ELSEVIER Journal of Accounting and Economics 21 (1996) 319–337

JOURNAL OF Accounting & Economics

How naive is the stock market's use of earnings information?

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(Received April 1995; final version received February 1996)

Abstract

Rendleman, Jones, and Latané (1987) and Bernard and Thomas (1990) hypothesize and report evidence that investors use a 'naive' seasonal random walk model, at least in part, for quarterly earnings. We show that the market acts as if it: (1) *does not* use a simple seasonal random walk model; (2) *does* exploit serial correlation at lags 1–4 in seasonally-differenced quarterly earnings; (3) *does* use the correct signs in exploiting serial correlation at each lag; but (4) *underestimates* the magnitude of serial correlation by approximately 50% on average. We discuss the consistency of alternative hypotheses with our evidence.

Key words: Anomalies; Capital markets; Time series forecasts

JEL classification: G14; M41

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We dedicate this paper to the memory of Victor L. Bernard. Together with Jake Thomas, Vic was instrumental in opening up this avenue of research. Vic and Jake generously provided us with their data. As the anonymous referee on the paper, Vic gave the type of insightful, constructive, and thorough advice that his colleagues had come to expect of him. We will miss him. We also received helpful comments from Larry Brown, Andrew Christie, John Hand, S.P. Kothari, Joshua Ronen, Terry Shevlin, Ross Watts, and especially Jerold Zimmerman (the editor), as well as seminar participants at the London School of Business and participants at the Sixth Annual Conference on Financial Economics and Accounting. Financial support was received from the Bradley Policy Research Center at the Simon School, University of Rochester and the John M. Olin Foundation.

SSDI 0165-4101(96)00420-X

1. Introduction

Rendleman et al. (1987) hypothesize, and report confirming evidence, that investors are unaware that firms' seasonally-differenced quarterly earnings are serially correlated. Consequently, investors do not fully exploit the information in past earnings changes, and make or imply inferior predictions of future earnings changes. Bernard and Thomas (1990) hypothesize that, due to the unexploited information, abnormal returns at earnings announcements can be predicted from past earnings. They report evidence that is seemingly immune to problems in measuring expected returns and that is startlingly consistent with this hypothesis.

While this evidence is consistent with the market not fully exploiting the information in past earnings changes, it neither explicitly nor implicitly reveals the extent to which the market *does* utilize past earnings information. Furthermore, interpretation of the evidence is clouded by inconsistent and ambiguous conclusions. For example, Bernard and Thomas (1990, p. 338) are careful to conclude that 'while prices may *partially* reflect [the information in past earnings concerning future earnings], they evidently do not reflect *all* available information'. However, it is unclear what 'partially' means in this context: is it knowledge of some but not all of the attributes of an optimal earnings expectation model (seasonals, random walks, drifts, serial correlation), incomplete knowledge of the parameter values of an optimal model, or some combination of these? In an attempt to clarify the issue, we investigate the expectation model that is implied by the market's reaction to seasonally-differenced quarterly earnings.

Using the Bernard and Thomas (1990) data, we show that the market does not act as if using a naive earnings expectation model. The price reaction to current earnings is consistent with investors being aware of both the existence and the sign pattern of serial correlation in seasonally-differenced quarterly earnings. The market acts as if aware of the sign of the serial correlation at each of the four lags in question, and for each of the three Bernard and Thomas size groups (i.e., in twelve of twelve instances). However, we also show that the market acts as if it underestimates the magnitude of the serial correlation, by approximately 50%.

Showing that the market acts as if aware of serial correlation does not contradict the empirical anomaly reported by Rendleman et al. (1987) and Bernard and Thomas (1990). Nevertheless, the result helps to clarify the anomaly and provides new clues concerning its source. Using the correct form of the time-series model for quarterly earnings, but with seemingly-incorrect parameters, is qualitatively different from using a totally incorrect model. The result rules out the 'naive expectations model' hypothesis. It directs attention instead to possible sources of bias in investors' assessments of serial correlation, or alternatively to biases in researchers' assessments of the ability of earnings to predict abnormal returns.[1]

2. The 'naive expectations model' hypothesis

The ability of current earnings information to predict future abnormal returns, known as 'post earnings announcement drift', has attracted considerable attention since it appeared in Ball and Brown (1968). The literature is surveyed in Ball (1992) and Bernard (1993).

Rendleman et al. (1987, pp. 142–143) hypothesize that at least part of this 'drift' is due to investors misunderstanding the time-series behavior of earnings:

> If investors fail to recognize the correlation that exists in *SUE*s [standardized unexpected earnings] over time, stock prices are unlikely to adjust to their equilibrium values at the time earnings are announced. However, over subsequent holding periods, excess returns should be realized as stock prices adjust to next quarter's *SUE*s, which are highly correlated with those of the current quarter.

SUE is defined as change in earnings relative to the equivalent quarter last year, detrended and scaled by standard deviation. Their hypothesis thus is that investors use a seasonal version of the Ball and Brown (1968) 'naive model', namely a seasonal random walk model.[2] Investors are assumed unaware of exploitable serial correlation in the model's forecast errors. In contrast, the existence of serial correlation in seasonally-differenced quarterly earnings has been known *to researchers* for two decades.[3] If investors are more naive than researchers in forming earnings expectations, then it is possible for researchers to earn abnormal returns by trading under more sophisticated models. Rendleman et al. (1987) report evidence that this is possible.

Bernard and Thomas (1990) provide a more direct and thorough test of this hypothesis. They focus on abnormal returns at the time of earnings

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[1]The latter could be due to earnings-related survival biases (Brown, Goetzmann, and Ross, 1995; Brown and Pope, 1995) or to earnings proxying for errors in estimating abnormal returns (Ball, 1978, 1992), for example.

[2]Following normal practice, we refer to this variable as Standardized Unexpected Earnings (*SUE*). This is a misleading term in our view. The earnings expectation assumes a seasonal random walk model for quarterly earnings, ignoring serial correlation in the seasonal differences. This is neither plausible (see Section 6), nor the optimal time-series model (Table 1), nor the model implicit in the actual market response to earnings (Table 3).

[3]See Watts (1975), Foster (1977), Griffin (1977), Brown and Rozeff (1979), Bernard and Thomas (1990), and Bartov (1992).

announcements, which they show can be predicted by a model that exploits the (+ , + , + , −) signs of the serial correlation, over four lags, in *SUE*s.[4] For example, they simulate trading strategies that are implemented at the time of an earnings announcement but are based on past earnings. Long positions are taken in the decile of the highest past-*SUE* stocks, and short positions are taken in the lowest past-*SUE* decile. The simulated strategy earns estimated abnormal returns of +1.32%, +0.70%, +0.04%, and −0.66% (*t*-statistics of +14.63, +8.46, +0.45, and −7.86; see their Table 2) when it is based on earnings announced 1–4 quarters previously, respectively. This implies a total of +2.72% abnormal return in the average quarter from trading on 'stale' earnings news.[5] Their full-sample regressions give similar results.

An attractive feature of the Bernard and Thomas (1990) research is that it develops and tests a refutable alternative to the efficient market hypothesis. If abnormal returns are not (1) observed at the time of subsequent quarters' earnings announcements and (2) a predictable function of past *SUE*, then the alternative is refuted. It clearly is not. Another attractive feature is that the results are seemingly robust to problems of measuring expected returns, because the estimated abnormal returns cover only three-day intervals (short enough to suggest 'small' expected returns) and are positive in all thirteen years studied (regular enough to suggest they are not returns for bearing some unmeasured risk).[6] Furthermore, the sample exceeds 80,000 earnings announcements, and the results are corroborated by Freeman and Tse (1989), Wiggins (1990), Abarbanell and Thomas (1992), Bartov (1992), Bae, Hughes, and Lee (1995), and Ball and Bartov (1995). These features of the research design, together with the novel and startling nature of the results, help explain the considerable impact that Bernard and Thomas (1990) has had on thinking about the relation between earnings and stock prices.

Nevertheless, there is some confusion as to the implications of this evidence. Rendleman et al. (1987, pp. 142–143) conclude that investors use a simple seasonal random-walk model, without incorporating serial correlation in *SUE*. Bernard and Thomas (1990, p. 307) reach much the same conclusion:

> A stock market in which prices are influenced by traders who anchor on a comparison of year-to-year changes in quarterly earnings, much like the financial press does in its coverage of earnings announcements (e.g., the Wall Street Journal's Digest of Earnings Reports), represents a disturbing departure from what would be predicted by existing models of efficient markets.

[4]The correlation at lag 3 is small, so this pattern sometimes is described as (+ , + , 0, −). In Table 1 it is significantly positive for all size groups, so we describe the pattern as (+ , + , + , −).

[5]Calculated as 1.32 + 0.70 + 0.04 + 0.66, reversing the sign at lag 4 to exploit the negative correlation.

[6]Expected returns increase with the return interval, so the problem of earnings proxying for expected returns (Ball, 1978, 1992) becomes larger in magnitude over longer intervals.

These interpretations credit investors with awareness of the fundamental random-walk property of earnings, but have them misapplying the model to seasonal (quarterly) earnings. In a review of the evidence, Bernard et al. (1993, p. 54) state a stronger conclusion:

> the market fails to appreciate fully even the most basic properties of the evolution of earnings.

Other statements are carefully qualified. For example (Bernard and Thomas, 1990, p. 307, emphasis added):

> What we study here is the possibility that market prices can be modeled *partially* as reflections of naive expectations.

But even these conclusions are ambiguous, in several senses. First, one could obtain the impression that the market is *totally* unaware of the serial correlation in a seasonal random-walk model's prediction errors. This cannot be clarified from the regressions reported by Bernard and Thomas (1990), which neither estimate nor imply an estimate of the extent to which the market acts as if aware of the serial correlation. That is not their purpose. Second, it is not clear whether 'partially' in this context refers to partial knowledge of components of the correct forecasting model (random walks, drifts, seasonals, existence of serial correlation, signs of the correlation at each lag) or to partial knowledge of parameter values in the correct model. Third, if it refers to partial parameter knowledge, does this mean systematically underestimating parameters for all stocks, systematically overestimating, or making random parameter estimation errors across time and/or stocks? To clarify the issue, we therefore offer some direct evidence.

3. A direct test of the 'naive expectations model' hypothesis

We investigate the expectation model implicit in the price reaction to current earnings, using a regression of form:

$$CAR_0 = k + a_0 SUE_0 + a_1 SUE_{-1} + a_2 SUE_{-2} + a_3 SUE_{-3} + a_4 SUE_{-4} + u_0. \quad (1)$$

The first independent variable (current SUE) is announced during the 'event window' in which the dependent variable (CAR) is observed. The other independent variables (lagged SUEs) measure components of the expectation of current SUE. We use the estimated coefficients on lagged SUEs, in a regression controlling for current SUE, to infer the extent to which investors incorporate the information in the prior four quarters' earnings when forming earnings expectations. This section outlines the rationale for making such an inference.

Prior research (see Fn. 3) shows that SUE_0 can be approximated as a linear function of lagged SUEs:

$$SUE_0 = b_0 + b_1 SUE_{-1} + b_2 SUE_{-2} + b_3 SUE_{-3} + b_4 SUE_{-4} + \varepsilon_0, \qquad (2)$$

where $b_1, b_2, b_3 > 0$, $b_4 < 0$, and ε_0 is the white-noise current earnings innovation. The question is the extent to which the market acts as if aware of the form of (2) and the magnitudes of the coefficients b_1 through b_4. To address this question, we compare the values of the coefficients estimated from earnings data in (2) with those implied by the market's use of past earnings information in (1).

Consider initially the case where the market is fully informed about the process generating SUE, including the magnitude of its parameters, and makes full use of the information in past earnings. That is, assume the market acts as if Eq. (2) best describes the time-series process of earnings. In this case, the price response (CAR_0) is linear in the earnings innovation (ε_0) alone:

$$CAR_0 = \alpha + \beta\varepsilon_0 + \omega_0, \qquad (3)$$

where $\beta > 0$ and ω_0 is white noise. It follows from Eqs. (2) and (3) that

$$CAR_0 = \alpha^* + \beta SUE_0 - b_1\beta SUE_{-1} - b_2\beta SUE_{-2} - b_3\beta SUE_{-3} - b_4\beta SUE_{-4} + \omega_0, \qquad (4)$$

where $\alpha^* = \alpha - b_0\beta$. The fully-informed case therefore predicts both the signs and the magnitudes of the coefficients on lagged SUEs, *in a regression controlling for* SUE_0.

In a regression of form (1), if the market is fully informed about the earnings process, the predicted *signs* of the coefficients on lagged SUEs exhibit a ($-$, $-$, $-$, $+$) sign pattern. The predicted pattern is reversed relative to the ($+$, $+$, $+$, $-$) sign pattern in SUE's serial correlation in (2). The sign reversal occurs because abnormal return is an increasing function of the earnings innovation ε_0 [$= SUE_0 - E(SUE_0)$], and thus is a decreasing function of $E(SUE_0)$. Note that the predicted signs of the coefficients on lagged SUEs also are reversed relative to those reported by Bernard and Thomas (1990, Table 5), whose regressions do not control for currently-announced SUE.

Furthermore, in a regression of form (1), the *magnitudes* as well as the signs of the coefficients on past SUE can be predicted under the hypothesis that the market is fully informed about the earnings process. If the market has perfect information on both the form of the process generating SUE and the magnitudes of the serial correlation coefficients, then the predicted values of the coefficients on SUE_{-1}, SUE_{-2}, SUE_{-3} and SUE_{-4} are $-b_1\beta$, $-b_2\beta$, $-b_3\beta$, and $-b_4\beta$, respectively. β can be estimated as a_0, the coefficient on current SUE in (1), and b_1 through b_4 can be estimated as the partial correlation coefficients on lagged earnings in regression (2).

Consider next the case where investors use a 'naive' seasonal random walk model, totally unaware of the serial correlation in *SUE*. (This is the original Rendleman et al. hypothesis.) Then, the predicted coefficients on lagged *SUE*s are zero. That is, CAR_0 is independent of SUE_{-1}, SUE_{-2}, SUE_{-3}, and SUE_{-4}, *when controlling for* SUE_0, because in this case investors react *only* to current earnings changes and ignore their predictability from past earnings changes.

Finally, consider the case where the market uses the correct expectations model, but systematically over-(under-)estimates the magnitude of serial correlation in *SUE*. Then, the predicted coefficients on lagged *SUE* are larger (smaller) in absolute value than predicted in the fully-informed case. Taken at face value, estimates of the coefficients on lagged *SUE* thus provide evidence on the markets assessment of the magnitude of serial correlation in *SUE*s.

4. Data

Data from their studies were kindly supplied by Bernard and Thomas. They require (1989, p. 6; 1990, Fn. 3) a minimum of nine earnings changes (ten quarters of earnings) to estimate the drift and standard deviation components of *SUE* plus four consecutive lagged *SUE*s for their (1990, Eq. 9) regression. We require one additional consecutive observation to control for current *SUE*.[7] Our sample comprises 70,728 quarterly earnings announcements made by NYSE–AMEX firms during 1974–86.

The variables in the Bernard and Thomas data set are earnings (*SUE*) and returns (*CAR*) by firm and quarter. *SUE* is seasonally-differenced quarterly earnings per share, detrended and scaled by its standard deviation estimated from prior observations, transformed to its cross-sectional decile rank, then scaled to range over the interval [0,1]. *CAR* is size-adjusted daily return cumulated over a three-day (− 2, 0) window, where 0 is the earnings announcement day.

5. Results

We first replicate prior results in our sample. We then show that the market incorporates lagged *SUE*s into its earnings expectation model, and reconcile this with prior results. Finally, we comment on the effects of size as a variable,

[7]Without this additional requirement, the sample comprises 76,034 observations. Requiring fifteen consecutive quarters of earnings data likely induces survival biases. Brown and Pope (1995) argue that requiring four subsequent quarters' earnings deletes firms that failed or were acquired over the following year from the sample, and that because these events are not independent of both future returns and current earnings, it induces a spurious dependence between current earnings and both future earnings and future returns. They suggest this explains in part the Bernard and Thomas (1989, 1990) results.

Table 1
Prediction of current *SUE* on the basis of lagged *SUE*s: Serial correlation in seasonally-differenced quarterly earnings

Model: $SUE_{i,t} = b_0 + \sum_{j=1}^{4} b_j SUE_{i,t-j}$

	b_0	b_1	b_2	b_3	b_4	Adj. R^2
Panel A: Full sample						
(n = 70728)	0.291	0.443	0.133	0.054	− 0.215	28.57%
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Panel B: By firm size						
Small firms	0.327	0.408	0.123	0.059	− 0.264	26.68%
(n = 24480)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Medium firms	0.276	0.454	0.142	0.055	− 0.208	29.99%
(n = 20894)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Large firms	0.277	0.462	0.130	0.044	− 0.183	29.39%
(n = 25354)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

The definitions of all variables are identical to those in Bernard and Thomas (1990). $SUE_{i,t}$ is the forecast error of the ith firm for quarter t from a seasonal random walk with trend, scaled by its estimation-period standard deviation. *SUE* deciles are based on rankings within the calendar quarter of the announcement of quarter t earnings. In all regressions, the values of the *SUE* variables are replaced by their decile rankings and then scaled so that they range from 0 (for the lowest decile) to 1 (for the highest decile). Small, medium, and large firms are in size deciles 1 to 4, 5 to 7, and 8 to 10, respectively, based on January 1 market values of equity. *P*-values in parentheses.

including survivorship effects. Following Bernard and Thomas, we estimate all regressions from pooled cross-section and time-series data.

5.1. Replication of prior results

Tables 1 and 2 verify that prior results hold in our sample. Table 1 reports pooled regressions of *SUE* on its four lagged values. The coefficients are estimated partial serial correlations from a multiple regression as in Eq. (1). Their signs follow the familiar (+ , + , + , −) pattern. Results for small, medium and large firms are similar.

Table 2 closely replicates the Bernard and Thomas (1990, Table 5) pooled regression of three-day size-adjusted returns (CAR) on four lagged values of *SUE*.[8] In this regression, there is no control for the currently-announced *SUE*.

[8]One difference is that we use *SUE*s as explanatory variables whereas Bernard and Thomas use the errors from a Foster (1977) first-order autoregressive earnings expectation model (in seasonal differences). Since the *SUE*s and the errors from the Foster (1977) model are highly correlated, it is not surprising that we get similar results. Our coefficient on *SUE* at lag 3 is negative, though insignificant (see Fn. 4).

Table 2
Relation between return at current earnings announcement and lagged (past) quarterly earnings, Bernard and Thomas (1990) regression, no control for current earnings

Model: $CAR_{i,t} = k + \sum_{j=1}^{4} a_j SUE_{i,t-j}$

	k	a_1	a_2	a_3	a_4	Adj. R^2
Panel A: Full sample						
(n = 70728)	− 0.160	1.204	0.322	− 0.052	− 0.829	0.78%
	(0.00)	(0.00)	(0.00)	(0.51)	(0.00)	
Panel B: By firm size						
Small firms	− 0.047	1.790	0.368	0.149	− 1.323	0.91%
(n = 24480)	(0.66)	(0.00)	(0.04)	(0.40)	(0.00)	
Medium firms	− 0.384	1.226	0.462	− 0.188	− 0.654	0.97%
(n = 20894)	(0.00)	(0.00)	(0.00)	(0.15)	(0.00)	
Large firms	− 0.207	0.719	0.194	− 0.098	− 0.426	0.63%
(n = 25354)	(0.00)	(0.00)	(0.02)	(0.25)	(0.00)	

The definitions of all variables are identical to those in Bernard and Thomas (1990). $CAR_{i,t}$ is the sum of daily abnormal returns in the three days − 2 to 0 relative to the earnings announcement date (day 0) of firm i in quarter t. Daily abnormal returns are the differences between daily returns of firm i and the returns for NYSE–AMEX firms of the same size decile, based on January 1 market values of equity. $SUE_{i,t}$ is the forecast error of the ith firm for quarter t from a seasonal random walk with trend, scaled by its estimation-period standard deviation. *SUE* deciles are based on rankings within the calendar quarter of the announcement of quarter t earnings. In all regressions, the values of the *SUE* variables are replaced by their decile rankings and then scaled so that they range from 0 (for the lowest decile) to 1 (for the highest decile). Small, medium, and large firms are in size decilies 1 to 4, 5 to 7, and 8 to 10, respectively, based on January 1 market values of equity. All parameter estimates are multiplied by 100. P-values in parentheses.

The absolute values of the coefficients on the four earnings lags sum to 2.44%, compared with the 2.59% they report. This sum can be interpreted as the regression estimate of the abnormal return from exploiting serial correlation.

5.2. Incorporation of lagged SUEs into earnings expectations

Table 3 reports the relation between lagged earnings and returns at the current earnings announcement, controlling for current earnings. The evidence rejects the hypothesis that investors use a naive seasonal random-walk expectations model for quarterly earnings. In an F-test for the incremental effect of the four lagged *SUE* variables, relative to a regression of returns on current *SUE* alone, the F-statistic of 78.32 is significant at the 0.001 level. Lagged *SUE*s contribute significantly to the explanatory power of the regression of returns on

Table 3
Relation between return at current earnings announcement and lagged (past) quarterly earnings, controlling for current earnings

Model: $CAR_{i,t} = k + \sum_{j=1}^{4} a_j SUE_{i,t-j}$

	k	a_0	a_1	a_2	a_3	a_4	Adj. R^2
Panel A: Full sample							
(n = 70728)	− 1.592	4.924	− 0.981	− 0.333	− 0.319	0.231	7.09%
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
F test: $a_{-1} = a_{-2} = a_{-3} = a_{-4} = 0$, $F(4, 63177) = 78.32$, p-value = 0.000							
Panel B: By firm size							
Small firms	− 2.727	8.191	− 1.557	− 0.645	− 0.340	0.843	10.08%
(n = 24480)	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	
Medium firms	− 1.622	4.481	− 0.811	− 0.176	− 0.435	0.281	7.42%
(n = 20894)	(0.00)	(0.00)	(0.00)	(0.16)	(0.00)	(0.02)	
Large firms	− 0.947	2.667	− 0.512	− 0.153	− 0.218	0.062	5.17%
(n = 25354)	(0.00)	(0.00)	(0.00)	(0.07)	(0.00)	(0.42)	

The definitions of all variables are identical to those in Bernard and Thomas (1990). $CAR_{i,t}$ is the sum of daily abnormal returns in the three days − 2 to 0 relative to the earnings announcement date (day 0) of firm i in quarter t. Daily abnormal returns are the differences between daily returns of firm i and the returns for NYSE–AMEX firms of the same size decile, based on January 1 market values of equity. $SUE_{i,t}$ is the forecast error of the ith firm for quarter t from a seasonal random walk with trend, scaled by its estimation-period standard deviation. *SUE* deciles are based on rankings within the calendar quarter of the announcement of quarter t earnings. In all regressions, the values of the *SUE* variables are replaced by their decile rankings and then scaled so that they range from 0 (for the lowest decile) to 1 (for the highest decile). Small, medium, and large firms are in size deciles 1 to 4, 5 to 7, and 8 to 10, respectively, based on January 1 market values of equity. All parameter estimates are multiplied by 100. P-values in parentheses.

current *SUE*, contrary to the hypothesis that investors ignore past earnings changes in forming expectations of current earnings.

Further, the coefficients on the four lagged *SUE* variables all have the predicted reversed (− , − , − , +) signs. Each is significant at the 1% level (t-statistics are − 12.86, − 4.34, − 4.17, and + 3.24). Each changes sign from the Bernard and Thomas (1990) regression, which does not control for current *SUE*. When the sample is stratified by firm size, twelve of the twelve signs (four lags for each of the three size groups) are consistent with investors being aware of the signs of the serial correlation in seasonally-differenced earnings. Thus, the evidence is consistent with investors being aware of both the *existence* and the *signs* of serial correlation for *all* of the four lags.

The *magnitudes* of the coefficients are consistent with the market systematically underestimating serial correlation in *SUE*s. For example, if investors fully incorporated the partial correlation between SUE_0 and SUE_{-1} in their expectation of SUE_0, then the coefficient on SUE_{-1} in Table 3 would be -2.181 ($-b_1\beta$, estimated as $-0.443*4.924$). The actual estimate is -0.981, which is 45% of the predicted value. Likewise, the coefficients for all four lagged *SUE*s are consistent with prices incorporating 45%, 50%, 119%, and 22% of the serial correlation at lags 1–4 respectively, in earnings expectations. Considering all lags together, the price response to current and past earnings is consistent with an approximately 50% underestimation of the magnitude of serial correlation in seasonally-differenced quarterly earnings.

Table 4 expresses these results in terms of point estimates of average partial correlations in *SUE*. For the full sample, the market acts as if using coefficients

Table 4
Serial correlation in seasonally-differenced quarterly earnings: Comparison of time-series estimates with estimates implied by market reaction to earnings

		Time-series estimate	Implied market estimate	Proportion
Panel A: Full sample				
Lag 1		0.443	0.199	45%
2		0.133	0.067	50
3		0.054	0.064	119
4		− 0.215	− 0.047	22
Panel B: By firm size				
Lag 1	Small firms	0.408	0.190	47%
2		0.123	0.078	63
3		0.059	0.041	69
4		− 0.204	− 0.102	50
Lag 1	Medium firms	0.454	0.181	40%
2		0.142	0.039	27
3		0.055	0.097	176
4		− 0.208	− 0.062	30
Lag 1	Large firms	0.461	0.192	42%
2		0.130	0.057	44
3		0.044	0.081	184
4		− 0.183	− 0.023	13

All correlations are point-estimates of partial correlations from pooled regressions. Time-series estimates are regression slopes (b_1, b_2, b_3, b_4) from Table 1. Implied market estimates are ratios of regression slopes for lagged *SUE* relative to regression slopes for current *SUE* (a_1/a_0, a_2/a_0, a_3/a_0, a_4/a_0) from Table 3. Proportion is implied market estimate as a percentage of time-series estimate. Small, medium, and large firms are in size deciles 1 to 4, 5 to 7, and 8 to 10, respectively, based on January 1 market values of equity.

of + 0.20, + 0.07, + 0.06 and − 0.05 at lags 1–4, compared with the equivalent time-series estimates of + 0.44, + 0.13, + 0.05, and − 0.22 from Table 1. Overall, the evidence is consistent with the market being aware of the existence and sign pattern of serial correlation, but underestimating its magnitude (i.e., underestimating the sizes of the correlation coefficients).

5.3. Reconciliation with prior results

The regressions reported in Tables 2 and 3 have a common dependent variable, abnormal return at the time of the current earnings announcement, but they have different objectives and thus different independent variables. The Table 2 replication of the Bernard and Thomas (1990) regression does not control for current earnings, and shows that the market does not fully exploit past earnings information. Conversely, the Table 3 regression controls for current earnings, and shows that the market does not fully ignore past earnings information.

The two approaches are easily reconciled, because the Bernard and Thomas (1990, Table 5) regression, as replicated in our Table 2, is a direct implication of the regressions reported in our Tables 1 and 3.[9] Table 3 shows that the price reaction to current and lagged earnings for the average firm/quarter is

$$CAR_0 = -1.592 + 4.924 * SUE_0 - 0.981 * SUE_{-1} - 0.333 * SUE_{-2} - 0.319 * SUE_{-3} + 0.231 * SUE_{-4} + \omega_0 .$$

Table 1 shows that

$$SUE_0 = 0.291 + 0.443 * SUE_{-1} + 0.133 * SUE_{-2} + 0.054 * SUE_{-3} - 0.215 * SUE_{-4} + \varepsilon_0 .$$

where ε_0 is independent of lagged *SUE*s by construction. By simple substitution, these two equations imply

$$CAR_0 = -0.159 + 1.200 * SUE_{-1} + 0.321 * SUE_{-2} - 0.053 * SUE_{-3} - 0.827 * SUE_{-4} + \varepsilon_0' ,$$

where $\varepsilon_0' = 4.924 * \varepsilon_0 + \omega_0$ is independent of the four lagged *SUE*s. With rounding error, this is the central Bernard and Thomas result, as replicated in our Table 2.

[9] However, the reverse is not possible, which is the principal reason that the Bernard and Thomas (1990) results do not imply an estimate of the extent to which the market *does* seem aware of serial correlation. A subsidiary reason is that they appear to report simple, not partial, serial correlation coefficients in their equivalent of our Table 1.

5.4. Size effects

It is well-known that the relation between earnings and stock prices is a function of size (Atiase, 1985; Freeman, 1987). Thus, in Bernard and Thomas (1990, Table 6) and in our results (Tables 2 and 3), the coefficients on *SUE*s and the regression R^2s decrease with the size grouping.[10] Two other results are more of interest. First, in Table 4 the closeness of the serial correlation implied by the market's reaction to earnings to the time-series estimate decreases with size. This is particularly the case at lags 1, 2 ,and 4 (lag 3 contains little information about future earnings). Second, the sample selection bias is particularly severe for small firms: while they are sampled from the bottom 40% of firms, they comprise only 34.6% of the firm/years in the sample. In contrast, medium and large firms are sampled from only 30% of the population, but comprise 29.5% and 35.8% of the firm/years, respectively.

6. Interpretation of results

As noted earlier, an attractive feature of Rendleman et al. (1987) and Bernard and Thomas (1990) is that a refutable hypothesis is proposed and tested as an alternative to market efficiency. In this section, we discuss what the alternative theory must look like to accommodate our finding that investors act as if aware of the existence and sign pattern of serial correlation in seasonally-differenced quarterly earnings, but also as if underestimating its magnitude.

Bernard and Thomas (1990, p. 307) refer to 'the possibility that market prices can be modeled partially as reflections of naive expectations'. If 'partial' is interpreted as meaning systematic underestimation of serial correlation magnitudes, to be consistent with our results, then this alternative hypothesis requires investors to be: (1) aware of random walks in earnings; (2) aware of seasonals in earnings; (3) aware of both the existence and the (+ , + , + , −) sign pattern of the correlation in seasonally-differenced earnings across adjacent calendar quarters; but (4) unaware that they systematically underestimate the correlation. We discuss each attribute in turn.

1. Aware of random walks in earnings. The alternative hypothesis has investors employing a random-walk model for quarterly earnings. One does not employ seasonal random-walk expectation models for (say) the daily temperature; one typically bases forecasts on the average historical temperature for the day, not the temperature on the same day last year, thereby seasonally adjusting a mean-reverting process. In the case of *annual* earnings, a random walk would

[10] The statistics are estimated from a single pooled regression for each size group, and thus reflect within-group dispersion.

be a well-informed choice (Ball and Watts, 1972), and there is evidence of its widespread use. For example, the practice of calculating P/E as the ratio of price to the most recent annual earnings observation is consistent with random walks in earnings, but not with other basic time-series models. A mean-reverting process would imply calculating the ratio of price to an average of past years' earnings. Common practice was approximately consistent with the actual time-series behavior of annual earnings well before Ball and Watts (1972) reported that annual earnings do approximate a random walk. Further evidence is provided by the literature on the magnitude of stock-price responses to reported earnings. A random-walk model implies that the amount of price change is a multiple of the amount of change in earnings per share, whereas a mean-reverting process implies that earnings and price changes are approximately the same in magnitude (Ball and Watts, 1972, pp. 665–666). Kothari and Sloan (1992) report that the price response to earnings is a multiple of earnings, consistent with awareness of random-walk earnings processes.[11]

2. *Aware of seasonal.* Quarterly earnings exhibit obvious seasonal behavior. The alternative hypothesis assumes investors allow for seasonals when forming earnings expectations.

3. *Aware of existence and form of serial correlation.* The original hypothesis of Rendleman et al. (1987), that investors use a 'naive' seasonal random-walk expectation model for quarterly earnings, assumes that investors regard the evolution of earnings in each of the four fiscal quarters as independent of its evolution in the other three quarters. Each quarter's earnings is assumed to take its own random walk, evolving as the accumulation of past earnings innovations *in that fiscal quarter alone*. The levels of the four quarterly series diverge over time, as each random-walk accumulates its own annual innovations. The firm effectively is viewed as four separate entities with four separate earnings processes, which in our view is an implausible model of investor behavior ('naive' or otherwise).[12] To accommodate our findings, this model must be modified to allow investors who, while presumably unaware of the language of serial correlation, nevertheless *act as if* aware of the (+ + + −) error pattern in the model's forecasts.

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[11] For a random walk, price change is a $(1 + 1/r)$ multiple of earnings change, where r is the interest rate. Kothari and Sloan (1992) estimate the mean multiple as 5.45 and argue that the appropriate $(1 + 1/r)$ is approximately 7–8.

[12] For example, at lag 1 the model assumes that change in a quarter's earnings (relative to the previous year) implies *absolutely nothing* about the next quarter's earnings (relative to the previous year). A precipitous fall in 1995.Q2 sales relative to 1994.Q2 is ignored in forming expectations for 1995.Q3 earnings. The inherent implausibility of the seasonal random walk model is one reason for our view that the *SUE* variable is misnamed.

4. But systematically underestimate the magnitude of dependence. For the 'partially naive investors' hypothesis to explain our results, investors in general must systematically underestimate the magnitude of the serial correlation in a seasonal random-walk model's prediction errors. Why not *over*estimate systematically? Or have unbiased but inefficient assessments of the magnitude (underestimation for some firms and some investors, but overestimation for other firms and investors)? What theory predicts systematic underestimation, for firms and investors in general, consistently over time (at least, in every year studied by Bernard and Thomas, 1990)?

One theory is that investors systematically *over*react to news, and thus prices exhibit subsequent corrections.[13] In his review of the relevant literature, Thaler (1993, p. xix) states:

> DeBondt and I were familiar with the work of Daniel Kahneman and Amos Tversky which showed that people have a tendency to make predictions that are not sufficiently regressive. That is, rather than being proper Bayesian decision makers, people tend to overweight recent information and underweight long-term tendencies (prior odds).

This theory is difficult to reconcile with post-earnings-announcement 'drift'. Thaler (1993, p. xix) acknowledges this when he refers to 'the apparent underreaction of stock prices to earnings announcements' as 'a seemingly contrary set of results'.[14]

Nor is it easy to reconcile the DeBondt and Thaler (1985, 1987) theory, that investors systematically overreact to the most recent information and then correct their mistakes, with evidence that investors systematically underestimate positive serial correlation at lags 1 and 2. Their theory implies price reversals, not continuations. Any reconciliation attempt would require a theory with three phases of investor behavior, in the following sequence: (1) underreaction to earnings information in the short term (approximately six months); (2) overreaction in the medium term; and then (3) long-term correction of the medium-term overreaction.

Bernard and Thomas (1990, p. 307) propose that investors 'anchor' on the earnings of the equivalent quarter in the previous year. 'Anchoring' is

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[13]See DeBondt and Thaler (1985, 1987), Chopra, Lakonishok, and Ritter (1992), Ball and Kothari (1989), Ball, Kothari, and Shanken (1995), and Kaul and Nimalendran (1990).

[14]Shiller's (e.g., 1981,1989) theory is that the market overreacts to information at the aggregate level, with the stock index therefore exhibiting excess volatility. Seemingly-unaware of the evidence on post-earnings-announcement drift, he concludes (1989, p. 426): 'price overreacts to current [index-level] dividends. ... . Price might also be described as overreacting to current earnings.' Bernard (1993, Ch.11) argues that price overreactions to information generally are logically consistent with price underreactions to quarterly earnings.

underreacting to recent information and overweighting older information.[15] As a theory of investor use of information generally, anchoring seems inconsistent with the theory and evidence of DeBondt and Thaler. Further, the theory does not explain why investors would 'anchor' on earnings reported as far back as four quarters ago, ignoring the intervening three quarters. Why don't investors anchor on the most recent quarter's earnings? Nor does the theory explain why investors use random-walk models, as distinct from anchoring on some average of past year's earnings.

In support of their hypothesis, Bernard and Thomas (1990, p. 307, cited in Section 2 above) state that anchoring on a comparison with earnings four quarters earlier is a feature of the financial press generally, and of the Digest of Earnings Reports in the *Wall Street Journal* in particular. We doubt that this institutional feature explains the results, for several reasons. First, there are many competing reporting institutions, and no single institution sets market prices. For example, *Value Line*'s digests commonly report the past four years of quarterly earnings, thus providing data for much more than the three lags in question and not anchoring on a single-quarter comparison. Second, even the *Wall Street Journal* does not restrict itself to a comparison with the equivalent quarter last year. Its practice is to report a comparison of total earnings in the company's fiscal year to date (YTD) with the equivalent YTD total last year, along with the comparison of earnings this quarter with the equivalent quarter last year.[16] Only in the company's first fiscal quarter of the year does this practice 'anchor' on earnings four quarters previously. Third, because the *Journal*'s YTD figure gives information about more lags in the later quarters of the fiscal year, we can test whether its reporting practices have any effect on the market's incorporation of lagged *SUE*s into prices. The *Journal*'s practice in the fourth fiscal quarter is to report a comparison of total fiscal-year earnings with the equivalent in the previous year, so the information in SUE_{-1}, SUE_{-2}, and SUE_{-3} is reported alongside SUE_0, thus providing a test of whether its practice in other quarters misleads investors to ignore serial correlation at those lags. Our results (unreported) imply otherwise: we find no discernable difference between the fourth quarter and other quarters in the market's use of lagged *SUE*s in forming expectations. We conclude that the data are inconsistent with this institutional version of the anchoring hypothesis.

Hand (1990) hypothesizes that 'unsophisticated' investors are more likely to invest in stocks with lower capitalization or a lower proportion of institutional investors (size and institutional following are highly correlated). This hypothesis

[15]See Libby (1981).

[16]This is the practice for NYSE–AMEX stocks. For example, in the Digest of Earnings on 27 October 1995, 272 of 301 announcements had a comparison of year-to-date (YTD) earnings with the previous YTD. Of the 29 missing a YTD comparison, 23 were NASDAQ firms.

predicts that small stocks are most likely to behave as if investors are unaware of the serial correlation in their *SUE*s. However, we earlier noted the Table 4 result that the opposite tends to occur. The small-firm group incorporates the *largest* proportion of the serial correlation into its implied earnings expectation.

In our view, the evidence remains anomalous, that is difficult to reconcile with any refutable theory. To accommodate all of the results, including our evidence that the market acts as if aware of, but also as if underestimating, the serial correlation in seasonally-differenced quarterly earnings, the combination of hypothesized investor behaviors required seems likely to be *ad hoc*. Our results do not contradict the predictability of estimated abnormal returns at future earnings announcements (Bernard and Thomas, 1990). Our results do change the tenor of the anomaly, because they rule out theories in which investors act as if naively unaware of the principal attributes of earnings behavior. They direct attention toward possible biases in investors' assessments of serial correlation magnitudes, or alternatively to biases in researchers' assessments of the ability of earnings to predict abnormal returns (such as sample selection bias).

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