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Forecasting Profitability and Earnings*

There is a strong presumption in economics that, in a competitive environment, profitability is mean reverting. We provide corroborating evidence. In a simple partial adjustment model, the estimated rate of mean reversion is about 38% per year. But a simple partial adjustment model with a uniform rate of mean reversion misses rich nonlinear patterns in the behavior of profitability. Specifically, we find that mean reversion is faster when profitability is below its mean and when it is further from its mean in either direction. We also show that the mean reversion in profitability produces predictable variation in earnings.

There is a strong presumption in economics that profitability is mean reverting. For example, Stigler (1963, p. 54) states, "There is no more important proposition in economic theory than that, under competition, the rate of return on investment tends toward equality in all industries. Entrepreneurs will seek to leave relatively unprofitable industries and enter relatively profitable industries."

These standard economic arguments imply that, in a competitive environment, profitability is mean reverting within as well as across industries. Other firms eventually mimic innovative products and technologies that produce above normal profitability for a firm. And the prospect of failure or takeover gives firms with low profitability incentives to allocate assets to more productive uses.

Mean reversion in profitability implies that changes in profitability and earnings are to some extent predictable. There is a large literature, mostly in accounting, that attempts to identify predictable variation in earnings and (less commonly) profitability. The evidence is, however, difficult to judge for three reasons.

i) Some early studies that produce tantalizing

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suggestions of predictability provide no formal tests (e.g., Beaver 1970; Brooks and Buckmaster 1976; and Lookabill 1976).

ii) When formal tests are provided, they are often based on time-series models fit separately to individual firms. To enhance power, the tests are restricted to firms with long earnings histories; requiring 20 years of data is common. One problem in this approach is survivor bias. The behavior of profitability and earnings for long-term survivors may not be representative. Moreover, although 20 years is a long period in a firm's life, 20 observations on annual earnings produce imprecise estimates of a time-series model. As a result, evidence that suggests economically interesting predictability is typically statistically weak (e.g., Lev 1969; Freeman, Ohlson, and Penman 1982).

iii) Cross-section regressions of changes in profitability or earnings on lagged changes and other variables can use large samples of firms and minimal survival requirements to test for predictability. Such tests can thus provide power with little survivor bias. Previous cross-section tests indeed seem to produce more reliable evidence of predictability (Freeman et al 1982; Collins and Kothari 1989; Easton and Zmijewski 1989; Ou and Penman 1989; Elgers and Lo 1994; Basu 1997). But except for Elgers and Lo (1994), the standard errors of the regression slopes in these cross-section tests are not adjusted for the correlation of regression residuals across firms. In effect, the standard errors use the patently unrealistic assumption that there is no correlation across firms in current changes in profitability and earnings (due, e.g., to current macroeconomic or industry shocks) beyond that absorbed by lagged predictor variables.

We take a different tack that preserves the power of the cross-section tests but produces inferences that allow for residual cross-correlation. In the spirit of Fama and MacBeth (1973), we forecast profitability and earnings with year-by-year cross-section regressions, and we use the average slopes and their time-series standard errors to draw inferences. This approach allows us to use large samples, an average of 2,343 firms per year. And the year-by-year variation in the slopes, which determines the standard errors of the average slopes, includes the effects of estimation error due to the correlation of the residuals across firms.

Allowing for residual cross-correlation is important. The average slopes from our year-by-year cross-section regressions are essentially equivalent to the slopes from pooled time-series cross-section regressions that include annual dummies to allow the average values of the variables to change through time. Pooled time-series cross-section regressions are a common choice for solving the power problem in time-series tests on individual firms (e.g., Freeman et al. 1982; Fairfield, Sweeney, and Yohn 1996). And the inference problem created by residual cross-correlation is typically ignored. Without showing the details, the Fama-MacBeth standard errors of our average regression slopes (which account for residual cross-correlation) are typically two to five times the ordinary least squares (OLS) standard errors from pooled time-series cross-section regressions.

Accurate inferences are important, but our main contribution is substantive. Confirming standard economic arguments, we find strong evidence that profitability (measured as the ratio of year t earnings before interest to total book assets, Y_t/A_t) is mean reverting. In a simple partial adjustment model, the rate of mean reversion is about 38% per year. But a simple partial adjustment model with a uniform rate of mean reversion does not do justice to the rich patterns in the behavior of profitability. Specifically, we find that the rate of mean reversion is higher when profitability is far from its mean, in either direction. The rate of mean reversion is also higher when profitability is below its mean.

Like changes in profitability, changes in earnings are predictable. When we restrict the explanatory variables to lagged earnings changes, we confirm the early qualitative evidence of Brooks and Buckmaster (1976) that changes in earnings tend to reverse from one year to the next, and large changes of either sign reverse faster than small changes. We also confirm the formal evidence of Elgers and Lo (1994) that negative changes in earnings reverse faster than positive changes.

For the most part, the existing literature does not examine the links between the predictability of profitability and the predictability of earnings. This is true even in the rare papers that examine both variables (e.g., Beaver 1970; Ball and Watts 1972). In contrast, like Freeman et al. (1982) and Lev (1983), our hypothesis is that much of what is predictable about earnings is due to the mean reversion of profitability. Our tests confirm the hypothesis. Our results thus imply that real-world forecasts of earnings (e.g., by security analysts) should incorporate the mean reversion in profitability. There is, however, predictable variation in earnings beyond that captured by our profitability model. Negative changes in earnings and extreme changes reverse faster than predicted by our nonlinear model for profitability.

We begin (Sec. I) with estimates of a simple partial adjustment model for profitability in which the rate of mean reversion is a constant, that is, it does not depend on how profitability deviates from its expected value. Section II fine-tunes the model to allow for nonlinear mean reversion. Section III tests for predictable changes in earnings. Section IV concludes.

I. A First-Pass Partial Adjustment Model for Profitability

As a first test for predictable variation in profitability, we estimate, for each year t from 1964 to 1995, a simple cross-section partial adjustment regression for the change in profitability from t to $t + 1$:

$$Y_{t+1}A_{t+1} - Y_t/A_t = a + b[Y_t/A_t - E(Y_t/A_t)] + c[Y_t/A_t - Y_{t-1}/A_{t-1}] + e_{t+1}, \quad (1a)$$

$$CP_{t+1} = a + b DFE_t + c CP_t + e_{t+1}. \quad (1b)$$

A_t is a firm's total book assets at the end of year t; Y_t is earnings before interest and extraordinary items but after taxes; Y_t/A_t is our measure of profitability; $E(Y_t/A_t)$ is its expected value; $CP_t = Y_t/A_t - Y_{t-1}/A_{t-1}$ is the change in profitability from $t - 1$ to t; and $DFE_t = Y_t/A_t - E(Y_t/A_t)$ is the deviation of profitability from its expected value. To simplify the notation, we omit the firm subscript that should appear on the regression variables and residuals and the year subscript that should appear on the regression coefficients.

We use a two-step approach to estimate (1). Each year t, we regress Y_t/A_t for the firms in our sample on variables meant to capture differences across firms in expected profitability. We then use the fitted values from this first-stage regression as the proxy for $E(Y_t/A_t)$ in the cross-section estimate of (1) for year t.

We use three variables to explain expected profitability in the first-stage regressions. (i) An old hypothesis is that dividends have information about expected earnings because firms target dividends to the permanent component of earnings (Miller and Modigliani 1961). Thus one of our proxies for expected profitability is D_t/BE_t, the ratio of year t dividends to the book value of common equity at the end of the year. (ii) Fama and French (1999) find that firms that do not pay dividends tend to be much less profitable than dividend payers. To capture any resulting nonlinearity in the relation between dividends and expected profitability, our second variable is a dummy, DD_t, that is 0.0 for dividend payers and 1.0 for nonpayers. (iii) Since the market value of a firm, V_t, is the current value of all future net cash flows, we use the market-to-book ratio, V_t/A_t, to pick up variation in expected profitability missed by the dividend variables. (Additional proxies for expected profitability tried but dropped for lack of explanatory power include the log of total assets [a measure of size] and the ratio of depreciation expense to total assets [a measure of capital intensity].) The proxy for expected profitability, $E(Y_t/A_t)$, in (1) is then the fitted value from the cross-section regression

$$Y_t/A_t = d_0 + d_1 V_t/A_t + d_2 DD_t + d_3 D_t/BE_t + \epsilon_t. \quad (2)$$

The tests exclude financial firms and utilities. Financial firms and utilities are highly regulated during much of our sample period, and regulation may produce unusual behavior of profitability. Otherwise it seems reasonable to expect that the explanatory variables in (2) do a good job capturing differences in expected profitability across industries as well as across firms. More extensive tests for industry effects would, of course, also be reasonable. They are left to future work.

We are concerned that influential observations might dominate the regressions. The variables in (1) and (2) are scaled by assets or book equity. This can create influential observations when A_t and BE_t are close to zero. To address this problem, we do not use firms with less than \$10 million in assets or \$5 million in book equity. These exclusions still leave us with hefty cross sections, an average of 2,343 firms per year.

We use the average slopes and the time-series standard errors of the average slopes in (1) and (2) to draw inferences. A benefit of this approach is that the standard errors of the average slopes include estimation error due to the correlation of the regression residuals across firms. Autocorrelation in the slopes from the year-by-year regressions is also a problem. The higher-order autocorrelations are random about zero, but first-order autocorrelations are sometimes large, around 0.5. We could adjust the standard errors of the average slopes for the estimated autocorrelation of the annual slopes. But with just 33 observations on the slopes for 1964–96, autocorrelation estimates are imprecise; the standard errors are around 0.18. We use a less formal approach to allow for the autocorrelation of the annual regression slopes. With first-order autocorrelations around 0.5, the variances of the average slopes, calculated assuming serial independence of the annual slopes, are too small by about 50%, and the standard errors of the average slopes should be inflated by 40%. Thus we require t-statistics around 2.8, rather than the usual 2.0, to infer reliability.[1]

Part A of table 1 shows average slopes from the first-stage regressions of Y_t/A_t on V_t/A_t, DD_t, and D_t/BE_t. All three variables have information about expected profitability, $E(Y_t/A_t)$. The positive average slope on D_t/BE_t is 8.61 standard errors from zero. The negative average slope on DD_t confirms that the relation between profitability and dividends is nonlinear; the expected profitability of firms that do not pay dividends is 0.026 lower ($t = -8.58$) than predicted by the relation

1. Elgers and Lo (1994) use annual cross-section regressions to model the autocorrelation of changes in earnings. Like us, they use the time-series standard errors of average regression slopes to allow for the correlation of residuals across firms. But they do not adjust the standard errors of the average slopes for the autocorrelation of the annual slopes. And they examine a much narrower range of models for the predictability of earnings.

TABLE 1 Regressions to Explain the Level of and Change in Profitability: 1964–96, 33 Years

A. Regressions to Explain the Level of Profitability, Y_t/A_t

1. Means and t-Statistics for the Means of the Year-by-Year Regression Coefficients

	Int	V_t/A_t	DD_t	D_t/BE_t	R^2
Mean	.047	.024	−.026	.19	.24
t(Mn)	22.066	10.224	−8.584	8.61	8.28

2. Means and Standard Deviations of the Regression Variables

	Y_t/A_t	V_t/A_t	DD_t	D_t/BE_t
Mean	.075	1.461	.339	.031
SD	.075	.977	.441	.059

B. Regressions to Explain the Change in Profitability, $CP_{t+1} = Y_{t+1}/A_{t+1} - Y_t/A_t$

1. Means and t-Statistics for the Means of the Year-by-Year Regression Coefficients

	Int	Y_t/A_t	$E(Y_t/A_t)$	$NDFE_t$	$SNDFE_t$	$SPDFE_t$	CP_t	NCP_t	$SNCP_t$	$SPCP_t$	R^2
Mean	−.003	−.39	.37				−.09				.21
t(Mn)	−1.400	−17.39	13.97				−5.01				8.60
Mean	.016	−.30					−.13				.18
t(Mn)	7.378	−14.30					−7.61				7.81

Mean	−.007						−.30				.10
t(Mn)	−4.221						−11.25				5.18
Mean	−.011						−.08	−.11	1.55	−.22	.15
t(Mn)	−5.389						−2.40	−1.61	5.46	−1.23	6.22
Mean	−.006	−.14	.14	−.12	.99	−1.91	−.04	.03	.55	−.19	.24
t(Mn)	−2.493	−5.17	5.15	−2.54	4.61	−6.05	−1.32	.56	3.52	−1.13	9.61

2. Means and Standard Deviations of the Regression Variables

	CP_{t+1}	Y_t/A_t	$E(Y_t/A_t)$	$NDFE_t$	$SNDFE_t$	$SPDFE_t$	CP_t	NCP_t	$SNCP_t$	$SPCP_t$
Mean	−.005	.075	.075	−.020	.004	.002	−.004	−.020	.004	.003
SD	.074	.075	.030	.051	.037	.030	.069	.047	.056	.045

NOTE.—The regressions are run for each year t, from 1964 to 1996, using NYSE, AMEX, and NASDAQ firms on Compustat with data for the year on all variables in any regression and with total assets greater than \$10 million and book common equity greater than \$5 million. The table shows means (across years) of regression intercepts (Int) and slopes, and t-statistics for the means t(Mn), defined as the mean divided by its standard error (times-series standard deviation of the coefficient divided by $(33)^{1/2}$). The table also shows averages (across years) of the means and standard deviations (SD) of the regression variables. The variables (and Compustat data items) are as follows. A_t is total book assets (6). D_t is dividends paid during fiscal year t (21). DD_t is a dummy that is 1.0 when dividends are zero and zero otherwise. Y_t is earnings before extraordinary items (18), plus interest expense (15), plus (when available) income statement deferred taxes (50) and investment tax credit (51). Book common equity, BE_t, is A_t minus liabilities (181) minus preferred stock (taken to be, in order and as available, redemption value [56], liquidating value [10], or par value [130]), plus balance sheet deferred taxes and investment tax credit (35) V_t, the total value of the firm, is its common stock price (199) times shares outstanding at the end of fiscal year t (25), plus A_t minus BE_t. $E(Y_t/A_t)$, the proxy for expected profitability, is the fitted value from the profitability regression for year t, summarized in part A. DFE_t is $Y_t/A_t - E(Y_t/A_t)$. $NDFE_t$ is DFE_t when DFE_t is negative and zero otherwise. $SNDFE_t$ is the square of DFE_t when DFE_t is negative and zero otherwise. $SPDFE_t$ is the square of DFE_t when DFE_t is positive and zero otherwise. CP_t is $Y_t/A_t - Y_{t-1}/A_{t-1}$. NCP_t is CP_t when CP_t is negative and zero otherwise. $SNCP_t$ is the square of CP_t when CP_t is negative and zero otherwise. $SPCP_t$ is the square of CP_t when CP_t is positive and zero otherwise.

between Y_t/A_t and D_t/BE_t. The strong positive average slope on V_t/A_t ($t = 10.22$) is consistent with the hypothesis that the market-to-book ratio (a proxy for Tobin's Q) captures variation in expected profitability missed by the dividend variables.

Part B of table 1 shows average slopes from second-stage estimates of the partial-adjustment model (1) that do not constrain the slopes on expected profitability, $E(Y_t/A_t)$, and observed profitability, Y_t/A_t. The partial-adjustment model predicts that the Y_t/A_t slope is negative, the $E(Y_t/A_t)$ slope is positive, and (if $E(Y_t/A_t)$ is measured with relatively little error) the two slopes are equal in absolute value. The average Y_t/A_t and $E(Y_t/A_t)$ slopes, -0.39 and 0.37, confirm these predictions. These average slopes are also quite precise (-17.39 and 13.97 standard errors from zero). All this is striking evidence that profitability is mean reverting.

The lagged change in profitability, $CP_t = Y_t/A_t - Y_{t-1}/A_{t-1}$, is included as an explanatory variable in (1) to test whether the mean reversion captured by the partial adjustment term, $DFE_t = Y_t/A_t - E(Y_t/A_t)$, is the sole source of predictable variation in profitability. Table 1 shows that, when the lagged change in profitability, CP_t, is used alone to explain CP_{t+1}, the slope on CP_t is strongly negative; on average, the change in profitability from t to $t + 1$ reverses 30% ($t = -11.25$) of the lagged change. But allowing for mean reversion, that is, including Y_t/A_t and $E(Y_t/A_t)$ in the regression, moves the CP_t slope close to zero, -0.09. Still, the average CP_t slope is -5.01 standard errors from zero. Thus there is small but statistically reliable negative autocorrelation in changes in profitability beyond what can explained by the partial adjustment term.

It is worth nothing that the evidence that the change in profitability is predictable from the lagged change is testimony to the power of the cross-section regressions. In a typical time-series test using 20 years of annual changes, the standard error of the autocorrelation of successive changes is about 0.23. Thus, a coefficient of -0.30, which is -11.25 standard errors from zero in the cross-section regressions, would be 1.30 standard errors from zero in a time-series regression with 20 observations. This is the generic power problem in tests that attempt to identify predictable variation in profitability (or earnings) using time-series models to fit individual firms.

Our estimate of the rate of mean reversion of profitability, in the neighborhood of 0.38 (38% per year) is similar to the median of the estimates for individual firms in Lev (1969). He fits separate partial adjustment models to 20 years of time-series data for individual firms. The resulting estimates of the rate of mean reversion are imprecise; the median is only 1.71 standard errors from zero. The cross-section partial adjustment regressions in Fairfield et al. (1996) also produces rates of mean reversion near 0.38. But they test the reliability of the estimates with out-of-sample forecasts that do not adjust for the correlation of the forecast errors across firms. We corroborate these earlier estimates, but with more precise methods.

Finally, simple economic stories say that competitive forces push profitability toward a common economy-wide mean. In the partial adjustment model (1), however, we allow $E(Y_t/A_t)$ to vary across firms. Cross-sectional differences in expected profitability can occur for several reasons. First, even with perfect competition, differences in risk produce differences in expected profitability. Second, our profitability measure, Y_t/A_t, is a noisy proxy for true economic profitability. For example, even if all firms share the same true expected profitability, systematic differences between the historical and replacement costs of assets create systematic differences in $E(Y_t/A_t)$. Third, differences in expected profitability can be the result of monopoly rents.

How do the estimates of (1) change if we assume all firms revert toward one overall equilibrium level of expected profitability? With this assumption, the partial adjustment model in (1a) simplifies to

$$Y_{t+1}/A_{t+1} - Y_t/A_t = a + bY_t/A_t + c(Y_t/A_t - Y_{t-1}/A_{t-1}) + e_{t+1}, \quad (3)$$

and profitability reverts to the grand mean at the rate $-b$. Table 1 shows that the estimated rate of mean reversion from (3) is 30% per year (t = 14.30). The higher rate of mean reversion produced by (1) then suggests that (2) captures meaningful differences across firms in expected profitability.

II. A Nonlinear Partial-Adjustment Model for Profitability

Though they attempt no formal inferences, Brooks and Buckmaster (1976) present evidence that changes in earnings are likely to reverse from one year to the next, the reversals are stronger for extreme changes of either sign, and they are stronger for negative changes. Elgers and Lo (1994) formally confirm the last result. These papers focus on changes in earnings. Given our hypothesis that the predictability of earnings should be largely due to mean reversion in profitability, it is interesting to test whether there is similar nonlinearity in the behavior of profitability. To this end, we expand the partial adjustment model (eq. [1]) as

$$\begin{aligned} CP_{t+1} = {} & a + (b_1 + b_2 NDFED_t + b_3 NDFED_t * DFE_t \\ & \quad + b_4 PDFED_t * DFE_t) DFE_t \\ & + (c_1 + c_2 NCPD_t + c_3 NCPD_t * CP_t \\ & + c_4 PCPD_t * CP_t) CP_t + e_{t+1}, \end{aligned} \quad (4a)$$

$$\begin{aligned} = {} & a + b_1 DFE_t + b_2 NDFE_t + b_3 SNDFE_t + b_4 SPDFE_t \\ & + c_1 CP_t + c_2 NCP_t + c_3 \, SNCP_t + c_4 SPCP_t + e_{t+1}. \end{aligned} \quad (4b)$$

$NDFED_t$, $PDFED_t$, $NCPD_t$, and $PCPD_t$ are dummy variables. $NDFED_t$ is 1.0 when DFE_t (the deviation of profitability from its expected value) is negative, and zero otherwise; $PDFED_t$ is 1.0 when DFE_t is positive; $NCPD_t$ is 1.0 when CP_t (the change in profitability from $t - 1$ to t) is negative; $PCPD_t$ is 1.0 when CP_t is positive. The derived variables in (4b) are negative deviations of profitability from its expected value ($NDFE_t$), squared negative deviations ($SNDFE_t$), squared positive deviations ($SPDFE_t$), negative changes in profitability (NCP_t), squared negative changes ($SNCP_t$), and squared positive changes ($SPCP_t$). In brief, b_2, b_3, and b_4 measure nonlinearity in the mean reversion of profitability, that is, in the speed of adjustment of profitability to its expected value. And c_2, c_3, and c_4 measure nonlinearity in the autocorrelation of changes in profitability.

Table 1 suggests that there is nonlinearity in the autocorrelation of changes in profitability similar to that observed by Brooks and Buckmaster (1976) and Elgers and Lo (1994) for changes in earnings. When we estimate (4b) without the mean reversion variables (i.e., suppressing b_1 to b_4), we find that changes in profitability tend to reverse (the CP_t slope is negative), negative changes tend to reverse faster than positive changes (the NCP_t slope is negative), and reversal is stronger for more extreme changes (the $SNCP_t$ slope is positive, and the $SPCP_t$ slope is negative). But most of these results are statistically weak. Only the $SNCP_t$ slope breaks our 2.8 standard error barrier for reliability.

We are more interested in whether the autocorrelation of changes in profitability can be attributed to mean reversion in the level of profitability. Table 1 shows that when we add the mean reversion variables—that is, we estimate the full version of (4b)—the slopes c_1 to c_4 on the autocorrelation variables move toward zero, and c_1, c_2, and c_4 are less than 1.35 standard errors from zero. The slope c_3 on $SNCP_t$ falls by about two-thirds in the full regression, but it is 3.52 standard errors from zero.

In the end, nonlinear mean reversion is a fairly complete story for the predictable variation in profitability. Allowing for nonlinearity pushes the slopes on Y_t/A_t and $E(Y_t/A_t)$ (the two components of the linear partial adjustment term, DFE_t) toward zero, but they remain opposite in sign, strikingly close in absolute value (−0.14 and 0.14), and more than five standard errors from zero. And the rate of mean reversion is highly nonlinear. Mean reversion is stronger when profitability is below its mean; the slope on $NDFE_t$ is −0.12 ($t = -2.54$). Mean reversion is also stronger when profitability is further from its mean; the slopes on the quadratic terms $SNDFE_t$ and $SPDFE_t$, 0.99 and −1.91, are more than 4.6 standard errors from zero.

From an economic perspective, it is plausible that the rate of mean reversion is higher when profitability is below its mean and when it is far from its mean in either direction. When profitability is low, the prospect of failure or takeover gives firms an incentive to allocate assets to more productive uses. And the incentive is stronger the further profitability is below its mean. Conversely, the incentives of other firms to mimic the products and technologies of their rivals increase when the rivals are more profitable. It is also possible, however, that nonlinear mean reversion, and mean reversion itself, trace in part to accounting decisions. For example, Basu (1997) argues that bias toward conservative reporting leads firms to report losses quickly but to spread gains over longer periods. Such a tendency can help explain why profitability reverts more quickly when it is low.

III. Predicting Earnings

The existing predictability literature focuses primarily on earnings rather than profitability. Moreover, the literature is largely agnostic about the economic forces that cause earnings to be predictable. Notable exceptions are Freeman et al. (1982) and Lev (1983). They argue that competitive forces produce mean reversion in profitability, which is then the source of predictable variation in earnings. This is also the stance adopted here. We now examine whether changes in earnings are predictable and how much of the predictability traces to the nonlinear mean reversion of profitability.

Table 2 shows estimates of (4) in which the dependent variable is the (scaled) change in earnings, $\mathrm{CE}_{t+1} = (Y_{t+1}/Y_t)/A_t$, rather than the change in profitability, $\mathrm{CP}_{t+1} = Y_{t+1}/A_{t+1} - Y_t/A_t$. The new regression is

$$\begin{aligned}\mathrm{CE}_{t+1} = a &+ (b_1 + b_2\mathrm{NDFED}_t + b_3\mathrm{NDFED}_t * \mathrm{DFE}_t \\ &\quad + b_4\mathrm{PDFED}_t * \mathrm{DFE}_t)\mathrm{DFE}_t \\ &+ (c_1 + c_2\mathrm{NCED}_t + c_3\mathrm{NCED}_t * \mathrm{CP}_t \\ &+ c_4\mathrm{PCED}_t * \mathrm{CP}_t)\mathrm{CE}_t + e_{t+1}\end{aligned} \tag{5a}$$

$$\begin{aligned}= a &+ b_1\mathrm{DFE}_t + b_2\mathrm{NDFE}_t + b_3\mathrm{SNDFE}_t + b_4\mathrm{SPDFE}_t \\ &+ c_1\mathrm{CE}_t + c_2\mathrm{NCE}_t + c_3\,\mathrm{SNCE}_t + c_4\mathrm{SPCE}_t + e_{t+1}.\end{aligned} \tag{5b}$$

The explanatory variables in the first line of (5b) are those used in (4b) to capture the mean reversion of profitability. The new variables are in the second line of (5b). They are designed to pick up autocorrelation in earnings changes left unexplained by the mean reversion of profitability. NCED_t and PCED_t in (5a) are dummy variables. NCED_t is 1.0 when CE_t (the change in earnings from $t - 1$ to t) is negative and zero otherwise. PCED_t is 1.0 when CE_t is positive. The derived variables in the second line of (5b) are negative changes in earnings (NCE_t), squared negative changes (SNCE_t), and squared positive changes

TABLE 2 Regressions to Explain the Change in Earnings: 1964–96, 33 Years

A. Average Slopes for Regressions to Explain the Change in Earnings, $dY_{t+1}/A_t = (Y_{t+1} - Y_t)/A_t$

	Int	Y_t/A_t	$E(Y_t/A_t)$	$NDFE_t$	$SNDFE_t$	$SPDFE_t$	CE_t	NCE_t	$SNCE_t$	$SPCE_t$	R^2
Mean	.011						−.14				.05
t(Mn)	7.034						−4.53				3.97
Mean	.002						.03	−.47			.09
t(Mn)	1.352						.98	−8.77			6.12
Mean	−.000						.19	−.43	1.66	−.62	.12
t(Mn)	−.108						6.02	−8.00	4.28	−5.65	6.15
Mean	−.008	−.32	.46				.24	−.24	1.45	−.66	.18
t(Mn)	−3.429	−13.12	13.57				7.90	−5.42	4.16	−6.05	7.53
Mean	−.016	.06	.12	−.30	1.11	−2.21	.18	−.26	.50	−.48	.20
t(Mn)	−6.291	1.93	3.24	−5.09	4.06	−6.64	5.76	−6.19	1.55	−5.04	7.91

B. Means and Standard Deviations of the Regression Variables

	CE_{t+1}	Y_t/A_t	$E(Y_t/A_t)$	$NDFE_t$	$SNDFE_t$	$SPDFE_t$	CE_t	NCE_t	$SNCE_t$	$SPCE_t$
Mean	.010	.075	.075	−.020	.004	.002	.012	−.016	.003	.004
SD	.074	.075	.030	.051	.037	.030	.074	.042	.042	.053

NOTE.—The regressions are run for each year t, from 1964 to 1996, using NYSE, AMEX, and NASDAQ firms on Compustat with data for the year on all the variables in any regression. Part A of the table shows means (across years) of the regression intercepts (Int) and slopes, and t-statistics for the means t(Mn), defined as the mean divided by its standard error (the times-series standard deviation of the regression coefficient divided by $(33)^{1/2}$). Part B shows averages (across years) of the means and standard deviations (SD) of the regression variables. $E(Y_t/A_t)$, the proxy for expected profitability, is the fitted value from the profitability regression for year t, summarized in part A of table 1. DFE_t is $Y_t/A_t - E(Y_t/A_t)$. $NDFE_t$ is DFE_t when DFE_t is negative and zero otherwise. $SNDFE_t$ is the square of DFE_t when DFE_t is negative and zero otherwise. $SPDFE_t$ is the square of DFE_t when DFE_t is positive and zero otherwise. CE_t is $(Y_t - Y_{t-1})/A_{t-1}$. NCE_t is CE_t when CE_t is negative and zero otherwise. $SNCE_t$ is the square of CE_t when CE_t is negative and zero otherwise. $SPCE_t$ is the square of CE_t when CE_t is positive and zero otherwise.

($SPCE_t$). Thus, c_2, c_3, and c_4 are meant to pick up nonlinearity in the autocorrelation of changes in earnings.

Table 2 says that there is indeed nonlinearity in the autocorrelation of earnings changes. When we use only the lagged change, CE_t, to predict CE_{t+1}, the slope is -0.14. This corroborates time-series evidence (Beaver 1970; Ball and Watts 1972) that the linear autocorrelation of successive changes in earnings is weak; earnings seem to behave much like a random walk. In our cross-section tests, however, the -0.14 autocorrelation is -4.53 standard errors from zero. Thus, even with a linear model, we can confidently conclude that earnings do not follow a random walk. When we add negative changes in earnings to the linear model, the slope on CE_t turns slightly positive, but the NCE_t slope is strongly negative, -0.47 ($t = -8.77$). This is in line with the evidence in Elgers and Lo (1994) that the tendency of earnings changes to reverse is more reliable for negative changes. But our tests also say that reversal is stronger for more extreme earnings changes of either sign. When we added squared positive and negative changes in earnings ($SPCE_t$ and $SNCE_t$) to the regressions that include CE_t and NCE_t, the slope on NCE_t remains strongly negative (-0.43, $t = -8.00$), and the $SNCE_t$ and $SPCE_t$ slopes, 1.66 and -0.62, are 4.28 and -5.65 standard errors from zero.

In short, there is a rich nonlinear pattern in the autocorrelation of successive changes in earnings. The reversal tendency of earnings changes is stronger for more extreme changes of either sign. And reversal is stronger when earnings have declined. All of this is formal corroboration of the early informal evidence on the predictability of earnings in Brooks and Buckmaster (1976).

We are interested in whether the autocorrelation of earnings changes can be attributed in whole or in part to nonlinar mean reversion in the level of profitability. Table 2 shows that when we add the linear mean reversion variables Y_t/A_t and $E(Y_t/A_t)$ to the regressions that also include the four autocorrelation variables (CE_t, NCE_t, $SNCE_t$, and $SPCE_t$), there is strong evidence that mean reversion leads to predictable variation in profitability; the slopes on Y_t/A_t and $E(Y_t/A_t)$, -0.32 and 0.46, are -13.12 and 13.57 standard errors from zero. But the average slopes on the autocorrelation variables remain strong (more than 4 standard errors from zero). Allowing for the nonlinear mean reversion of profitability (adding DFE_t, $SNDFE_t$, and $SPDFE_2$ to the regressions) moves the slopes on most of the autocorrelation variables closer to zero, but the CE_t, NCE_t, and $SPCE_t$ slopes are still more than four standard errors from zero. Thus, it seems that the nonlinear behavior of profitability is far from a complete story for the predictiable variation in earnings.

Since the specific functional form we use to model the mean reversion of profitability is surely misspecified, it is not surprising that it misses some of the predictability of earnings changes. But there is another reason to question the specification of the earnings change regressions. Unconditional expected earnings growth, $E(Y_{t+1} - Y_t)/A_t = E(CE_{t+1})$, surely differs across firms. As a result, some of the apparent forecast power of the explanatory variables in the CE_{t+1} regressions is probably driven by differences in unconditional expected earnings changes rather than by true predictability of earnings. In contrast, since profitability cannot drift forever up or down, the unconditional expected value of the change, $CP_{t+1} = Y_{t+1}/A_{t+1} - Y_t/A_t$, is probably close to zero for most firms. Thus, the profitability regression (4) is probably better specified than the earnings change regression (5).

There is evidence that variation across firms in unconditional expected earnings growth is a problem in the estimates of (5). Though noisy, the lagged change in earnings is a likely candidate to pick up variation across firms in $E(CE_{t+1})$. Since reversal seems to be the general characteristic of earnings changes, the positive slope on CE_t in the full version of (5), 0.18 ($t = 5.76$), suggests that this varible does identify variation in unconditional expected earnings growth.

One might get cleaner estimates of the predictability of changes in earnings by modeling variation across firms in expected earnings growth. But our view is that profitability, not earnings, is the interesting economic variable. And the interesting predictability issue is whether competitive forces produce mean reversion in profitability.

IV. Conclusions

Standard economic arguments say that in a competitive environment, profitability is mean reverting. Our evidence is in line with this prediction. In a simple partial adjustment model, the rate of mean reversion is about 38% per year. But the mean reversion of profitability is highly nonlinear. Mean reversion is faster when profitability is below its mean and when it is far from its mean in either direction.

There is also predictable variation in earnings. Much of it traces to the mean reversion of profitability. An important practical implication of this result is that forecasts of earnings (e.g., by security analysts) should exploit the mean reversion in profitability. In particular, negative changes in earnings and extreme changes seem to reverse faster than predicted by our specific model for the mean reversion of profitability.

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