Quadrophobia: Strategic Rounding of EPS Data[*]

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ABSTRACT

Earnings management to round up reported EPS causes under-representation of the number four in the first post-decimal digit of EPS data, or "quadrophobia." We develop a simple measure of earnings management based on a firm's history of quadrophobia. Quadrophobia is pervasive and persistent, and predicts future restatements, SEC enforcement actions, and class action litigation. Quadrophobia, even if the result of proper accounting practices, thus appears correlated with a propensity to engage in other problematic accounting practices. The incidence of quadrophobia increases (declines) when firms gain (lose) analyst coverage and is more pronounced in pro forma earnings in a manner consistent with capital market pressure causing strategic rounding.

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1 Introduction

The exercise of managerial discretion is unavoidable when preparing financial statements. Inventory valuations, financial asset writedowns, and the setting of accruals and reserves, are among the dozens of decisions that require discretion. A common concern among investors, regulators, and academics is that discretion can be exercised to obscure a firm's actual financial performance, particularly through practices known as earnings management.

This paper develops a novel and simple measure of earnings management that analyzes the distribution of the first post-decimal digit in EPS data, reported in cents per share, for evidence that management has "rounded up" its reported EPS results. We document that this measure predicts problematic accounting practices that lead to future restatements, enforcement actions by the Securities and Exchange Commission (SEC), and class action securities fraud litigation. Our measure of earnings management can therefore be used in conjunction with other firm characteristics to predict violations of accounting standards and federal securities laws.

Our measure is based on the following argument. Reported earnings per share in the United States are rounded to the nearest cent: earnings of 13.4 cents are rounded down to 13 cents, while earnings of 13.5 cents are rounded up to 14 cents. The amount of accounting discretion required to increase the rounded EPS by one cent, other factors equal, is at a minimum when the first digit to the right of the decimal in EPS calculations is a four. In this case, increasing the unrounded EPS by only a tenth of a cent by upwardly manipulating total earnings will increase the reported EPS by one cent. Statistically significant underrepresentation of the number four in the first post-decimal digit of EPS data, a pattern we call "quadrophobia," thus serves as evidence of earnings management.

We study the incidence of quadrophobia in quarterly earnings reports for publicly traded firms over the period spanning 1980 to 2013. We document that quadrophobia is pervasive: the number four is significantly underrepresented in the first post-decimal digit of EPS, particularly among firms that are covered by analysts and have high market-to-book ratios. For example, while the frequency of the number four under the null hypothesis of no earnings management

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is 10%,[1] its frequency in reported EPS data of firms with analyst coverage is only 7.9%.

We also find that quadrophobia is persistent: companies with a history of rounding behavior are more likely to continue the practice. For example, the probability that a company that has not reported a four in the first post-decimal digit of its EPS for ten years will report a four in any of its next three quarters is only 6.3%. In contrast, a company with a history of reporting at least one four over a ten-year period has a 8.3% chance of reporting a four in its next three quarters, and the difference is statistically significant. It therefore appears that individual managements engage in patterns of practice that are likely to generate strategic rounding behavior and the phenomenon is not randomly distributed across all reporting companies.

Motivated by this finding, we construct a simple measure of earnings management, a quadrophobia score, based on the history of quadrophobia for each individual company. For every firm-quarter observation, the quadrophobia score measures the incidence of the number four in the first post-decimal digit of the firm's EPS over several preceding quarters. Companies with high quadrophobia scores have not reported a four over several prior quarters and hence are more likely to have engaged in strategic rounding behavior.

Since our measure of earnings management is only based on the statistical distribution of digits in EPS, its advantage is that it is independent of firm characteristics unrelated to earnings management. This is important given the concern in the literature about accrual-based measures being systematically correlated with firm characteristics related to fundamental firm performance (e.g., Dechow, Sloan, and Sweeney (1995), Kothari, Leone, and Weasley (2002), Dechow and Dichev (2002), Owens, Wu, and Zimmerman (2013)).

We show that this measure of earnings management works well for predicting future accounting irregularities: companies with high quadrophobia scores are significantly more likely to restate their financial statements, be named as defendants in SEC Accounting and Auditing Enforcement Releases (AAERs), and be involved in class action securities fraud litigation. This result holds after controlling for various firm characteristics that have previously been demonstrated in the literature to be associated with the likelihood of accounting manipulation, such

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[1]Section 3 explains in detail why the distribution of the first post-decimal digit of EPS in the absence of earnings management is uniform.

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as discretionary accruals, external financing activity, and the market's growth expectations, among others. Thus, even if quadrophobia results from the exercise of legitimate accounting discretion, it appears to be practiced by managements that are more likely to engage in other problematic practices that give rise to restatements and litigation.

Finally, we present evidence that strategic rounding behavior by companies is caused by capital market pressure. Analyst coverage is strongly correlated with quadrophobia: the incidence of the number four in the first post-decimal digit is 7.9% when a firm has analyst coverage compared to 9% when it does not, and the probability of quadrophobia at any given firm increases (decreases) when analyst coverage is initiated (dropped). Companies engaging in strategic rounding also target "pro forma" ("street") EPS, which is calculated by analysts to adjust earnings for non-recurring items, rather than GAAP EPS. In addition, quadrophobia is particularly pronounced when the result of rounding allows firms to meet or come close to analyst expectations.

Our paper contributes to the literature that develops models to predict earnings restatements, AAERs, and class action lawsuits. Dechow, Ge, and Schrand (2010) present a comprehensive review of this literature. These papers use accrual quality, financial performance, capital market incentives, off-balance-sheet information, corporate governance characteristics, and managerial compensation (e.g., Beneish (1999), Dechow, Sloan, and Sweeney (1995, 1996), Armstrong, Jagolinzer, and Larcker (2010), Dechow et al. (2011)), as well as linguistic features of management conference calls (Larcker and Zakolyukina (2012)) to predict accounting manipulation. In contrast, our paper relies exclusively on the distributional properties of earnings per share data to predict manipulation. This approach has two advantages. First, because our predictor is based on the distributional properties of earnings, it measures earnings quality directly, rather than some variable correlated with earnings quality. Second, our measure is very simple to construct and only requires data on net income and the number of outstanding shares for a single firm.

The paper is also related to studies of distributional patterns in reported earnings. Several papers explore whether the distribution of earnings around certain thresholds is smooth or exhibits discontinuities consistent with earnings management (e.g., Burgstahler and Dichev

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(1997), Degeorge, Patel, and Zeckhauser (1999)). Our paper is most closely related to papers that identify rounding in aggregate earnings (Carslaw (1988), Thomas (1989)) and earnings per share (Thomas (1989), Craig (1992), Das and Zhang (2003)). In particular, Craig (1992) and Das and Zhang (2003) show that numbers below (above) five are under- (over-) represented in the first post-decimal digit in positive EPS. Moreover, Das and Zhang (2003) show that this pattern is reversed for negative earnings and that firms are likely to round up to report positive profits, meet analysts' forecasts, and sustain recent performance. Our main contribution to these papers is to develop a simple measure of earnings management for each company (the quadrophobia score) and to show that this measure is persistent and predictive of earnings restatements, AAERs, and class action lawsuits.

Finally, our paper is related to the literature that explores the effects of financial analysts on earnings management. Several papers have documented the use of earnings management to meet or exceed analyst expectations (e.g., Payne and Robb (2000), Matsumoto (2002), Bartov, Givoly, and Hayn (2002), and Burgstahler and Eames (2006)). Our paper contributes to this literature by showing that earnings management in the form of rounding is pronounced in "pro forma" (or "street") EPS developed by analysts, rather than in GAAP EPS, and that the incidence of quadrophobia is sensitive to the initiation and cessation of analyst coverage.

The remainder of the paper is organized as follows. Section 2 describes the data and provides descriptive statistics for our sample. Section 3 describes our methodology and presents evidence of strategic rounding behavior. Section 4 develops the quadrophobia score and demonstrates that quadrophobia is persistent. Section 5 presents our main results about the relation between quadrophobia and the incidence of restatements, AAER proceedings, and class action securities litigation. Section 6 analyzes the effects of initiation and cessation of analyst coverage, compares rounding in GAAP and pro forma EPS, and looks at the distance between the firm's EPS and the consensus analyst forecast. Section 7 discusses public policy implications, and Section 8 concludes.

2   Data

We obtain all firm-quarter observations from Compustat fundamental quarterly files for the period spanning 1980 to 2013. We eliminate all observations with missing net income data, data describing the number of shares used to calculate EPS, or observations that show negative total assets. The resulting sample of 951,612 firm-quarter observations covers 25,189 companies. Analyst data covering the same period are obtained from the I/B/E/S Summary database. For each firm-quarter observation we capture the most recent consensus forecast prior to the earnings announcement date. Consensus analyst forecasts are available for approximately 35% of observations.

Table 1 presents descriptive statistics for our sample. The sample firms have median total assets of $118 million and median market capitalization of $90 million.

[Table 1 here]

Because we are interested in the first post-decimal digit of EPS expressed in cents, we cannot use EPS data provided by Compustat; those data are already rounded to the nearest cent. To obtain the unrounded EPS expressed in cents, we multiply income after extraordinary items (Compustat data item IBADJQ + Compustat data item XIDOQ) by 100 and divide by the number of common shares used to calculate EPS (Compustat data items CSHPRQ and CSHFDQ for basic and diluted EPS, respectively).

3   Evidence of rounding

Our measure of earnings management is based on the observation that managers have an incentive to round up reported earnings, which manifests itself in an abnormal numerical distribution of the first post-decimal digit of EPS expressed in cents. Specifically, EPS data are rounded up to the next highest cent if the first post-decimal digit is five through nine, and rounded down to the next lowest cent if that digit is one through four. Because the amount of earnings management required to obtain an extra rounded cent of reported EPS is minimized when the

first post-decimal digit is a four, we hypothesize that earnings management through rounding causes an under-representation of the number four in the first post-decimal digit of EPS.

To test this hypothesis, we specify a null hypothesis that describes the baseline distribution of numbers in the first post-decimal digit that prevails in the absence of earnings management. Common intuition suggests that any number should be equally likely to appear as the first post-decimal digit, and that numbers zero through nine should therefore be uniformly distributed.[2] To test whether the uniform distribution is an appropriate null hypothesis, we study the distribution of the first post-decimal digit of per-share accounting data that do not regularly attract market attention and for which there is no incentive to manage through rounding. We focus on sales per share, and operating income per share calculated both before and after depreciation.[3]

To test the null hypothesis that the frequency of any number in the first post-decimal digit equals the expected frequency $p_0 = 0.1$, we apply the statistic $z = \frac{p - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$, where n is the sample size and p is the frequency of the number in the sample. Under the null hypothesis, z has a standard Normal distribution.[4]

In subsequent tests, we restrict our sample in the following way. First, we consider only positive EPS values because we expect the pattern to reverse for negative values. Second, we eliminate observations with per share figures below 0.1 cents because the first post-decimal digit is always zero for such observations, which may bias upwards the frequency of zeros and bias downwards the frequency of other digits even if the underlying distribution is in fact uniform.

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[2]The uniform distribution of the first post-decimal digit is consistent with Benford's law (Benford, 1938). Benford's law suggests that in a random sample, the *first* digit of financial and other data sets is distributed according to Benford's distribution, with number one being over-represented, but that the distribution of the *n-th* digit approaches the uniform distribution exponentially fast as n approaches infinity (Hill, 1995). Because average quarterly EPS in our sample is 28 cents per share, the first post-decimal digit in EPS expressed in cents is, on average, the third digit of EPS data, and hence its distribution should be close to uniform. See Carslaw (1988), Thomas (1989), and Amiram, Bozanic, and Rouen (2014) for examples of the use of Benford's law to detect earnings management.

[3]We also consider a number of other series of per-share data, including cash holdings per share and assets per share, and find similar results. The analysis is available from the authors on request.

[4]Similarly, to compare the frequency of any number in two different samples, we use the statistic $\tilde{z} = \frac{p_1 - p_2}{\sqrt{p(1-p)(\frac{1}{n_1} + \frac{1}{n_2})}}$, where p_1, p_2 are the frequencies of the number in question in the two samples, n_1, n_2 are the sample sizes, and p is the frequency of the number in the combined sample of size $n_1 + n_2$. Under the null hypothesis that the frequency in the two samples is the same, $\tilde{z}$ is a standard Normal variable (Fleiss, Levin, and Paik (2003)).

This constraint eliminates fewer than 2% of all observations, and our results are not sensitive to the inclusion or exclusion of these observations.

Figure 1 illustrates the time-series distribution of the number four in the first post-decimal digit for sales per share, per-share operating income before and after depreciation, and earnings per share, each expressed in cents. The solid lines represent the frequency of four in each year, and the dotted lines correspond to 95% confidence intervals around the expected frequency of 0.1.

[Figure 1 here]

In all data series except EPS, the frequency of four is statistically indistinguishable from 0.1 for each year in the sample. In the EPS data, however, the number four is significantly and consistently under-represented. The lowest observed frequency was 0.0754 in 1998, indicating that almost one quarter of the fours expected in the absence of earnings management were missing. We call this pattern "quadrophobia."

Note that by a similar logic, strategic rounding behavior should result in numbers one through three also being under-represented, although to a smaller extent, and numbers five through nine being over-represented. Table 2 presents the frequency of each number in the first post-decimal digit of EPS and provides support for this hypothesis. In particular, the frequency of numbers two through four is statistically significantly below 0.1, while the frequency of numbers five through nine is statistically significantly above 0.1. This pattern is consistent with the findings in Craig (1992) and Das and Zhang (2003) for earlier samples.

[Table 2 here]

As is apparent from Table 2, the deviation from the uniform distribution is the largest for the number four. This is consistent with the observation that the amount of discretion needed to round up reported EPS is minimized when the first post-decimal digit is a four. We therefore focus on the distribution of the number four as our key characteristic of interest and use this distribution to measure firms' accounting aggressiveness. While our results continue to hold for

measures that also account for the distribution of other digits, we focus on the number four to construct the simplest possible measure.

In the remainder of the section, we refine our findings by emphasizing the difference between basic and diluted EPS.

3.1   Rounding in basic and diluted EPS

In order to accurately measure the incidence of quadrophobia, it is important to distinguish between basic and diluted EPS. Diluted EPS take into account the outstanding stock options, warrants, and convertible securities, which can be converted into common stock and reduce earnings per share. Prior to adoption of FAS 128, companies were only required to report *primary* EPS, which included the dilutive effect of certain stock-based awards only if such inclusion diluted EPS by at least 3% (the "materiality threshold"). In addition, companies that exceeded the "materiality threshold" were also required to report fully diluted EPS, which included all potentially dilutive securities. Because primary EPS included a certain amount of dilution, reporting primary and fully diluted EPS disclosed only a partial range of dilution to readers of financial statements. Moreover, there was evidence that the complex calculation of primary EPS was not fully understood and not always consistently applied by reporting companies (see Statement of Financial Accounting Standards No. 128). For these reasons, FAS 128 replaced primary EPS with basic EPS (the number that excludes any potential dilution from the calculation of EPS) and required dual representation of basic and diluted EPS on the income statement for all companies regardless of capital structure.

Prior to adoption of FAS 128, primary EPS was likely to be the main measure used by analysts and other readers of financial statements because a large percentage of reporting companies did not have to report fully diluted EPS. On the other hand, after the adoption of FAS 128, analysts and investors are likely to focus on diluted EPS because it is more informative to investors than basic EPS.[5] Note that it is quite unlikely that managements are able simulta-

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[5]Some respondents to the EPS Prospectus noted that that they did not find basic EPS to be a useful statistic and thought that users would focus only on diluted EPS (see Statement of Financial Accounting Standards No. 128). See also Jennings, LeClere and Thompson (1997), who provide some evidence that diluted EPS is a more useful EPS measure than basic EPS.

neously to round basic and diluted EPS unless they coincide. Thus, we expect quadrophobia to be pronounced in primary EPS prior to the 1997 adoption of FAS 128 and in diluted EPS thereafter. Figures 2(a) and 2(b) are consistent with this hypothesis.

Figure 2(a) demonstrates that the frequency of the number four in diluted EPS after 1997 was as low as in primary EPS before 1997, while the frequency of the number four in basic EPS is substantially higher than in diluted EPS. Figure 2(b) focuses on the sample of observations where the basic and diluted EPS figures differ from each other by at least 0.1 cents, to ensure that the post-decimal digits in the two EPS figures are different. For these observations we find very little evidence of post-1997 rounding in basic EPS and significant evidence of rounding in diluted EPS. These results suggest that rounding in basic EPS observed in Figure 2(a) is mostly caused by the subsample of observations where the two figures coincide.

The data thus indicate that FAS 128 caused a shift in rounding behavior from primary EPS to diluted EPS. Therefore, our analysis (including the results already presented above in Figure 1) measures quadrophobia using primary EPS for all years prior to 1997 and diluted EPS thereafter.

[Figure 2 here]

4   Earnings management measure and persistence

In this section, we build on the analysis in the previous section to construct a measure of earnings management and demonstrate that quadrophobia is persistent: quadrophobia in any given period is more pronounced among firms with a history of quadrophobia, suggesting that certain management teams are systematically more likely to engage in aggressive accounting practices to round up their EPS. We therefore use a company's historic pattern of rounding behavior as a measure of its propensity to engage in earnings management.

To test whether quadrophobia is persistent, for each firm i and quarter t, we construct a quadrophobia score (Q-score), $Q_{i,t}$, which measures the extent of rounding by firm i in the past. Specifically, the Q-score is large if there were few fours in the first post-decimal digit of EPS in prior quarters, suggesting that a history of rounding behavior is more likely. If quadrophobia is

persistent, then the Q-score should be negatively correlated with the frequency of the number four in EPS reported by firm i in quarters subsequent to quarter t.

We construct several quadrophobia scores, each distinguished by the number of previous quarters that enter the calculation. More precisely, $Q_{i,t}^{(N)}$ is a binary variable set equal to zero if there was at least one four in the first post-decimal digit of EPS over N quarters with positive earnings prior to and including quarter t, and set equal to one otherwise. Formally, if d_j denotes the first post-decimal digit of EPS in quarter j, then

$$Q_{i,t}^{(N)} = \begin{cases} 0 & if \ \sum_{j=1}^{N} 1\{d_j = 4\} > 0, \\ 1 & if \ \sum_{j=1}^{N} 1\{d_j = 4\} = 0, \end{cases}$$

where j spans N quarters with positive earnings prior to and including quarter t. Higher values of N indicate that more past quarters are included in the score. We therefore expect that scores with higher values of N will have greater predictive power. However, because a larger number of past observations are required for higher N, sample size declines with N.

Table 3 presents results of univariate tests for $Q_{i,t}^{(N)}$, $N = 1, 2, 5, 10, 20$, and 40. For each N we divide the sample into two subsamples corresponding to values of $Q_{i,t}^{(N)}$ being zero and one. For each subsample and for each $k = 1$, 2, and 3, we calculate the average frequency P_{t+k} of the number four in the first post-decimal digit of EPS reported in quarter $t + k$. Results for the subsample with $Q_{i,t}^{(N)} = 1$ (quadrophobia) are reported in the first row and results for the subsample with $Q_{i,t}^{(N)} = 0$ (no quadrophobia) are reported in the second row. The third row presents z-statistics for the null hypothesis that the frequencies in the two subsamples are equal.

Table 3 strongly confirms the persistence hypothesis: the frequency in the second row is consistently higher than in the first row and that difference is always highly significant. Predictive power declines slightly as we predict further into the future (higher k) but remains strong. In unreported results, an analysis over ten future quarters generates similar results.

As expected, the predictive power of $Q_{i,t}^{(N)}$ increases with N: the difference in frequencies between the two subsamples increases from approximately 0.01 for $N = 1$, 2 and 5 (the past five quarters) to about 0.02 as we consider the horizon of ten years ($N = 40$). The absence

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of fours over the horizon of ten years is relatively strong evidence of earnings management: if fours are uniformly distributed, the probability that a company will not report a four in forty quarters is 0.9^{40}, or 1.47%. Accordingly, if a company has for ten years failed to report a four in the first post-decimal digit of its EPS, there is no more than a 6.5% chance that it will report a four in any of the next three quarters.

[Table 3 here]

We next conduct a multivariate analysis to examine other determinants of rounding behavior and verify that quadrophobia is persistent even after controlling for these other factors. First, a company's incentives to round EPS figures are likely to be stronger when the absolute value of its EPS is small, because a one cent increase in EPS then constitutes a larger percentage of the reported number. Second, we expect firms with higher market-to-book ratios to have stronger incentives to engage in rounding: the market-to-book ratio proxies for growth opportunities, and firms with better growth opportunities are more likely to have interest in raising capital from public markets. Firm size is likely to have a two-fold effect on the incentive to engage in rounding. On the one hand, if smaller firms do not expect much following in the market, they expect little benefit from increasing their EPS by one cent and hence have little incentive to engage in rounding. At the other extreme, if larger firms are more intensely scrutinized by auditors and regulators, they may find it harder to apply accounting discretion. In addition, larger companies have more shares outstanding and would therefore have to identify a larger aggregate amount of earnings over which to exercise discretion in order to increase EPS by a tenth of a cent. We therefore specify a model that tests for a non-monotonic relation between rounding behavior and company size. Finally, we expect analyst coverage to be an important determinant of quadrophobia.[6]

We apply probit analysis to test these hypotheses. For robustness checks, we replicated the analysis with a logit model and a linear probability model and obtained similar results. The dependent binary variable is set to one if the first post-decimal digit in EPS in quarter t is four,

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[6] The literature indicates that the stock market heavily punishes companies for missing analysts' earnings expectations and rewards firms for exceeding expectations. See, e.g., Kasznik and McNichols (1999), Bartov, Givoly, and Hayn (2002), and Bhojraj et al. (2009).

and set to zero otherwise. A negative coefficient on an explanatory variable thus implies that fours are less common, that is, quadrophobia is more pronounced as the explanatory variable increases.

The key explanatory variable of interest is Q-score, $\tilde{Q}_{i,t}^{(10)}$, which is similar to the Q-score introduced in the univariate analysis but does not include the observation in the current quarter. In particular, $\tilde{Q}_{i,t}^{(10)}$ equals zero if there was at least one four in the first post-decimal digit of EPS over ten quarters with positive earnings prior to but not including quarter t, and equals one otherwise. Our proxy for firm size (SIZE) is the logarithm of total assets, and we include both linear and quadratic terms of firm size in our set of explanatory variables. We have also considered the logarithms of market capitalization and of sales as alternative proxies for size and obtained similar results. We measure the market-to-book ratio (M/B) as the sum of total assets and market value of equity minus the book value of equity divided by total assets, measured as of the end of the quarter for which earnings are announced. For robustness checks, we have included the price-to-earnings ratio instead of the market-to-book ratio and obtained similar results. The variable EPS is the company's earnings per share. Each continuous variable is winsorized at 1% and 99% to mitigate the influence of outliers. The binary variable ANALYST is set to one if the consensus analyst forecast is available for the corresponding firm-quarter observation, and zero otherwise.

Results of the estimation are presented in Table 4. Model (1) only includes the Q-score, model (2) adds the other control variables, and model (3) augments model (2) with year fixed effects to control for time trends in earnings management behavior. Coefficients are reported in the first column, t-statistics are reported in parentheses, and the corresponding marginal effects are reported in the second column to the right of the coefficients.

Consistent with the persistence hypothesis, the Q-score is highly statistically and economically significant with a marginal probability of about -0.01. Other variables have expected signs and are highly significant. The coefficients on the two size variables indicate that there is an inverse U-shaped relation between firm size and quadrophobia, with larger and smaller companies less likely to engage in rounding, as expected. Firms with higher market-to-book ratios and lower EPS are more likely to engage in quadrophobia, as previously suggested. AN-

ALYST is both statistically and economically significant with a marginal effect equal to -0.013. In other words, the frequency of the number four for companies with analyst coverage is on average lower by about 0.013 than for companies without analyst coverage.

[Table 4 here]

We perform several robustness checks using other definitions of quadrophobia scores. First, we extend the definition to combine digits three and four: the Q-score equals one if there were no threes or fours in the first post-decimal digits of EPS in the past N quarters. Second, instead of considering a binary variable, we introduce a variable that takes $N + 1$ values: the Q-score equals k if there are exactly k fours in the past N quarters with positive earnings, $k \in \{0, 1, ..., N\}$. The results are available from the authors upon request and are consistent with the finding of persistence in quadrophobia, although the persistence of these quadrophobia scores is slightly weaker.

This analysis does not, however, preclude the possibility that persistence of quadrophobia merely reflects stability of EPS data rather than persistence of earnings management. In particular, if the difference in EPS between two subsequent quarters is smaller than 0.1 cents, then the first post-decimal digit in these EPS figures is likely to be the same, leading to a positive autocorrelation in the frequency of the number four. To address this concern, we search for all pairs of consecutive quarters with the same post-decimal digit of reported EPS. These observations are rare and constitute less than 5% of the sample. We exclude these pairs from our sample and repeat the analysis on the remaining observations. The results remain unchanged, confirming that the positive correlation is driven by persistence of rounding behavior and not persistence in the levels of EPS. In robustness checks, we exclude observations with a difference in consecutive EPS of less than 0.05 or 0.1 cents per share and obtain similar results.

5 Predictive regressions

Although quadrophobia is pervasive and persistent, the extent to which this form of earnings management is benign cannot be determined from the preceding analysis. In particular,

quadrophobia could represent legitimate accounting discretion and be unrelated to any violation of accounting standards. The data presented in this section, however, demonstrate that quadrophobia is practiced by managements that are more likely to engage in other problematic forms of accounting conduct, and that quadrophobia predicts future restatements, SEC enforcement actions, and class action securities fraud litigation.

The restatement data are from Glass, Lewis & Co. and cover 4667 restatements filed between 2003 and 2009.[7] We identify all quarters that were restated and, if a firm's annual financial statement was restated, assume that all quarters in that year were restated. The AAER data are from the SEC website and cover 326 enforcement actions between 2003 and 2011. We have read the first paragraph of each AAER to verify that it relates to accounting fraud committed by the company. We then combine these data with the data on restatements to identify the restated quarters. Finally, the class action securities fraud litigation data are from the Stanford Law School/Cornerstone Research Securities Class Action Clearinghouse and cover 1222 lawsuits filed between 1996 and 2012. The restatement data set defines the period that was restated, and the class action data set defines the period over which the alleged fraud was uncorrected in the market. We refer to these periods as the "alleged violation periods" for the three types of events.

To examine whether quadrophobia anticipates potentially problematic accounting practices we conduct three separate sets of probit regressions in which the dependent variable measures the future incidence of restatements, SEC enforcement actions, or class action litigation. For each type of event, the dependent variable for a firm-quarter pair (i, t) is set to zero if this firm never experiences this event after quarter t or if the alleged violation period for this event starts later than five years after quarter t, and set to one if the alleged violation period starts within five years from quarter t.[8]

We measure quadrophobia through the Q-score introduced in the multivariate analysis in

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[7]The Glass Lewis & Co. data set includes restatements filed to correct accounting errors as defined by Accounting Principles Board (APB) opinion 20 and does not include restatements for changes in accounting principles and restatements filed to make minor wording changes or typographical errors.

[8]We have considered several definitions of the dependent variable, varying by the number of years used to predict ahead, and obtained similar results. We have also used logit analysis and a linear probability model and obtained similar results.

Section 4. The Q-score, $\tilde{Q}_{i,t}^{(10)}$, is a binary variable set to zero if there was at least one four in the first post-decimal digit of EPS over ten quarters with positive earnings prior to but not including quarter t, and set to one otherwise. We repeated the tests considering five previous quarters in the definition of the Q-score with similar results. Quadrophobic firms have high Q-scores, and if quadrophobia anticipates future accounting controversy, then Q-scores should be positively correlated with the future incidence of accounting violations. Results presented in Table 5 strongly confirm this hypothesis.

We perform the analysis separately for restatements, SEC enforcement actions, and lawsuits and present the results in panels A, B and C of Table 5, respectively. First, consider model (1), which includes Q-score as the sole explanatory variable. As panel A of the table demonstrates, the coefficient for the Q-score is positive and significant at the 1% level in predicting all three types of events.

We next demonstrate that the predictive power of the Q-score is robust to the inclusion of other firm characteristics that have been shown in the literature to predict accounting violations. Model (2) controls for accrual quality, measured by the absolute value of discretionary accruals from the modified Jones model (Dechow, Sloan, and Sweeney (1995)). In particular, for each year and each two-digit SIC code, we estimate the regression

$$\frac{Accruals_t}{TA_{t-1}} = \alpha_0 + \alpha_1 \frac{1}{TA_{t-1}} + \alpha_2 \frac{\Delta Sales_t - \Delta Rec_t}{TA_{t-1}} + \alpha_3 \frac{PPE_t}{TA_{t-1}} + \varepsilon_{it},$$

where TA_{t-1} are lagged total assets, $\Delta Sales_t$ and ΔRec_t are changes in sales and receivables, respectively, PPE_t is net property, plant and equipment, and $Accruals_t$ are total accruals, defined as the change in current assets minus the change in cash holdings, minus the change in current liabilities excluding the current portion of long-term debt, and minus depreciation and amortization. Discretionary accruals are then defined as the residuals from this regression.

As expected, the absolute value of discretionary accruals is positively related to the future incidence of accounting violations. Importantly, the Q-score retains its predictive power: the coefficient continues to be positive and strongly significant.

We next augment the model with additional control variables. Prior research suggests that

market-to-book ratio, debt and equity issuance activity, leverage, and financial performance are likely to be associated with the incidence of manipulation (e.g., Dechow, Sloan, and Sweeney (1996), Dechow et al. (2011), Burns and Kedia (2006), Richardson, Tuna, and Wu (2002)). In particular, companies with higher market-to-book ratios and companies that need to raise external financing face greater capital market pressure and are therefore more likely to engage in aggressive accounting practices. Leverage is expected to be positively associated with the incidence of fraud because of incentives to meet debt covenants. Finally, because managers may try to manage earnings to mask deteriorating performance, changes in return on assets are expected to be negatively associated with the propensity to engage in manipulation. We introduce these additional variables in model (3) of Table 5. We proxy for the firm's issuance activity by a binary variable ISSUE set equal to one if the firm issued securities during that year ($SSTK > 0$ or $DLTIS > 0$) and zero otherwise. Leverage is measured as the sum of short-term and long-term debt scaled by total assets. Each continuous variable is winsorized at 1% and 99% to mitigate the influence of outliers.

As model (3) demonstrates, the coefficient for the Q-score remains positive and significant for each of the three types of events after including these additional control variables. There is a strong positive relation between all three types of accounting irregularities and market-to-book ratio and issuance activity, indicating that capital market pressure motivates firms to adopt aggressive accounting practices. Consistent with the debt covenant hypothesis, the coefficient on leverage is positive and significant as well. Changes in return on assets are, however, not significantly related to the incidence of any of the three types of events.

[Table 5 here]

6 Capital market pressure

The evidence in Section 4 suggests that quadrophobia is caused by capital market pressure: it is more pronounced when a firm is covered by analysts and has a high market-to-book ratio. In this section, we examine this issue in greater detail and present additional evidence that market pressure causes strategic rounding behavior. First, we show that firms target "pro

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forma" ("street") EPS that are issued by analysts, rather than GAAP EPS. Second, we find that the addition (elimination) of analyst coverage increases (decreases) quadrophobia even after adjusting for other explanatory variables. Finally, we show that the closer earnings are to the consensus analyst forecast, the greater the incentive to engage in strategic rounding.

6.1   The pro forma effect

Prior literature has shown that the stock market punishes companies for missing analysts' earnings expectations and rewards them for beating these expectations (e.g., Kasznik and McNichols (1999), Bartov, Givoly, and Hayn (2002), and Bhojraj et al. (2009)). Analysts tend to issue forecasts based on recurring income, excluding one-time gains and losses, and the resulting EPS figure is called "pro forma EPS" or "street EPS" (see, e.g., Bradshaw and Sloan (2002)). If capital market pressure and the desire to meet analyst expectations causes quadrophobia, firms should have an incentive to target pro forma rather than GAAP EPS figures when rounding up their earnings. This section presents evidence supporting this hypothesis.

We begin with the observation that it is difficult simultaneously to round up GAAP and pro forma EPS when they differ sufficiently from each other. Therefore, if companies target pro forma EPS, the extent of quadrophobia in GAAP EPS should be stronger for the subset of firm-quarters where pro forma estimates are sufficiently close to GAAP EPS than for the subset of firm-quarters where the two estimates are different.[9] To identify pro forma EPS, we use the I/B/E/S data item ACTUAL, which is constructed by I/B/E/S by adjusting reported EPS data to the method used by the majority of analysts.[10]

Accordingly, we divide our sample of firm-quarter observations with analyst coverage into two subsamples. The first consists of all observations where actual EPS reported by I/B/E/S

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[9]The data necessary to directly examine the extent of rounding in pro forma EPS are not available. The I/B/E/S item ACTUAL is already rounded to the nearest cent and thus does not support a calculation of the first post-decimal digit *before* rounding.

[10]According to the I/B/E/S Glossary (2002),"With very few exceptions analysts make their earnings forecasts on a continuing operations basis. This means that I/B/E/S receives an analyst's forecast after discontinued operations, extra-ordinary charges, and other non-operating items have been backed out. While this is far and away the best method for valuing a company, it often causes a discrepancy when a company reports earnings. I/B/E/S adjusts reported earnings to match analysts' forecasts on both an annual and quarterly basis. This is why I/B/E/S actuals may not agree with other published actuals; i.e. Compustat."

(pro forma EPS) coincides with EPS calculated from Compustat (GAAP EPS) when rounded to the nearest cent, and the second consists of observations for which the two figures are different. Thus, we hypothesize that the first (second) subsample captures observations for which analyst forecasts were tied to GAAP (pro forma) EPS. Our results indicate that rounding in the first, GAAP-consistent, subsample is much stronger than in the second subsample, where companies and analysts are likely targeting pro forma estimates that differ from GAAP. In particular, Table 6 presents the frequency of the number four in the two subsamples for each year (we start in 1984 because I/B/E/S data are very limited prior to 1984). Results for the GAAP-consistent subsample are reported in the first row, and results for the second subsample are reported in the second row. The third row presents z-statistics for the null hypothesis that the frequencies in the two subsamples are equal. The table shows that in almost every year, the frequency of the number four in the GAAP-consistent subsample is substantially smaller than in the second subsample, and the difference is statistically significant. Over the entire sample period, the average frequencies of the number four in the two subsamples are 0.0685 and 0.0871, respectively.[11]

This evidence supports the hypothesis that quadrophobia is caused by capital market pressure. Moreover, it shows that our findings to this stage are likely conservative and understate the prevalence of quadrophobia among publicly reporting companies.

[Table 6 here]

6.2   Initiation and cessation of analyst coverage

To provide additional evidence that market pressure causes quadrophobia, we note that most companies in our sample were not followed by analysts over the entire trading period. Some companies first received analyst coverage after several years of trading, while others lost coverage over time. If analyst coverage causes managers to round up earnings, then the incidence of quadrophobia should increase after the introduction of analyst coverage and decrease after the

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[11]This finding is consistent with the evidence in Bradshaw and Sloan (2002), who examine earnings announcements disclosures and show an increasing emphasis of managers on pro forma measures over GAAP measures over the last twenty years.

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cessation of coverage.

We focus on the subsample of firms that were covered by analysts at some point over the sample period, 1980-2013. Approximately 80% of these firms have a reporting history that precedes the initiation of analyst coverage. The average pre-coverage history is ten years long. In contrast, it is rarer for analysts to drop firms from coverage: only 20% of firms that have coverage wind up losing it. The average post-coverage history for these firms is two years long. We define two binary variables: BeforeCov equals one if the firm-quarter observation belongs to the period before analyst coverage was initiated for the firm, and AfterCov equals one if the firm-quarter observation belongs to the period after analysts dropped coverage. A firm-quarter observation with both binary variables equal to zero corresponds to the period when the firm was followed by analysts. The hypothesis that analyst coverage causes quadrophobia implies a positive relation between both binary variables and the frequency of the number four in the first post-decimal digit of EPS.

Model 1 of Table 7 presents results of a probit regression, where the dependent variable is a binary variable set to one if four is the first post-decimal digit of EPS, and set to zero otherwise. T-statistics are reported in parentheses, and marginal probabilities are reported to the right of coefficients. Both BeforeCov and AfterCov are positive and highly significant with marginal effects of about 0.007 and 0.019, respectively. The average frequency of digit four in EPS reported by the company thus decreases by 0.007 after the initiation of analyst coverage and increases by 0.019 after coverage is dropped. With an average frequency of digit four in a random sample of 0.1, these effects are economically large.

It is possible, however, that changes in company characteristics could co-determine analyst coverage and quadrophobia. To separate the effect of analyst coverage from other potential determinants of rounding behavior, we follow the literature on the determinants of analyst coverage (e.g., Bhushan (1989), McNichols and O'Brien (2001)) and include firm size, market-to-book ratio, price, and leverage as control variables. Each continuous variable is winsorized at 1% and 99%. Results of these estimates are reported in models (2) and (3) of Table 7. Model (3) is similar to model (2) but also includes year fixed effects to control for time trends in earnings management behavior. As the table demonstrates, the effect of analyst coverage

remains powerful in the presence of these control variables: coefficients on both BeforeCov and AfterCov are positive and significant with marginal effects of 0.01 and 0.02, as previously.

[Table 7 here]

In our final test, presented in Figure 3, we show that the incentive to engage in quadrophobia is especially powerful when rounding allows companies to meet or come close to analyst expectations. The sample consists of all firm-quarter observations with EPS greater than 0.1 cents for which the consensus analyst forecast is available in I/B/E/S. The horizontal axis measures the difference in cents between reported EPS and the consensus analyst forecast from I/B/E/S, each expressed in cents per share. The histogram presents the average frequency of the number four in the first post-decimal EPS digit for all observations with a given difference between reported and consensus EPS. The dotted line denotes the lower bound of the 95% confidence interval around 0.1. Figure 3 confirms the hypothesis that quadrophobia is especially pronounced when the EPS number reported by the company is close to analyst expectations. The frequency of four is as low as 0.068 for situations in which analyst forecasts equal reported EPS. As the difference between the consensus forecast and reported EPS increases, regardless of whether the company misses or exceeds expectations, the frequency of strategic rounding declines.

[Figure 3 here]

7   Policy implications

In this section, we discuss the policy implications of quadrophobia. We start with the observation that the dollar amounts involved in quadrophobia can be relatively small. In 2013, the most recent year in our sample, the mean (median) aggregate amount of earnings over which management would have to exercise discretion in order to move quarterly EPS by a tenth of a cent was \$222,000 (\$44,000), or 0.15% (0.37%) of the company's total quarterly earnings.[12]

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[12]An increase of \$0.001 in earnings per share requires increasing aggregated earnings by N*\$0.001, where N is the number of shares outstanding. The average (median) quarterly earnings for companies with positive earnings in 2013 were \$145 million (12 million), and the average (median) number of shares outstanding was 222 million (44 million).

If the focus is on the quantitative materiality of the dollars at issue, one could argue that quadrophobia is not a major problem in the market.

SAB 99, however, suggests that both qualitative and quantitative factors should be considered in determining materiality. In particular, even small dollar amounts can be material if they are likely to affect stock prices, hide a failure to meet analyst expectations, or have the effect of increasing executive compensation, among other considerations. Thus, while heuristic approaches to materiality are common in practice, legal precedent rejects simplistic reliance on a single benchmark. See, e.g., Ganino v. Citizens Utility Co., 228 F.3d 154 (2d Cir. 2000).

The finding that quadrophobia predicts future restatements, SEC enforcement actions, and class action litigation, is consistent with the broader concern expressed in SAB 99. Indeed, even if quadrophobia reflects the exercise of legitimate accounting judgment, our results suggest that its presence signals an aggressive approach to accounting that increases exposure to restatement risk, AAER proceedings, and class action securities fraud claims.

From a forensic perspective, a history of quadrophobia thus appears to be an effective predictor of whether a company is likely to violate accounting norms or federal securities laws. However, we counsel caution against excessive reliance on the quadrophobia score as a univariate predictor and suggest that it should be used in conjunction with other firm characteristics that have been shown in the literature to predict fraud. Suppose, for example, that a company fails to report a four in the first post-decimal digit of EPS for a period of five years, or twenty quarters. How unusual is that? If fours are uniformly distributed, then the probability that a company will not report a four in twenty consecutive quarters is 0.9^{20}, or 12.2%, which is not negligible. Quadrophobia is, therefore, more likely useful as an input to a multivariate effort to develop forensic tools that can better predict the incidence of fraud.

8 Conclusion

This paper develops a simple measure of earnings management based on the distribution of digits in EPS data. Specifically, if firms manage earnings in order to increase their reported EPS by one cent, then the number four should be significantly under-represented in the first

post-decimal digit of EPS data reported in cents, a pattern we call "quadrophobia." We show that quadrophobia is pervasive among publicly traded firms and is strongly driven by capital market pressure. Quadrophobia is also persistent: firms that engaged in strategic rounding in the past are also more likely to engage in rounding behavior in the future. Accordingly, our measure of earnings management, the Q-score, tracks the history of quadrophobia in a given firm by quantifying the frequency of the number four in the first post-decimal digit of its past EPS. Our main result is that firms with a history of quadrophobia are more likely to engage in potentially problematic accounting practices, leading to restatements, SEC enforcement actions, and class action securities fraud litigation. From a forensic perspective, quadrophobia therefore appears to be a useful indicator of concern regarding the quality of public company financial statements.

In future research, the quadrophobia score could be used to answer several important questions, such as managerial motives for managing earnings and the capital market consequences of earnings management. It would also be useful to combine the quadrophobia score with other measures of earnings quality to develop an aggregate measure of earnings management that works well in predicting violations of accounting standards.

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Figure 1: Frequency of the number four in the first post-decimal digit
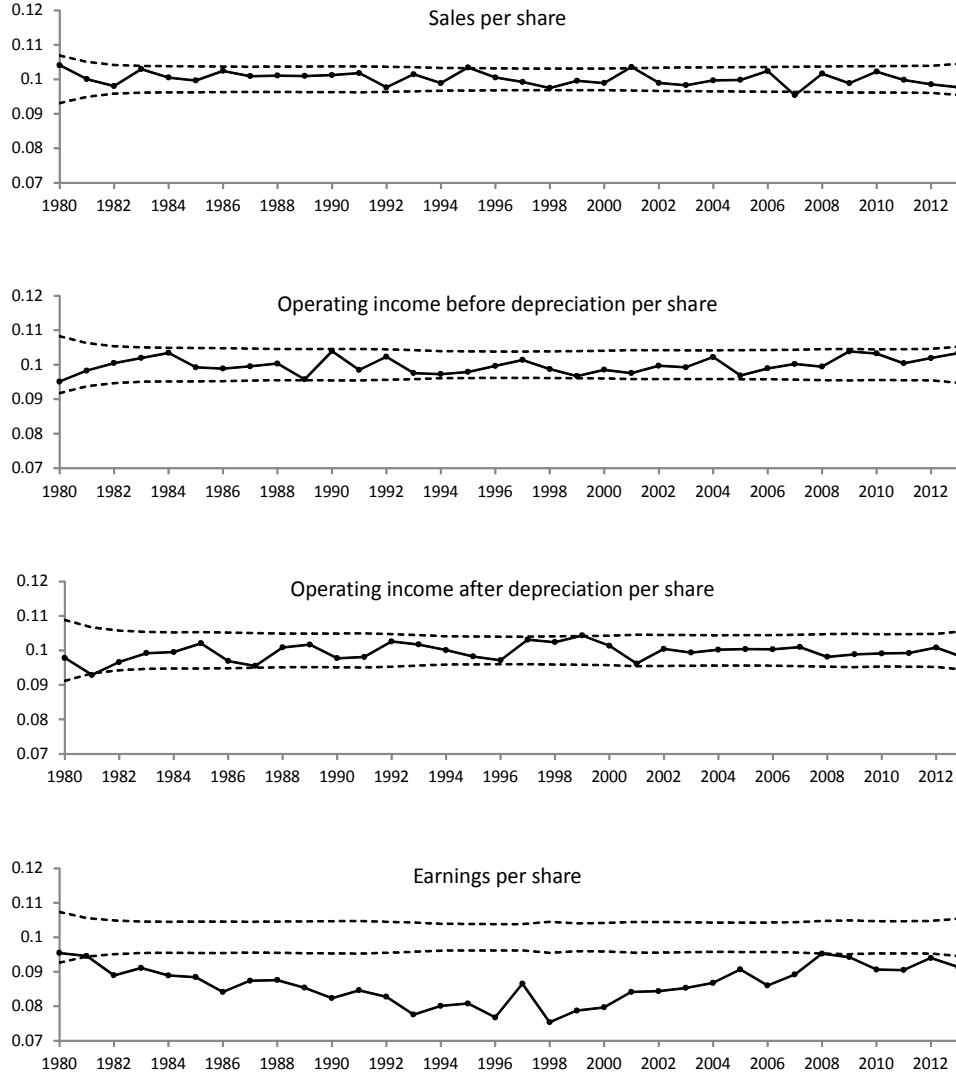
Test of the null hypothesis that the frequency of the number four in the first post-decimal digit of quarterly sales per share, operating income before and after depreciation per share, and earnings per share, all expressed in cents, is equal to 10%. Each per share figure is calculated as the ratio between the aggregate figure and the number of common shares used to calculate earnings per share. Earnings per share are defined as primary EPS before 1997 and as diluted EPS after 1997. The sample includes all firm-quarter observations for which the corresponding per share figure is greater than 0.1 cents. The solid lines represent the frequency of the number four observed in the data. The dotted lines correspond to 95% confidence intervals around 0.1.

Figure 2(a): Frequency of the number four in primary, basic and diluted EPS
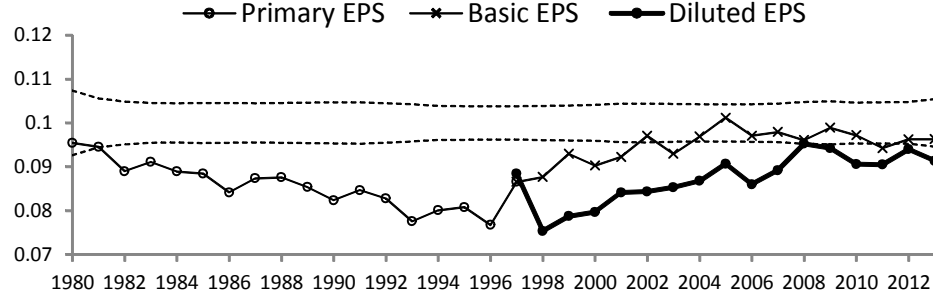
Figure 2(b): Frequency of the number four for the sample where basic and diluted EPS differ
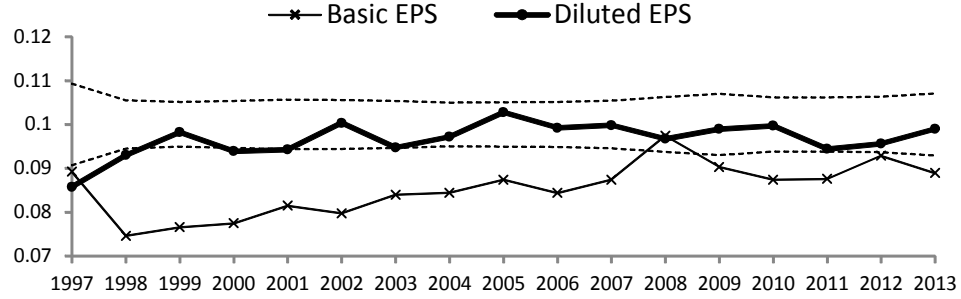
Fig. 2(a) presents the frequency of the number four in the first post-decimal digit of quarterly primary, basic and diluted EPS. The sample consists of all firm-quarter observations with EPS greater than 0.1 cents. The bold solid line corresponds to the frequency of the number four in diluted EPS, and the thin solid lines represent primary and basic EPS. The dotted lines correspond to 95% confidence intervals around 0.1. Fig. 2(b) repeats the analysis on the sample where basic and diluted EPS differ by at least 0.1 cents.

Figure 3: Incentives to meet analyst forecasts
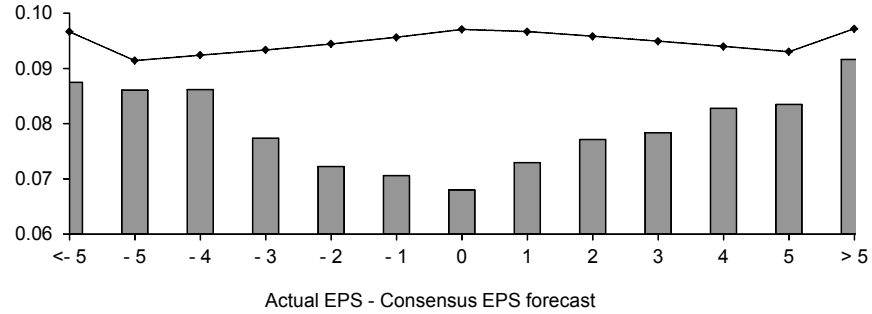
Fig. 3 demonstrates how the frequency of the number four in the first post-decimal digit of EPS depends on how close reported EPS are to analyst expectations. The sample consists of all firm-quarter observations with EPS greater than 0.1 cents for which the consensus analyst forecast is available in I/B/E/S. The x-axis corresponds to the difference in cents between actual EPS reported by I/B/E/S and the corresponding average analyst forecast. The y-axis presents the average frequency of the number four in firm-quarter observations with a given difference over the period 1980-2013. The dotted line corresponds to the lower bound of the 95% confidence interval around 0.1.

Table 1: Summary statistics

	Mean	25$^{\text{th}}$	50$^{\text{th}}$	75$^{\text{th}}$
Total Assets ($M)	4677.7	18	117.6	752.5
Market Capitalization ($M)	1824.1	18.6	90.4	521.6
Sales ($M)	448.7	3.2	19.9	119.8
Market-to-book Ratio	4.0	1.0	1.3	2.2
Income before EI ($M)	23.4	-0.4	0.4	5.1
Basic EPS ($)	0.28	-0.05	0.07	0.35
Book Leverage	0.23	0.04	0.19	0.36
Return on Assets	-0.51	-0.02	0.004	0.02
No. of Obs.	951,612			

Descriptive statistics for the sample of firm-quarter observations from Compustat over the 1980-2013 period. The sample includes all observations with positive total assets and available data on net income and the number of common shares used to calculate basic EPS.

Table 2: Distribution of the first post-decimal digit in EPS

0	1	2	3	4	5	6	7	8	9
0.1075^a	0.1006	0.0946^a	0.0900^a	0.0857^a	0.1051^a	0.1054^a	0.1041^a	0.1016^a	0.1053^a
(19.17)	(1.63)	(-13.82)	(-25.45)	(-36.44)	(13.07)	(13.75)	(10.54)	(4.03)	(13.53)

The frequency of numbers 0-9 in the first post-decimal digit in quarterly earnings per share. The sample includes all firm-quarter observations for which earnings per share are greater than 0.1 cents. Z-statistics for the test of the null hypothesis that the frequency of each digit is equal to 10% are reported in parentheses. Superscripts a,b,c denote significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 3: Persistence, univariate analysis

N	$Q_t^{(N)}$	P_{t+1}	P_{t+2}	P_{t+3}
1	1	0.083	0.083	0.083
	0	0.091	0.090	0.087
	z-test	$(5.23)^a$	$(4.17)^a$	$(2.50)^b$
2	1	0.083	0.083	0.082
	0	0.090	0.088	0.089
	z-test	$(6.45)^a$	$(4.84)^a$	$(5.70)^a$
5	1	0.080	0.081	0.081
	0	0.089	0.088	0.088
	z-test	$(9.50)^a$	$(8.09)^a$	$(8.09)^a$
10	1	0.077	0.077	0.077
	0	0.087	0.088	0.087
	z-test	$(10.97)^a$	$(10.89)^a$	$(10.53)^a$
20	1	0.071	0.071	0.071
	0	0.085	0.086	0.085
	z-test	$(11.11)^a$	$(10.75)^a$	$(10.33)^a$
40	1	0.063	0.064	0.065
	0	0.083	0.084	0.084
	z-test	$(6.36)^a$	$(6.18)^a$	$(5.68)^a$

The table demonstrates how the probability of observing the number four in the first post-decimal digit of EPS of a given firm depends on the frequency of the number four for this firm in the past. The sample consists of all firm-quarter observations with EPS greater than 0.1 cents. For a firm-quarter observation (i,t), the dummy variable $Q_{it}^{(N)}$ equals zero if there was at least one four in the first post-decimal digit of EPS of firm i over N quarters with positive earnings prior to and including quarter t, and equals one otherwise. For each N, k=1,2,3, and q=0,1, we compute P_{t+k}, which is the conditional frequency of the number four in quarter t+k conditional on $Q_{it}^{(N)}$ being equal to q. Z-statistics for the test of the null hypothesis that the difference between the frequencies of the number four conditional on $Q_{it}^{(N)}$=0 and $Q_{it}^{(N)}$=1 is equal to zero, are reported in parentheses. Superscripts a,b,c denote significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 4: Persistence, probit analysis

	(1)		(2)		(3)	
	Coeff.	Marg.prob.	Coeff.	Marg.prob.	Coeff.	Marg.prob.
Intercept	-1.35^a		-1.26^a		-1.24^a	
	(-360.05)		(-68.18)		(-56.83)	
Q-SCORE	-0.06^a	-0.0137	-0.06^a	-0.0119	-0.06^a	-0.0114
	(-11.04)		(-9.92)		(-9.47)	
SIZE			-0.03^a	0.0004	-0.03^a	-0.0001
			(-5.23)		(-5.55)	
$SIZE^2$			0.00^a		0.00^a	
			(6.14)		(5.87)	
M/B			-0.01^a	-0.0019	-0.01^a	-0.0020
			(-4.78)		(-4.99)	
EPS			0.00^a	0.0001	0.00^a	0.0001
			(7.90)		(8.11)	
ANALYST			-0.06^a	-0.0121	-0.06^a	-0.0134
			(-8.83)		(-9.56)	
Year fixed effects	No		No		Yes	
No. of Obs.	390,964		390,964		390,964	

Probit regressions of DUMMY4 on company characteristics. DUMMY4 equals one if four is the first post-decimal digit in EPS reported in cents, and equals zero otherwise. The sample consists of all firm-quarter observations with EPS greater than 0.1 cents. Q-SCORE in quarter t is set to zero if there was at least one four in the first post-decimal digit of EPS reported by the firm over ten quarters with positive earnings prior to but not including quarter t, and set to one otherwise. SIZE is the logarithm of total assets. M/B is the ratio of the market value of total assets to the book value of total assets. EPS is the value of earnings per share. ANALYST is set to one if the consensus analyst forecast is available for the corresponding firm-quarter observation, and set to zero otherwise. Each continuous variable is winsorized at 1% and 99%. T-statistics are reported in parentheses, marginal effects are reported to the right of the coefficients. Superscripts a,b,c denote significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 5: Predictive regressions

	A: Restatements			B: AAER			C: Litigation		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	-1.30^a	-1.31^a	-1.62^a	-2.26^a	-2.26^a	-2.67^a	-1.77^a	-1.80^a	-2.31^a
	(-270.01)	(-209.12)	(-125.11)	(-212.90)	(-166.60)	(-91.60)	(-273.19)	(-209.49)	(-121.52)
Q-SCORE	0.04^a	0.05^a	0.03^a	0.05^a	0.05^a	0.04^b	0.06^a	0.05^a	0.03^a
	(6.74)	(6.00)	(3.56)	(3.76)	(3.07)	(2.24)	(6.91)	(4.94)	(2.64)
JONES_RES		0.45^a	0.44^a		0.33^a	0.31^a		0.23^a	0.18^a
		(25.61)	(23.85)		(8.60)	(7.72)		(9.72)	(7.31)
M/B			0.05^a			0.11^a			0.14^a
			(12.81)			(16.73)			(35.66)
LEVERAGE			0.08^a			0.37^a			0.24^a
			(3.74)			(7.86)			(7.76)
ΔROA			-0.21			-0.07			-0.20
			(-1.31)			(-0.22)			(-0.98)
ISSUE			0.30^a			0.18^a			0.24^a
			(30.96)			(8.21)			(16.10)
No. of Obs.	293,862	188,822	177,832	246,626	159,854	150,043	287,328	187,553	177,430

The table presents results of probit regressions, where the dependent variable for a firm-quarter pair (i,t) is set to zero if the firm never experiences a restatement (AAER, class action lawsuit) after quarter t, or if the alleged violation period for this event starts later than five years after quarter t, and set to one if the alleged violation period starts within five years from quarter t. The sample consists of firm-quarter observations with available data for the next five years. Q-SCORE for a given firm in quarter t is set to zero if there was at least one four in the first post-decimal digit of EPS reported by the firm over ten quarters with positive earnings prior to but not including quarter t, and set to one otherwise. JONES_RES is computed as the absolute value of the residuals from the modified Jones model, which is estimated cross-sectionally for every two-digit SIC code and year. M/B is the ratio of the market value of total assets to the book value of total assets. LEVERAGE is the sum of short-term and long-term debt scaled by total assets. ROA is income before extraordinary items scaled by lagged total assets, and ΔROA is ROA_t - ROA_{t-1}. ISSUE is set equal to one if the firm issued securities during that year (SSTK>0 or DLTIS>0) and zero otherwise. Each continuous variable is winsorized at 1% and 99%. T-statistics are reported in parentheses. Superscripts a,b,c denote significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 6: Quadrophobia in GAAP versus pro forma EPS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Pro forma = GAAP	0.0797	0.0675	0.0761	0.0539	0.0577	0.0580	0.0619	0.0557	0.0482	0.0580
Pro forma ≠ GAAP	0.0842	0.0862	0.0793	0.0866	0.0880	0.0818	0.0765	0.0769	0.0868	0.0707
z-test	(0.26)	$(1.71)^c$	(0.31)	$(3.49)^a$	$(3.45)^a$	$(2.91)^a$	$(1.90)^b$	$(2.80)^a$	$(5.33)^a$	$(2.04)^b$

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pro forma = GAAP	0.0578	0.0565	0.0535	0.0812	0.0407	0.0493	0.0546	0.0480	0.0577	0.0572
Pro forma ≠ GAAP	0.0815	0.0774	0.0709	0.0839	0.0832	0.0815	0.0800	0.0830	0.0861	0.0868
z-test	$(4.12)^a$	$(3.75)^a$	$(3.44)^a$	(0.47)	$(7.29)^a$	$(6.22)^a$	$(4.53)^a$	$(5.54)^a$	$(4.48)^a$	$(5.09)^a$

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Pro forma = GAAP	0.0648	0.0765	0.0683	0.0775	0.0766	0.0808	0.0810	0.0812	0.0855	0.0768
Pro forma ≠ GAAP	0.0917	0.0991	0.0988	0.0971	0.1171	0.1145	0.1095	0.1031	0.1070	0.1111
z-test	$(4.94)^a$	$(4.11)^a$	$(5.77)^a$	$(3.55)^a$	$(6.67)^a$	$(5.27)^a$	$(4.73)^a$	$(3.58)^a$	$(3.35)^a$	$(2.72)^a$

The first row represents the frequency of the number four in the first post-decimal digit of EPS in the sample where actual EPS reported by I/B/E/S (pro forma EPS) coincide with EPS calculated from Compustat (GAAP EPS) when rounded to the nearest cent. The second row represents the frequency of the number four in the sample where the two figures are different. Z-statistics for the test of the null hypothesis that the difference between the frequency of the number four in the two samples equals zero, are reported in parentheses. Superscripts a,b,c denote significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 7: Initiation and cessation of analyst coverage

	(1)		(2)		(3)	
	Coeff.	Marg.prob.	Coeff.	Marg.prob.	Coeff.	Marg.prob.
Intercept	-1.40^a		-1.29^a		-1.23^a	
	(-432.27)		(-53.56)		(-39.12)	
SIZE			-0.04^a	0.0003	-0.04^a	-0.0003
			(-5.86)		(-6.17)	
SIZE^2			0.00^a		0.00^a	
			(6.84)		(6.70)	
M/B			-0.02^a	-0.0023	-0.02^a	-0.0024
			(-5.77)		(-5.59)	
PRICE			0.00^a	0.0001	0.00^a	0.0001
			(3.54)		(3.62)	
LEVERAGE			0.02	0.0029	0.03^c	0.0045
			(1.24)		(1.79)	
BeforeCov	0.03^a	0.0065	0.03^a	0.0057	0.03^a	0.0073
	(4.46)		(3.66)		(4.44)	
AfterCov	0.09^a	0.0194	0.10^a	0.0204	0.09^a	0.0186
	(6.49)		(6.47)		(5.67)	
Year fixed effects	No		No		Yes	
No. of Obs.	419263		386842		386842	

Probit regressions of DUMMY4 on company characteristics. DUMMY4 equals one if four is the first post-decimal digit in EPS reported in cents, and equals zero otherwise. We focus on the subsample of firms that were covered by analysts at some point over the sample period, 1980-2013, and on firm-quarter observations with EPS greater than 0.1 cents. BeforeCov for company i in quarter t equals one if company i first appears in I/B/E/S after quarter t, and equals zero otherwise. AfterCov for company i in quarter t equals one if company i appears last in I/B/E/S prior to quarter t, and equals zero otherwise. SIZE is the logarithm of total assets. M/B is the ratio of the market value of total assets to the book value of total assets. PRICE is the closing price at the end of the quarter. LEVERAGE is the sum of short-term and long-term debt scaled by total assets. Each continuous variable is winsorized at 1% and 99%. T-statistics are reported in parentheses, marginal effects are reported to the right of the coefficients. Superscripts a,b,c denote significance at the 0.01, 0.05 and 0.1 levels, respectively.