in this model is the variance of the noise term, \( \sigma_e^2 \), with quality decreasing in the variance. Though researchers often define the precision of earnings in terms of the statistical properties of earnings (typically as the inverse of the variance of earnings), precision is an attribute only meaningfully defined in terms of the statistical properties of the inference of firm value derived from earnings, namely, the posterior variance of firm value. In the case of the conventional model, the variance of earnings has the same comparative
statics properties with respect to accounting quality as the posterior variance.

To illustrate, we use the conventional normal random variables representation. Specifically, let $\tilde{u} \sim N(\mu, \sigma_u^2)$ and $\tilde{e} \sim N(0, \sigma_e^2)$. The conditional expectation of the liquidating value $\tilde{u}$ given earnings $\tilde{y}$ is $\mu + \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}(\tilde{y} - \mu)$, where $\tilde{y}$ denotes the realization of the signal, and the posterior variance of the liquidating value is

$$\sigma_u^2 - \frac{\sigma_u^4}{\sigma_u^2 + \sigma_e^2} = \frac{\sigma_e^2 \sigma_u^2}{\sigma_u^2 + \sigma_e^2}.$$

The derivative of the posterior variance with respect to $\sigma_e^2$ is $\frac{\sigma_e^2 \sigma_u^2}{(\sigma_u^2 + \sigma_e^2)^2} > 0$. Thus, in this model, defining the precision of earnings in terms of the variance of earnings is equivalent to defining it in terms of the posterior variance of the inference of firm value derived from earnings.

3 Expanded model: earnings variance can be information

We expand the conventional model in this section. Firm value is the sum of a series of cash flow realizations rather than a single liquidating dividend. The introduction of multiple periods requires us to formalize the modeling of accruals, including reversals. We assume clean-surplus accounting.

There are four periods in the model. To simplify the model, we assume that the firm does not engage in any transactions entailing the recognition of income and the collection and disbursement of cash in the same period. That is, the firm engages only in accrual transactions. These transactions occur in periods 1, 2, and 3; the collections/disbursements of cash occur in periods 2, 3, and 4. Let $\tilde{V}$ be the value of the firm, and $\tilde{C}_i$, $i \in \{2, 3, 4\}$ be the amount of cash collected in period $i$. Formally, $\tilde{V} = \tilde{C}_2 + \tilde{C}_3 + \tilde{C}_4$. Designate the transactions that generate the cash flows, as $\tilde{s}_i$, $i \in \{1, 2, 3\}$. The firm always collects the cash in the period following the transaction, so that $\tilde{s}_1 = \tilde{C}_2$, $\tilde{s}_2 = \tilde{C}_3$, and $\tilde{s}_3 = \tilde{C}_4$. An alternative version of the value of the firm, then, is $\tilde{V} = \tilde{s}_1 + \tilde{s}_2 + \tilde{s}_3$.

Let $\tilde{X}_1 = \tilde{s}_1 + \tilde{x}_1 + \tilde{f}_1$ be earnings. The random variable $\tilde{x}_1$ represents noise in earnings, and $\tilde{f}_1$ represents information about two-period-ahead cash flow $\tilde{s}_2$. Both $\tilde{s}_1$ and $\tilde{f}_1$ are forward-looking information: $\tilde{s}_1$ captures the one-period ahead cash flow effects of current
period transactions and \( \tilde{f}_1 \) anticipates the two-period ahead cash flow effects of transactions that have not occurred yet. Because the firm collects no cash until period 2, and we assume clean-surplus accounting, the entire amount of first-period earnings is an accrual. The firm collects \( \tilde{s}_1 \) in period 2. The remaining amount of the first-period accrual \( \tilde{x}_1 + \tilde{f}_1 \) is reversed out of the accrual account, and therefore also reversed out of second-period earnings. Finally, \( \tilde{s}_2 + \tilde{x}_2 + \tilde{f}_2 \) is added to the accrual account, so that second-period earnings is the change in net assets:

\[
\tilde{X}_2 = (\tilde{s}_1 + \tilde{s}_2 + \tilde{x}_2 + \tilde{f}_2) - (\tilde{s}_1 + \tilde{x}_1 + \tilde{f}_1) = \tilde{s}_2 + \tilde{x}_2 - \tilde{x}_1 + \tilde{f}_2 - \tilde{f}_1.
\]

We assume that the random variables \( \tilde{s}_i = \tilde{C}_{i+1}, \tilde{x}_i, \) and \( \tilde{f}_i \) are normally distributed with mean 0 and variances \( \sigma^2_c, \sigma^2_x, \) and \( \sigma^2_f, \) respectively. The covariance between \( \tilde{s}_i \) and \( \tilde{s}_{i+1} \) is \( \rho_c \sigma^2_c, \) where \( \rho_c \) is the correlation between \( s_i \) and \( s_{i+1}. \) The covariance between \( \tilde{f}_i \) and \( \tilde{s}_{i+1} \) is \( \rho_f \sigma_c \sigma_f, \) where \( \rho_f \) is the correlation between \( \tilde{f}_i \) and \( \tilde{s}_{i+1}. \) All other correlations are 0.

We continue to define the precision of earnings, or accounting quality, in terms of the statistical properties of the conditional expectation of firm value derived from earnings, not the statistical properties of earnings itself. The unconditional variance of firm value is \( 3(1 + 2\rho_c)\sigma^2_c. \) The posterior variance conditional on \( \tilde{X}_1 \) is

\[
3(1 + 2\rho_c)\sigma^2_c = \frac{[(1 + \rho_c)\sigma^2_c + \rho_f \sigma_f \sigma_c]^2}{\sigma^2_c + \sigma^2_x + \sigma^2_f}.
\]

We summarize how changes in \( \rho_f, \sigma^2_x, \) and \( \sigma^2_f \) affect accounting quality in the following proposition.

**Proposition 1** Earnings quality (the inverse of the posterior variance of firm value) is decreasing in the noise in earnings (\( \sigma^2_x \)) and increasing in the correlation of two-period-ahead information with two-period-ahead cash flows (\( \rho_f \)). Earnings quality is increasing in the variance of two-period-ahead information (\( \sigma^2_f \)) if the correlation of two-period-ahead information and two-period-ahead cash flows is sufficiently high (\( \rho_f > \rho^\text{post} = \frac{(1 + \rho_c)\sigma_c \sigma_f}{\sigma^2_c + \sigma^2_x} \)).

The explanation of the results is as follows. An increase in \( \sigma^2_x \) adds variance to the earnings signal without adding information. Conversely, an increase in \( \rho_f \) adds information about
two-period-ahead cash flows without obscuring the information about one-period-ahead cash flows. As a result, earnings quality is monotonically decreasing in the former and increasing in the latter. Increasing the variance of two-period-ahead information has competing effects: reducing the accuracy of the inference about $\hat{s}_1$ (noise effect) and increasing the accuracy of the inference about $\hat{s}_2$ (information effect). If the correlation between two-period-ahead information in earnings and two-period-ahead cash flows is high enough, then increases in the variance of $\hat{f}_1$ improve the inference about firm value. Otherwise, the noise effect dominates the information effect.

The variance of first-period earnings is $\sigma_s^2 + \sigma_x^2 + \sigma_f^2$. Unlike the conventional model, there are two sources of noise with respect to next-period cash flows $\hat{s}_1$, $\hat{x}_1$ and $\hat{f}_1$. The key distinction between the expanded and conventional model is that $\hat{f}_1$, noise with respect to one-period-ahead cash flows, is informative about two-period-ahead cash flow. This creates a source of variance in earnings that is potentially negatively correlated with the posterior variance of firm value. The precision of earnings, therefore, is not equivalent to earnings variance. We state this formally in the following corollary.

**Corollary 1** For $\rho_f > \rho_{post}$, earnings variance and earnings precision (inverse of posterior variance) are both increasing in the variance of two-period-ahead information.

A second corollary pertains to the variance of the first-period price change.

**Corollary 2** The variance of the first-period price change is increasing in earnings precision.

Corollary 2 shows that one can measure the new information in the earnings signal without reference to earnings. This type of argument forms the basis of empirical measures such as the Beaver (1968) U-statistic, among others.

4 Why does it matter (theory)?

The distinction in our model between the precision of earnings and the variance of earnings matters in the context of the interpretation of various empirical measures: the short-window earnings response coefficient (ERC), the persistence of earnings, the predictability of earnings,
and the Dechow and Dichev (2002) measure of accrual quality. As Collins and Kothari (1989) explain, short-window tests are essentially event studies in which researchers interpret the slope coefficient of a regression of abnormal earnings on earnings surprises as a proxy for the new information in earnings. Researchers have cited the other three measures as properties desirably in accounting earnings. In the conventional model, the measures are all increasing in the precision (quality) of earnings, which we define as the inverse of the posterior estimate of firm value. In our expanded model, however, the measures are not congruent with earnings precision. We demonstrate this with the earning response coefficient, which is $\gamma_1$ in the regression of returns on earnings:\(^1\)

$$P_1 - P_0 = \gamma_0 + \gamma_1 X_1 + \tilde{e}.$$  

**Proposition 2** The earnings response coefficient is \(\frac{(1+\rho_c)\sigma_c^2 + \rho_f \sigma_f \sigma_c}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2}\). The ERC is strictly decreasing in the variance of noise \(\sigma_x^2\) and strictly increasing in the correlation of two-period-ahead information in earnings with two-period-ahead cash flows \(\rho_f\). The earnings response coefficient is increasing in the variance of two-period-ahead information \(\sigma_f^2\) if \(\rho_f > \rho_{erc} = \frac{2(1+\rho_c)\sigma_c \sigma_f}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2} \).

The ERC is the covariance between returns and earnings scaled by the variance of earnings. Increasing the noise in earnings \(\sigma_x^2\) dampens the price response (the numerator) and increases the variance of earnings (the denominator). Both forces work in tandem to increase the ERC. Increasing the correlation between two-period-ahead information in earnings and two-period-ahead cash flows increases the price response without changing the variance of earnings. Hence, the ERC is again increasing in the precision of earnings. Increasing the variance of two-period-ahead information, however, has the competing effects of magnifying the price response (the numerator) and increasing earnings variance (the denominator). If the correlation is low enough, the variance effect dominates and the ERC is decreasing in accounting quality. The results imply that there is a range of correlations, specifically \(\rho_{post} < \rho_f < \rho_{erc}\), over which increases in the variance of two-period-ahead information improve earnings quality (lower the posterior variance of firm value) but reduce the earnings quality.

\(^1\)Because \(P_0\) is fixed, we do not deflate by earnings.
response coefficient. This result is related to, but distinct from, Subramanyam (1996), who shows that price responses to earnings surprises can be nonlinear, or even nonmonotonic, when the market revises its beliefs about the precision of the earnings signal based on its realization. Whereas in Subramanyam (1996), the earnings coefficient may be nonmonotonic with respect to the earnings surprise, in our paper it may be nonmonotonic with respect to the size of the revision of expectations of firm value.

The statistical intuition for earnings persistence, defined as the coefficient on the regression of lead earnings on current earnings, and earnings predictability, defined as the correlation between current and lead earnings, are similar. Statistical correlation is a relative measure, scaling the covariance of the variables of interest by the product of their standard deviations. If changes in accounting quality affect both the covariance and the deflator in opposite ways, as is implicitly assumed by the conventional model, the interpretation of statistically based measures is unambiguous. Otherwise, it is ambiguous. We summarize the results in the following proposition.

**Proposition 3**

1. The persistence of earnings is
   \[ \rho \sigma^2_c - \sigma^2_f + \rho_f \sigma_c \sigma_f \]
   The persistence is strictly decreasing in the variance of noise (\(\sigma^2_x\)) and strictly increasing in the correlation of two-period-ahead information with two-period-ahead cash flows (\(\rho_f\)). The persistence is increasing in the variance of two-period-ahead information if \(\rho_f > \rho_{\text{pers}}\), where \(\rho_{\text{pers}} = \frac{2(1+\rho_c)\sigma_c \sigma_f}{\sigma^2_c - \sigma^2_f + \sigma^2_x}\).

2. The predictability of earnings is
   \[ \frac{\rho \sigma^2_c - \sigma^2_f + \rho_f \sigma_c \sigma_f}{\sqrt{\sigma^2_c + \sigma^2_f + \rho_f \sigma_c \sigma_f} \sqrt{\sigma^2_f + 2\sigma^2_c + 2\sigma^2_f - 2\rho_f \sigma_c \sigma_f}} \]
   The persistence is strictly decreasing in the variance of noise (\(\sigma^2_x\)), strictly increasing in the correlation of two-period-ahead information with future cash flows (\(\rho_f\)). The persistence is increasing in the variance of two-period-ahead information if \(\rho_f > \rho_{\text{prep}}\), where \(\rho_{\text{prep}}\) is the expression in the Appendix.

We next examine a measure of accrual quality that is not in the form of a covariance divided by the variance of earnings. Specifically, Dechow and Dichev (2002) measure the quality of accruals as the variance of the residual of a regression of the change in working
capital on lag, current, and lead cash flow from operations. Because our model considers accruals only, there is no need to include the lag cash flows. Assuming full reversal of all working capital accounts every period, the change in accruals (change in working capital) in period 2 in our model is:

\[
\tilde{s}_2 - \tilde{s}_1 + \tilde{x}_2 - \tilde{x}_1 + \tilde{f}_2 - \tilde{f}_1.
\]

The measure of accrual quality is the variance of residuals in the following regression:

\[
(s_2 - s_1 + x_2 - x_1 + f_2 - f_1) = \lambda_0 + \lambda_1 C_2 + \lambda_2 C_3 + \tilde{e}.
\]

**Proposition 4** The variance of residuals is \(2\sigma_x^2 + 2\sigma_f^2\), strictly increasing in both the variance of the noise (\(\sigma_x^2\)) and the variance of the two-period-ahead information (\(\sigma_f^2\)).

Over the range of \(\rho_f\) for which increases in the variance of forward-looking information improve earnings quality (lower the posterior variance), the Dechow and Dichev measure indicates lower accrual quality. The intuition is that the amount \(f_1\) does not result in a cash inflow or outflow in period 2. In this sense, it is an accounting “error and the DD measures properly captures it. In a valuation sense, however, this accounting “error, because it provides information about future cash flows, is useful to investors and improves the precision of earnings.

The next corollary formally states our main result.

**Corollary 3**

i. If \(\rho_{post} < \rho_f < \min\{\rho^{erc}, \rho^{pred}\}\), then all four measures are decreasing in \(\sigma_f^2\) even though increases in \(\sigma_f^2\) improve the precision (quality) of earnings.

ii. If \(\sigma_f^2 = \rho_f = 0\) (the conventional model), all four measures are increasing in the precision (quality) of earnings.

The corollary states the conditions under which the measures have the counterintuitive comparative statics. The corollary also indicates that the conventional model is a special
case of our more general model in which $\sigma_f^2 = \rho_f = 0$. Note also that we can generate qualitatively similar results with other specifications of earnings, including specifications not using normally distributed random variables.

Our goal is to provide guidance to empiricists as to situations in which using the econometric measures may be problematic. Figure 1 illustrates how the range of $\rho_f$ in part $i$ of the corollary changes with respect to changes in various parameters. In all panels, the posterior estimate of firm value is increasing in the variance of forward-looking information ($\sigma_f^2$) only in the dark-shaded region on the left, and at least one of the ERC, persistence, or predictability of earnings is increasing in $\sigma_f^2$ in the dark-shaded region on the right. For the values of $\rho_f$ in the lighter-shaded region in the middle, then, more precise earnings are associated with lower values of all four of the econometric measures of accrual quality.

Panel A shows that as the variance of cash flows increases, the range over which part $i$ of the corollary holds shrinks. The cutoff for the posterior variance declines as the forward-looking information is more valuable. However, the cutoff for the measures declines even more, as the increases in $\sigma_c^2$ affect the covariances (numerators) relatively more than they affect the variances (denominators). Panel B shows that the range expands as $\sigma_f^2$ increases. The posterior variance cutoff increases—the quality of the forward-looking information ($\rho_f$) must increase to offset the additional noise represented by higher $\sigma_f^2$. However, the cutoff for measures increases even more, encompassing the entire range of $\rho_f$ for high enough $\sigma_f^2$. Panel C shows that the relevant range shrinks slightly as the autocorrelation of cash flows ($\rho_c$) increases. Panel D shows that the relevant range expands as the variance of noise ($\sigma_x^2$) increases. The cutoff for the measures decreases, but not as much as the posterior variance cutoff. As $\sigma_x^2$ increases, forward-looking information is relatively more important.

5 Why does it matter (data)?

In section 3, we demonstrate that higher earnings variance can be associated with more new information in earnings. In section 4, we show that this property confounds inferences about

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*The Dechow and Dichev measure is strictly increasing in $\sigma_f^2$ for all parameter values.*
common empirical measures. In this section, we examine cross-sectional and time-series evidence.

5.1 Cross-sectional

There are three steps in our research design for our cross-sectional tests. First, we identify an empirical measure independent of earnings gauging the same underlying attribute of accounting information gauged by one of the empirical measures in the previous section (i.e., new information in earnings, persistence, or predictability). Second, we identify two samples of firms in which the two measures, presumably capturing the same attribute, contradict each other. Third, we document that difference in earnings variance across the two samples drives the empirical finding.

We focus on short-window ERCs. Researchers have interpreted short-window ERCs as measures of the amount of new information in earnings. Corollary 2 shows that the return variance, the calculation of which is independent of earnings, is strictly increasing in the amount of new information in earnings. We have two measures, then, for the same underlying construct. If both measures are valid, they should have similar econometric properties. We compute both measures for samples of non-loss (firm \( i \) is a non-loss firm in year \( t \) if it shows no quarterly losses in \( t \)) and loss firms.

The return variance referred to in Corollary 2 is the variance across the entire distribution of possible announcement period returns. We can observe only one realization (the actual announcement period return) in the real data. As a proxy for return variance, we use the announcement period absolute abnormal return deflated by the annual standard deviation of absolute abnormal returns. Researchers have frequently used this as a measure of new information in earnings. The purpose of the deflation is to control for differences in return variance. This is especially important in our samples because loss firms have systematically

\[ \text{To the extent that earnings announcement returns are driven by non-earnings information included in the announcements that is uncorrelated with earnings, the measures capture slightly different underlying constructs. One could imagine, for example, that loss firms include more information in their quarterly earnings releases than non-loss firms. The price reaction, then, is a response not only to earnings but to the additional information. A larger price reaction affects both measures, but if the additional information is noise with respect to earnings then it would dampen the ERC. We believe, however, that it is unlikely that amount of additional information is uncorrelated with earnings.} \]
higher earnings variance, higher cash flow variance, and higher return variance. As a result, the loss firm sample has higher absolute abnormal returns in all years. This does not imply more new information in earnings, as the cause could instead be underlying return variance.

The standardized absolute abnormal return measure has been used in various forms since Beaver (1968). We compute the version on page 523 of Francis, Schipper, and Vincent (2002). Specifically, for firm $i$ in year $t$ and quarter $j$, $\text{std}(|AR|)_{i,t,j} = \frac{|AR|_{i,t,j}}{\sigma(|AR|_{i,t})}$, where $|AR|_{i,t,j}$ is the largest of the absolute abnormal returns in the three-day period centered around the earnings announcement, and $\sigma(|AR|_{i,t})$ is the standard deviation of all daily absolute abnormal returns in the year.

For every year from 1978 to 2004, we compute $\text{std}(|AR|)$ for all firms that have excess return ($bxret$) data on CRSP and a full set of quarterly earnings announcements on Compustat. In all years, the mean loss-firm absolute abnormal return ($|AR|$) is significantly higher than the mean $|AR|$ for non-loss firms. Furthermore, in 1978 and 1979, there is no statistically significant difference between the mean standardized absolute abnormal return ($\text{std}(|AR|)$) across the two samples. In subsequent years, however, the mean $\text{std}(|AR|)$ for non-loss firms is 6% to 27% higher than the mean $\text{std}(|AR|)$ for loss firms. Starting in 1980, we truncate the sample of non-loss firms so that the average standardized absolute abnormal return ($\text{std}(|AR|)$) is equal across both samples in each year. On average, we truncate 6% of the no-loss firm sample each year, eliminating the highest $\text{std}(|AR|)$ realizations.\footnote{We fix the mean $\text{std}(|AR|)$ across the two samples. The loss sample is more diffuse than the non-loss sample, but not dramatically so. The variance, skewness, and kurtosis for the loss sample are 1.44, 1.37 and 5.00, respectively, and 1.09, 0.74, and 2.69, respectively, for the truncated non-loss firm sample.}

After truncation, we have two samples in which the amount of new information in earnings, as measured by $\text{std}(|AR|)$, is the same. This leads to our first hypothesis:

\textbf{Hypothesis 1} The amount of new information in earnings, as measured by the earnings response coefficients, is the same for the loss sample and the truncated non-loss sample in all years.
To test the hypothesis, we estimate the following cross-sectional regression:

\[ AR_{i,j} = \gamma_1 I_{i,j}^N + \gamma_2 I_{i,j}^N UE_{i,j} + \gamma_3 I_{i,j}^L + \gamma_4 I_{i,j}^L UE_{i,j}, \]

where \( I_{i,j}^N \) is an indicator variable for a non-loss firm, \( I_{i,j}^L \) is an indicator variable for loss firm, and \( UE_{i,j} \) is the unexplained earnings, defined as \( (Earnings_{i,j,t} - Earnings_{i,j,t-1})/Price_{i,j,t-1} \).

An f-test of the equality of \( \gamma_2 \) and \( \gamma_4 \) is the main statistical test in this section of the paper. We use the truncated sample of non-loss firms in the regression. The earnings response coefficients on the truncated sample of non-loss firms reported in Table 1 range between 7% and 46% lower than the earnings response coefficients on all non-loss firms (not tabulated).

We report the results in Table 1. By construction, the \( std|AR| \), reported in the far-right column, is the same in all periods for both samples, implying the same average amount of new information in the quarterly earnings announcements as measured by the returns-based metric. The main test in the Tables is the test of the equality of \( \gamma_2 \) and \( \gamma_4 \), the respective earnings response coefficients. The coefficient on unexpected earnings is higher for the non-loss sample than the loss sample in 26 of the 27 years. The difference is significant at the 1% level in 12 years and significant at the 5% level for 17 years. The non-loss sample coefficient in the pooled cross-sectional regression, reported in the last row, is roughly six times the magnitude of the loss sample coefficient, significant at the 1% level. The different measures of new information, then, yield different results for the two samples. The columns labeled var(ue), providing the respective variances of unexpected earnings, provide the explanation for the results. The same mean \( std|AR| \) is associated with unexpected earnings variances 3 to 10 times higher for the loss firms during the sample period.

The difference in unexpected earnings variances across the two samples also influences the power of the respective regression tests. While the coefficient on the earnings surprise is significant at the 1% level for all years for the non-loss firms, the coefficient is significant at the 1% level for 4 years, at the 5% level for 6 years, and insignificant for the remaining 17 years for the loss firms. One would reject the null hypothesis that earnings provide new information for the loss sample in more than half the years even though the mean loss firm \( std|AR| \) is the same as the mean-loss firm \( std|AR| \)s that generated significant regression
coefficients in 26 of the 27 years.

Our empirical findings suggest that low loss-firm short-window ERCs are an empirical artifact rather than an economic phenomenon. Our results, however, do not directly address Hayn (1995), who finds that loss firms also have low long-window ERCs and argues that this is caused by the proximity of the liquidation option for loss firms. Long-window information content is a concept distinct from short-window earnings usefulness. Without an independent measure of long-window information content, we cannot perform an analysis on long-window ERCs equivalent to our short-window ERC analysis.

5.2 Time series

In the previous results, we created cross-sectional subsamples based on loss/non-loss firms and performed yearly regressions to demonstrate that properties of earnings variance can confound the interpretation of the short-term ERC as a measure of new information in earnings announcements. In the next test, we attempt to examine directly the relation between information and earnings variance on a firm-specific time-series basis. In particular, we test the following hypothesis:

Hypothesis 2 The amount of new information in earnings is decreasing in the variance of unexpected earnings, consistent with the conventional modeling of earnings.

For each firm \( i \) in our full sample we first compute the time-series average of new information, \( \text{std}|AR|_i \), and the time-series variance of earnings surprises, \( \text{vsur}_i \), and then estimate the following cross-sectional regression:

\[
\text{std}|AR|_i = \beta_1 + \beta_2 \text{vsur}_i + \beta_3 \text{avgloss}_i + \beta_4 \text{size}_i + \sum \text{industry}_i + \epsilon,
\]

where \( \text{avgloss}_i \) is the percentage of firm-years in which there was at least one losing quarter, \( \text{size}_i \) is assets, and \( \text{industry}_i \) is an indicator variable for the two-digit SIC (minimum 50 data points). The sign and significance of the coefficient on \( \text{vsur}_i \), \( \beta_2 \), represents the test
on the hypothesis. To test the relation between information and variance, we would ideally want to observe the price reaction to an earnings signal that was the exclusive source of information for the firm. As it is, the price reacts only to the information in earnings not already pre-empted by other information sources, not to all of the information in earnings. For this reason, we include the control variables. We predict that the coefficient on \textit{avgloss} will be negative. We have no prediction for the sign on size. On the one hand, there is more information for large firms that would preempt earnings announcements; on the other, their accounting numbers may be more reliable.

We start with 5,891 firm observations, reduced to 5,731 by the requirement that there be at least nine quarters of data to compute the variance of earnings. We report the results in Table 2. Consistent with the earlier findings that loss firms have lower std|AR|s, the coefficient on \textit{avgloss} is significantly negative. The coefficient on size is significantly positive. We have no prediction on this coefficient. The coefficient on \textit{vsur} is positive but insignificant. That is, on a cross-sectional basis, there is a positive association between new information in earnings and earnings variance, but the relationship is not statistically significant at conventional levels. Though we can reject the null hypothesis of a negative relation between information in earnings and earnings variance, we do not have evidence of a positive relation between the two. The latter result would have been a stronger confirmation of the validity of our theoretical concerns.

6 Conclusion

We extend the conventional model of earnings to include forward-looking information. In our model, there is no longer a monotonic relation between the variance of earnings and precision of the posterior estimate of firm value. The reason is that while the forward-looking information is noise with respect to the cash flow implications of current-period accruals, decreasing precision, it is information with respect to the cash flow implications of future accruals, increasing precision. If the correlation between the forward-looking information and future cash flows is high enough, increasing the variance of the forward-looking information,
which also increase the total earnings variance, generates a more precise posterior estimate of firm value. We argue that as Generally Accepted Accounting Principles embrace fair-value accounting for more asset and liability categories, the amount of forward-looking information in earnings will also increase, making our model more salient.

We show that the non-monotonicity of the variance-information relation confounds the interpretation of various econometric measures, including the earnings response coefficient, earnings persistence, earnings predictability, and the Dechow and Dichev (2002) measure. The intuition for the first three is that they are based on coefficients of a regression in which earnings is a right-hand side variable. The ERC, for example, is the ratio of the covariance of earnings and returns to the variance of earnings. If both the covariance and the variance are increasing in the precision of earnings, then the comparative statics for the ratio are ambiguous.

We document our theoretical concerns in cross-sectional and time-series tests of returns-earnings data. In the cross-sectional tests, we construct samples of loss and non-loss firms that have the same standardized absolute abnormal announcement return, a measure of new information in earnings. We then show that the short-window ERC, also a measure of new information in earnings, is significantly higher for the non-loss firms than loss firms in 26 of 27 years. Consistent with our theoretical argument, the earnings variance is significantly higher for the loss firm sample, explaining the contradiction between the two measures of the same underlying attribute. The results of our time-series tests, in which we regress the firm-specific average standardized absolute abnormal announcement return on the firm-specific earnings variance and other control variables, are weaker. The coefficient is positive, allowing us to reject the null hypothesis of the conventional negative relation between earnings variance and information, but insignificant.
Appendix: Proofs of Propositions

Proof of Proposition 1

Firm value conditional on the realization of first-period earnings is:

\[ E[C_1 + C_2 + C_3|s_1 + f_1 + x_1] = \frac{\text{Cov}(C_1 + C_2 + C_3, s_1 + f_1 + x_1)}{\text{Var}(s_1 + f_1 + x_1)}. \]

Now,

\[ \text{Cov}(C_1 + C_2 + C_3, s_1 + f_1 + x_1) = \sigma_c^2 + \rho_f \sigma_c \sigma_f + \rho_c \sigma_c^2 = (1 + \rho_c)\sigma_c^2, \]

and

\[ \text{Var}(s_1 + f_1 + x_1) = \sigma_c^2 + \sigma_f^2 + \sigma_x^2, \]

yielding

\[ P_0 = E[C_1 + C_2 + C_3|s_1 + f_1 + x_1] = \frac{(1 + \rho_c)\sigma_c^2 + \rho_c \sigma_c \sigma_f}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2} \tilde{X}_1, \]

where \( \tilde{X}_1 \) denotes the realization of earnings. The variance of firm value conditional on the realization of first-period earnings is

\[ \text{Var}(C_1 + C_2 + C_3|s_1 + f_1 + x_1) = \text{Var}(C_1 + C_2 + C_3) - \frac{\text{Cov}(C_1 + C_2 + C_3, s_1 + f_1 + x_1)^2}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2} \]

\[ = 3\sigma_c^2(1 + 2\rho) - \frac{[(1 + \rho_c)\sigma_c^2 + \rho_f \sigma_c \sigma_f]^2}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2} \]

The comparative statics with respect to \( \sigma_x^2 \) and \( \rho_f \) are straightforward. Setting the derivative of the posterior with respect to \( \sigma_f^2 \) equal to 0 and solving for \( \rho_f \) yields the last results.

Proof of Proposition 2

Let \( \hat{P}_i \) denote the price at time \( i \).

\[ P_0 = 0 \]

\[ P_1 = E[\hat{C}_2 + \hat{C}_3 + \hat{C}_4|\tilde{X}_1] = E[\tilde{s}_1 + \tilde{s}_2 + \tilde{s}_3|\tilde{X}_1] = E[\tilde{s}_1 + \tilde{s}_2|\tilde{X}_1]. \]
The covariance between $\tilde{s}_1 + \tilde{s}_2$ and $\tilde{X}_1$ is $(1 + \rho_c)\sigma_c^2 + \rho_f \sigma_c \sigma_f$. The properties of the conditional normal imply that the posterior estimate of firm value is

$$E[\tilde{s}_1 + \tilde{s}_2|\tilde{X}_1] = P_1 = \frac{(1 + \rho_c)\sigma_c^2 + \rho_f \sigma_c \sigma_f}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2} \hat{X}_1.$$ 

The comparative statics with respect to $\sigma_x^2$ and $\rho_f$ are straightforward. Setting the derivative of the ERC with respect to $\sigma_f^2$ equal to 0 and solving for $\rho_f$ yields the condition in the proposition.

**Proof of Proposition 3**

The persistence coefficient is

$$\text{Cov}(\hat{X}_1, \hat{X}_2) = \frac{\rho_c \sigma_c^2 + \rho_f \sigma_c \sigma_f - \sigma_c^2}{\sigma_c^2 + \sigma_f^2 + \sigma_x^2}.$$ 

The comparative statics with respect to $\sigma_x^2$ and $\rho_f$ are straightforward. Setting the derivative of the ERC with respect to $\sigma_f^2$ equal to 0 and solving for $\rho_f$ yields the condition in the proposition.

Earnings predictability is the correlation between current and next-period earnings:

$$\text{Cov}(\hat{X}_1, \hat{X}_2) = \frac{\rho_c \sigma_c^2 + \rho_f \sigma_c \sigma_f - \sigma_c^2}{\sqrt{\sigma_c^2 + \sigma_f^2 + \sigma_x^2} \sqrt{\sigma_c^2 + 2\sigma_c^2 + 2\sigma_f^2 - 2\rho_f \sigma_f \sigma_c}}.$$ 

The comparative statics with respect to $\sigma_x^2$ and $\rho_f$ are straightforward. Setting the derivative of the ERC with respect to $\sigma_f^2$ equal to 0 and solving for $\rho_f$ yields an unwieldy closed-form expression (furnished upon request).

**Proof of Proposition 4**

The covariance between accruals and $\tilde{C}_2$ is $-\sigma_c^2 + \rho_c \sigma_c^2$ and the covariance between accruals and $\tilde{C}_3$ is $\sigma_c^2 - \rho_c \sigma_c^2 - \rho_f \sigma_c \sigma_f$, implying that $\lambda_1 = -1 + \frac{\rho_c \sigma_c \sigma_f}{(1 - \rho_c)\sigma_c}$ and $\lambda_2 = 1 - \frac{\rho_f \sigma_f}{(1 - \rho_c)\sigma_c}$. If $\rho_f = \sigma_f^2 = 0$, the coefficients reduce to $\lambda_1 = -1$ and $\lambda_2 = 1$.

The residual is:

$$\tilde{s}_2 - \tilde{s}_1 + \tilde{e}_2 - \tilde{e}_1 + \tilde{f}_2 - \tilde{f}_1 - (\gamma_0 + \gamma_1 \tilde{s}_1 + \gamma_2 \tilde{s}_2) = \tilde{x}_2 - \tilde{x}_1 + \tilde{f}_2 - \tilde{f}_1 + (1 - \gamma_2) \tilde{s}_2 - (1 + \gamma_1) \tilde{s}_1.$$
The variance of the residual is:

\[ 2\sigma_x^2 + \sigma_f^2 + [(1 - \gamma_2)^2 \sigma_c^2 + (1 + \gamma_1)^2 - 2(1 - \gamma_2)(1 + \gamma_1)\rho_c \sigma_c^2] - (1 - \gamma_2)\rho_f \sigma_c \sigma_f. \]

This reduces to \( 2\sigma_x^2 + 2\sigma_f^2 \).
References


FIGURE 1

Panel A: Correlation between forward-looking information and future cash flows ($\rho_f$)

In the lighter-shaded region, all the measures are decreasing in the precision of earnings.

Panel B: Correlation between forward-looking information and future cash flows ($\rho_f$)

In the lighter-shaded region, all the measures are decreasing in the precision of earnings.

Panel C: Correlation between forward-looking information and future cash flows ($\rho_f$)

In the lighter-shaded region, all the measures are decreasing in the precision of earnings.

Panel D: Correlation between forward-looking information and future cash flows ($\rho_f$)

In the lighter-shaded region, all the measures are decreasing in the precision of earnings.
TABLE 1

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NON-LOSS FIRMS</th>
<th>LOSS FIRMS</th>
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<td>p-value</td>
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<td>0.00078</td>
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</table>

**significant at the 1% level  *significant at the 5% level. Standard errors are robust.

We estimate the following regression for each year:

\[ AR_{i,j} = \gamma_1 I_{i,j}^{Samp1} + \gamma_2 I_{i,j}^{Samp2} + \gamma_3 I_{i,j}^{Samp3} + \gamma_4 I_{i,j}^{Samp4} + UE_{i,j} \]

\[ AR_{ij} \] is the absolute abnormal return for firm i in quarter j, the I_{ij} are indicator variables with Samp.1 designating the truncated sample of non-loss firms and Samp.2 designating the sample of loss firms. Loss firms are defined as having at least one losing quarter during the year. All variables are winsorized at 1%. The main test is an f-test of the equality of \( \gamma_2 \) and \( \gamma_4 \), with the p-value reported in the next to last column. std | AR | is the absolute abnormal return standardized by the firm-specific of returns. By construction, std | AR |, reported in the last column, is the same across the two samples. Std | AR | and the g’s are both considered measures of the amount of new information in earnings announcements. var(ue) is the variance of unexpected earnings for the samples, defined as (earn_{ij,t} - earn_{ij,t-1})/price_{ij,t-1}.
**TABLE 2**

The regression model is:

\[ \text{std} | AR_{i,j} | = \beta_1 + \beta_2 \text{vsur}_i + \beta_3 \text{avgloss}_i + \beta_4 \text{size}_i + \sum \beta_j \text{industry}_j + \epsilon \]

<table>
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<tr>
<th>variable</th>
<th>(\beta_1)</th>
<th>(\beta_2)</th>
<th>(\beta_3)</th>
<th>(\beta_4)</th>
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</table>

**significant at the 1% level. Standard errors are robust.**

\(N = 5,731, r\text{-squared}: 9.10\%\)

\(\text{std} | AR_{i,j} | \) is the absolute abnormal announcement period return deflated by the firm-specific variance of abnormal returns, \(\text{vsur}\) is the firm-specific time-series variance of unexpected earnings, \(\text{avgloss}\) is the percentage of years the firm experienced at least one quarterly loss, \(\text{size}\) is the time-series average of assets.