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An alternative approach to detect earnings management to meet or beat benchmarks

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Abstract

Purpose – The authors propose an alternative robust technique to test for discontinuities in distributions and provide consistent evidence of discontinuities around zero for both scaled and unscaled earnings levels and changes. The advantage of the proposed test is that it does not rely on arbitrary choice of bin width choices.
Design/methodology/approach – To evaluate the power of the test, the authors examine the density function of non-discretionary earnings and detect no evidence of discontinuities around zero in levels and changes of these non-discretionary earnings. As robustness, the authors use pre-managed earnings excluding accrual and real manipulation and find similar evidence.
Findings – The finding using our technique support the Burgstahler and Dichev (1997) interpretation on earnings management, even for smaller sample sizes and reject the theory that discontinuities arise from scaling and sampling methods.
Originality/value – The study provides an overview of those studies that support and those that oppose using "testing for discontinuities" as a way to examine earnings management. The authors advance the literature by providing an alternative methodology supporting the view that the kink in the distribution represents earnings management.

Keywords Earnings management, Earnings frequency distribution, Discretionary accruals, Earnings benchmarks
Paper type Research paper

1. Introduction

In an influential paper, Burgstahler and Dichev (1997) provide evidence of discontinuities around zero earnings and zero changes in earnings using a frequency distributional approach, which they interpret as earnings management to meet or beat these benchmarks [1]. This interpretation is supported by others (e.g. Beatty *et al.*, 2002; Donelson *et al.*, 2013; Burgstahler and Chuk, 2015; Byzalov and Basu, 2019). Gilliam *et al.* (2015) find that these discontinuities disappear following the enactment of the Sarbanes-Oxley Act of 2002 (hereafter, SOX), in line with the earnings management interpretation. However, they only examine one measure of earnings (net income scaled by market value of equity) to reach this

JEL Classification — C18, G14, M41

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conclusion. Others have argued that the discontinuities are not evidence of earnings management but a result of scaling and sample selection (Durtschi and Easton, 2005, 2009), tax effects (Beaver *et al.*, 2007) or the time-series properties of earnings (Li, 2014; Hemmer and Labro, 2019).

As discussed in Degeorge *et al.* (1999), construction of empirical tests in the frequency distributional approach requires a choice of bin width that balances the need for a precise density estimate against the need for fine resolution. Bordeman and Demerjian (2022) show that discontinuities of distributions in debt ratios are sensitive to different bin widths using the context of firms managing earnings in order to avoid violating debt covenants. Lahr (2014) documents how different choices of histogram bin widths in testing for discontinuities in earnings distributions can lead to different results. He proposes a bootstrap test which addresses this issue by endogenizing bin selection. However, researchers still have to specify an arguably arbitrary *a priori* bin width as a starting value for the estimation of the density function (Lahr, 2014, p. 5).

In this paper, we introduce a statistical method for testing the existence of discontinuities in the density function of the annual earnings and changes in earnings inspired by Lahr (2014) [2]. Our approach is non-parametric and does not depend on an arbitrary choice of bin width. Allen *et al.* (2017) show the methodological benefits of non-parametric bunching estimation procedures for investigating patterns and implications of distributions around a reference point. Conceptually, our technique first constructs a smoothed series, which has the same empirical distribution function as the original data. Second, the density function of the actual data is compared with the smoothed density function. If a discontinuity does exist, then the two density functions are globally (for the whole dataset) identical but differ around the point of the discontinuity.

Our proposed methodology has two main advantages over prior methodologies. First, the formation of the distribution is not dependent on bin width selection but relies on the data itself. Second, the statistical test we use to detect discontinuities around zero does not use the bins around zero as it has been stated in the literature, but it is based on the U-statistic, proposed by Mann and Whitney (1947), which does not assume normal distributions. This second point is important when earnings do not follow a normal distribution, which may be the case for earnings distributions. For example, Beaver *et al.* (2007) argue that asymmetric earnings distributions are likely due to the asymmetrical nature of accounting conservatism, taxes, the inclusion of different sized-firms in large samples and listing requirements for sustained profits.

We begin by replicating the Burgstahler and Dichev (1997) tests in US firms with available data over the period 2000–2020 and find discontinuities around zero earnings levels and changes consistent with the earnings management interpretation. While our sample period is similar to Gilliam *et al.* (2015) with caveats as discussed below, our conclusions differ. We also provide results using unscaled variables following Durtschi and Easton (2009) and find that some of the discontinuities disappear seemingly consistent with their argument that scaling and sample selection contribute to discontinuities in smaller samples. However, using our alternative methodology, we find results consistent with the Burgstahler and Dichev (1997) interpretation using both scaled and unscaled earnings variables. To evaluate the validity of our proposed methodology and its inability to reject when the null is true, we examine whether the presence of discretionary accruals relates to these findings. As expected, we find that these discontinuities disappear when discretionary accruals are excluded from earnings and earnings changes, consistent with managers not managing towards benchmarks in earnings before discretionary accruals.

In further analyses, we replicate the tests using the distribution of earnings before total manipulation (accrual and real manipulation) as well as analyst forecast errors (i.e. examine discontinuities around zero forecast errors). The findings are in line with expectations.

Overall, this study contributes to prior literature in two important areas. First, we propose an alternative methodology that resolves seemingly conflicting findings in prior literature. Using the standard distributional approach may yield different results depending on whether earnings are scaled. In contrast, using our alternative methodology provides consistent results for scaled and unscaled earnings. Our methodology is arguably an improvement as it removes a subjective choice in analyses of empirical histograms and of the density functions constructed for an *a priori* selected bin width. More specifically, the methodology prevents researchers from affecting the outcome of the research by their own preferences, which is missing from the literature. This distributional methodology can potentially be used in alternative settings with multiple thresholds, such as in studies of errors in financial statement numbers as in Amiram *et al.* (2015).

The literature on the use of discontinuities is still relevant and therefore would benefit from improved methodological approaches. Recent studies include Bordeman and Demerjian (2022) who find that discontinuities in the distribution of debt/equity measures are sensitive to bin width selection. Stice *et al.* (2022) examine frequency distributions of revenues and test for discontinuities around base-ten thresholds. Orozco and Rubio (2022) examine discontinuities in the distribution of regulatory capital to test whether banks manage this to exceed thresholds imposed by the Federal Deposit Insurance Corporation Act of 1991. Therefore, these strands of research would benefit from the proposed alternative methodology.

Second, we provide evidence that discretionary accruals (as well as total manipulation, including real manipulation) are related to the discontinuities in earnings, in a manner not considered by Dechow *et al.* (2003). Even though some prior literature provides convincing evidence in favor of the earnings management interpretation, several papers are within specific settings and therefore results need not extrapolate to large sample distributions (e.g. Beatty *et al.*, 2002 find evidence of earnings management around earnings increases in public banks compared to private banks; Donelson *et al.*, 2013 find discontinuities in distributions of restatement firms).

These findings are important to regulators, investors and other financial statement users in understanding the financial reporting environment. In addition, our findings should inform researchers who question whether the discontinuities around the earnings benchmarks are evidence of earnings management or due to methodological choices.

The remainder of the paper is organized as follows. The next section presents the background and literature review, followed by an explanation of the statistical approach in section 3. Section 4 presents the sample selection and variable construction, followed by results in section 5 and robustness tests in section 6. Section 7 concludes.

2. Background and literature review

Prior research on earnings management using a frequency distributional approach establishes three significant benchmarks around zero in earnings levels (to avoid reporting losses), earnings changes (to avoid declines in earnings) and analysts' forecast errors (to meet analyst forecasts) [3]. Burgstahler and Dichev (1997) present the first empirical evidence of discontinuities in earnings' distributions in a US sample during 1976–1994 and interpret this as evidence of earnings management. They find unusually high frequencies of small positive earnings and small increases in earnings, as well as unusually low frequencies of small losses and small decreases in earnings. Degeorge *et al.* (1999) present similar evidence while including analyst earnings forecasts as an additional benchmark to meet. Similar findings have also been documented in later studies (e.g. Burgstahler and Eames, 2003, 2006).

Kerstein and Rai (2007) model shifts in the cumulative earnings distribution during the fourth quarter to explain the discontinuity around zero earnings (see also Das *et al.*, 2009).

They show that compared to a control group, a high proportion of firms with small cumulative profits or losses at the beginning of the fourth-quarter report small annual profits rather than small annual losses. This suggests that upward earnings management causes the discontinuity and indicates which firms are likely to manage earnings upward. Donelson *et al.* (2013) study firms that faced class action litigation and subsequently restated earnings figures. They find evidence of discontinuities in histograms of the initially reported earnings (prior to restatement) and find no such evidence for the same sample when using the subsequently restated earnings. Together, these studies suggest that US managers apply discretion to beat the aforementioned earnings benchmarks [4]. An alternative interpretation is provided by de la Rosa and Lambertsen (2022), who analytically model the role of loss-averse investors in the capital market and show that discontinuities can be caused by strategic reporting by firms.

Gilliam *et al.* (2015) find no discontinuities following the 2002 enactment of SOX and interpret this as evidence of more constraints on managing accruals in recent years. Similarly, Cohen *et al.* (2008) hypothesize and find that stronger US Securities and Exchange Commission (SEC) enforcement of accrual-based earnings management after SOX lead to decreased accrual-based earnings management, seemingly consistent with the absence of discontinuities documented in Gilliam *et al.* (2015). Further evidence documents a shift from accrual manipulation to real activities manipulation following SOX since the latter is subject to lower levels of regulatory scrutiny (e.g. Cohen *et al.*, 2008, 2013; Francis *et al.*, 2016; Cooper *et al.*, 2018; Baker *et al.*, 2019). Recently, Pincus *et al.* (2022) report similar evidence, while Espahbodi *et al.* (2022) find that accrual manipulation reverted back to its pre-SOX levels over the long-term. As a result, it is not clear that SOX adoption would lead to less earnings management to meet or beat earnings benchmarks. Instead, it is possible that the smaller sample size in Gilliam *et al.* (2015) lowers the power of their tests, i.e. it is more difficult to reject the null hypothesis. This is corroborated by recent results in the UK setting where Liu (2020) finds no significant change in the use of accrual-based and/or real earnings management for firm-years suspected of beating/meeting zero, prior year, or analyst forecast consensus earnings thresholds before and after the tightening of audit requirements.

As a result, trying alternative tests is helpful to better understand the effect of SOX. Interestingly, in a recent UK sample (2009–2015), Al-Shattarat *et al.* (2022) find evidence of real earnings management in firms that just meet zero earnings and changes in earnings benchmarks. Makarem *et al.* (2018) find that both small-profit and small-loss firms are engaged in manipulation of accruals as well as real activities. At the same time Haga *et al.* (2019) suggest that manipulation of accruals enables benchmark beating with high precision, while manipulation of cash flows does not. With the exception of Gilliam *et al.* (2015), prior studies discussed above provide evidence of discontinuities in distributions around earnings benchmarks and interpret these as resulting from earnings management.

Durtschi and Easton (2005) challenge the interpretation of the distributional approach and the commonly held view that the discontinuities within earnings histograms stem from earnings management. Durtschi and Easton (2009) conclude that the shape of distribution of earnings is inconclusive evidence of earnings management without consideration of other factors such as sample selection biases, scaling factors, averaging and accounting methods. They demonstrate that the elimination of observations with small profits and small losses in the sample selection process results in too many observations in the smallest profit bin and too few observations in the smallest loss bin in the distribution. They also argue that various scaling factors used in earnings management studies differ among profit and loss companies, which highly influence distributions.

This view supports Dechow *et al.* (2003) who argue that a shift in the earnings distribution is influenced by sample selection biases and scaling. In line with this, Beaver *et al.* (2007) find that asymmetric earnings distributions are likely due to the asymmetrical nature of accounting conservatism, taxes, the inclusion of different sized-firms in large samples and listing requirements for sustained profits. The evidence of marathon runners' completion times presented in Allen *et al.* (2017) suggests that managers take real actions to improve performance when slightly below target earnings. In other words, the discontinuities in the distribution of earnings could stem from changes in operational practices.

Li (2014) analytically and empirically show that discontinuities of analyst forecast errors can occur endogenously depending on the time-series properties of earnings. Similarly, Hemmer and Labro (2019) theoretically show that the frequency distribution of earnings may exhibit a kink at zero, as a natural consequence of using past earnings as the basis for value-increasing managerial decision.

In contrast, Jacob and Jorgensen (2007) suggest that irregularities in distributions are not caused by selection bias and scaling. Their tests demonstrate irregularities at zero in the distribution of unscaled income as well as in the distribution of scaled net income, using quarterly results. Jorgensen *et al.* (2014) furthermore show that the irregularities are not due to scaling and sampling factors by examining earnings per share (EPS) distributions around the change in the mandatory reporting of EPS surrounding Statement of Financial Accounting Standard No. 128. Burgstahler (2014) argues that the current evidence points to earnings management behavior. In a sample of US firms during the period 1988–2010, Xu (2016) finds evidence of accruals management to meet the zero EPS benchmark.

Part of the current literature on the distributional approach pays particular attention to interval or bin widths. As noted by Degeorge *et al.* (1999) and Glaum *et al.* (2004), bin widths have to be carefully selected because the shape of distribution is dependent on them. For instance, even if the true distribution is discontinuous, it may appear as continuous if bins are excessively large (Bollen and Pool, 2009). Moreover, the power of the standardized difference test proposed by Burgstahler and Dichev (1997) is considerably reduced by the magnitude of the bin width (Burgstahler and Chuk, 2015). In order to determine bin widths, various studies use different methods. The majority of the studies use either visual inspection or the Silverman's (1986) rule of thumb. Lahr (2014) uses a bootstrap method to endogenize the selection of bin widths and highlights that shifts in the origin of a histogram can be arbitrarily changed even if plausible bin widths have been determined. Recently, Byzalov and Basu (2019) develop an alternative methodology to test for discontinuities around earnings benchmarks conditional on multiple explanatory variables. Their method allows for narrower bin widths without sacrificing test power; however, one still has to choose the bin width.

A review of the literature investigating discontinuities around earnings benchmarks highlights the differences in bin widths used in the aforementioned articles. Appendix lists prior research articles using the distributional approach, highlighting the bin widths as well as variables used, which documents the diversity of bin widths used. For example, bin widths for earnings levels range from 0.0025 (Glaum *et al.*, 2004) to 0.01 (Holland and Ramsay, 2003). To help in resolving the issue of whether discontinuities in the earnings distribution is evidence of earnings management or other factors, in the next section, we introduce an alternative technique that does not rely on a subjective choice of bin widths.

3. Statistical methodology and hypotheses

Prior empirical research on earnings management around benchmarks has mostly been based on constructing histograms with a subjective choice of bin width and derives a test statistic based on the expected number of observations in each histogram bin. However, their results are highly dependent on the choice of histogram bin width. Other researchers such as Lahr (2014) have sought to endogenize the bin width selection through the use of bootstrap methods using a kernel density function [5]. However, the kernel distribution relies on the choice of bin width as well. Furthermore, the test statistic used in prior research assumes normal distributional properties which may not hold in samples of earnings and changes in earnings (Christodoulou and McLeay, 2009).

We therefore propose an alternative methodology to alleviate these issues, which would add to the debate on whether discontinuities around certain benchmarks provide evidence of earnings management. Specifically, in order to provide robust statistical evidence for the existence of discontinuities around zero earnings and changes in earnings, we first determine a smoothed density function of the variable under investigation under the absence of discontinuity. Then we compare the density function of the actual data with the generated smoothed density function. If a discontinuity does exist, then these two functions must be globally identical (stochastically equal) and they must differ around the point of discontinuity (stochastically different).

The proposed technique is comprised of 4 steps. Let us assume that we want to test for the existence of discontinuities around zero in the density function of a generic earnings variable, x_t:

Step 1. In order to avoid any possible bias due to extreme outliers, we omit from the data sample the observations that are outside three standard deviations from $\overline{x_t}$.

Step 2. We generate the smoothed series $x_t^{(s)}$. Based on the ordered data $x_{(t)}$, the smoothed series is estimated by regressing $x_{(t)}$ on a k^{th} degree polynomial of index t [6]:

$$x_{(t)} = \beta_0 + \sum_{j=1}^{k} \beta_j t^j + \varepsilon_t, \tag{1}$$

where ε_t refers to a white noise process. The k order is selected according to the Schwarz (1978) Bayesian information criterion. The smoothed series, $x_t^{(s)} \equiv \widehat{\beta}_0 + \sum_{j=1}^{k} \widehat{\beta}_j t^j$, represents the theoretical x_t in the absence of discontinuities in its distribution.

Step 3. The distributions of the series x_t and $x_t^{(s)}$ should be statistically indistinguishable. In other words, globally (for the whole set of values) the constructed data must have the same empirical distribution function as the original data. We utilize the U-statistic, firstly proposed by Mann and Whitney (1947), in order to investigate the first null hypothesis that the series x_t and $x_t^{(s)}$ with continuous cumulative distribution functions f and g have stochastically equal density functions against the alternative hypothesis that one distribution is stochastically smaller than the other. Under the null hypothesis,

$$H_0 : f\left(\{x_t\}_{t=1}^{T}\right) = g\left(\left\{x_t^{(s)}\right\}_{t=1}^{T}\right), \tag{2}$$

the series x_t and $x_t^{(s)}$ are globally identical.

Step 4. The distributions of the series x_t and $x_t^{(s)}$ around the point of discontinuity (in our case this is the zero value) may be stochastically different. We denote the point of discontinuity by $x_{t,0}$. Under the alternative hypothesis of earnings management, e.g. in the case of $x_t \equiv E_t$ (earnings in year t) we should have, locally, to the left of the benchmark, $x_{t,0}$ less companies than to the left of $x_{t,0}^{(s)}$. Additionally, we should have, locally, to the right of $x_{t,0}$ more companies than to the right of $x_{t,0}^{(s)}$. If this is the case, then the series x_t and $x_t^{(s)}$ are not locally (around the point $x_{t,0}$) identical. Applying the Mann–Whitney U-statistic, we investigate the null hypothesis that the series x_t and $x_t^{(s)}$ have stochastically equal distributions around the point of discontinuity:

$$H_0 : f\left(\left\{x_{t,0}\right\}_{t=0^-}^{0^+}\right) = g\left(\left\{x_{t,0}^{(s)}\right\}_{t=0^-}^{0^+}\right). \quad (3)$$

If the null hypothesis is rejected, the series x_t and $x_t^{(s)}$ have locally (around the point of discontinuity) distinguishable distributions.

Therefore, if the null hypothesis in step 3 is not rejected, and the null hypothesis in step 4 is rejected, then the distribution of the original data, x_t, and the distribution of the constructed data, $x_t^{(s)}$, are globally stochastically equal but locally (around $x_{t,0}$) they are stochastically different. Hence, the x_t has a point of discontinuity at $x_{t,0}$.

Our methodology therefore differs from Lahr (2014) in one important regard. Under the kernel distribution estimation in Lahr (2014), researchers must supply an *a priori* bin width estimate as a starting value (e.g. one derived from Silverman's (1986) rule of thumb) in addition to a kernel function and confidence level for the bootstrap step. In contrast, our proposed method does not require this and instead relies on the data itself to build the smooth distribution without a need to select any bandwidths.

4. Sample selection and construction of variables

4.1 Sample selection

The sample includes all firm-year observations with available annual reported earnings data of US listed firms for the period 2000–2020. Our sample period is comparable in length to studies such as Burgstahler and Dichev (1997) and Durtschi and Easton (2005). Furthermore, our sample is recent covering the post-SOX period as tested in Gilliam *et al.* (2015) whereby they document the disappearance of the discontinuities around earnings benchmarks. This data is collected from *Compustat*®. We eliminate all firms within the financial industry. Following Durtschi and Easton (2009), we impose no other restrictions in the sample selection process. The final sample ranges from 70,034 to 110,615 observations. We collect data necessary for calculating discretionary accruals for all firms over the period 2000–2020. Consistent with prior research, outliers are removed in calculating discretionary accruals.

4.2 Variables examined

We examine the distribution of several variables and test whether any discontinuities exist around the benchmarks. Following prior research using the distributional approach, we examine the distribution of several earnings and earnings changes variables to test whether firms manage earnings to avoid losses and to avoid declines earnings relative to prior year's earnings; i.e. Degeorge *et al.* (1999).

The first variable examined is E_t (earnings in year t) which is measured as net income scaled by opening market value of equity in year. We also examine the distribution of ΔE_t (change in earnings between year t and the previous year, $t-1$) scaled by opening market value of equity in year $t-1$ [7].

Since Durtschi and Easton (2005, 2009) suggest that the discontinuities around zero earnings levels and zero earnings changes may be due to scaling the earnings variables, we also use unscaled net income, NI_t and change in net income, ΔNI_t as alternative measures. Following the argument proposed by Durtschi and Easton (2005) that sample selection criteria from using market value of equity as a deflator may also be the driver of the discontinuities shown, we also use an alternative measure of earnings, namely diluted earnings per share excluding extraordinary items in year t, EPS_t and the change in this variable ΔEPS_t from year $t-1$ to year t [8].

We also examine whether levels and changes of estimated non-discretionary earnings, defined as earnings less discretionary accruals, exhibit discontinuities around zero. Discretionary accruals are commonly used to manage earnings (Jones, 1991; Ayers *et al.*, 2006) and therefore may cause discontinuities in earnings distributions. Gore *et al.* (2007) report similar findings in the UK setting. Coulton *et al.* (2005) examine discretionary accruals for Australian firms just meeting and missing earnings benchmarks and find that benchmark beaters have large positive discretionary accruals compared to other firms. However, a similar result is found for firms that have just missed the benchmarks.

We calculate discretionary accruals (DA_t) using the modified Jones model (Jones, 1991; Dechow *et al.*, 1995) adjusted for performance as proposed by Kothari *et al.* (2005), as the residual from the following regression:

$$TA_{it} = \alpha_0 + \alpha_1(1/A_{it-1}) + \alpha_2(\Delta REV_{it}) + \alpha_3(PPE_{it}) + \alpha_4 ROA_{it} + \varepsilon_{it}, \quad (4)$$

where TA_{it} are the total accruals for firm i in year t (defined as earnings before extraordinary items less cash from operations), A_{it-1} are the total assets for firm i in year $t-1$, ΔREV_{it} denotes the revenues for firm i in year t less revenues in year $t-1$ scaled by total assets at $t-1$, ΔREC_{it} are the net receivables for firm i in year t less net receivables in year $t-1$ scaled by total assets at $t-1$, and PPE_{it} represents the gross property plant and equipment for firm i in year t scaled by total assets at $t-1$. ROA_{it} refers to return on assets for firm i in year t, measured as net income divided by total assets and ε_{it} denotes the normally distributed error term. The regression is run by industry-year in line with Kothari *et al.* (2005).

We then calculate earnings and change in earnings before discretionary accruals by subtracting discretionary accruals from earnings in each year t as follows:

$$NDE_{it} = E_{it} - DA_{it}, \quad (5)$$

$$\Delta NDE_{it} = \Delta E_{it} - \Delta DA_{it}, \quad (6)$$

where NDE_{it} is non-discretionary earnings for firm i in year t, ΔNDE_{it} is non-discretionary change in earnings for firm i in year t, ΔDA_{it} is change in discretionary accruals for firm i from year $t-1$ to year t, and all other variables are as previously defined [9].

We present our analyses in the next section using the distributional approach as well as our alternative methodology for the following eight variables [10]:

E_t = Earnings (net income) scaled by market value of equity in year t;

NI_t = Unscaled net income in year t, in millions;

EPS_t = Diluted earnings before extraordinary items per share in year t;

NDE_t = Non-discretionary earnings, scaled by total assets in year $t-1$;

ΔE_t = Change in earnings (net income) scaled by market value of equity from year $t-1$ to year t;

ΔNI_t = Change in net income from year $t-1$ to year t, in millions;

ΔEPS_t = Change in diluted earnings before extraordinary items per share from year $t-1$ to year t;

ΔNDE_t = Change in non-discretionary earnings from year $t-1$ to year t scaled by total assets in year $t-1$.

We test the hypotheses for each of these variables by first generating a smoothed series for all variables, E_t, NI_t, EPS_t, NDE_t, ΔE_t, ΔNI_t, ΔEPS_t, ΔNDE_t as described in the previous section. We then test whether the distribution appears globally identical to the original data series, as well as test for any local discontinuities around zero earnings levels and earnings changes. To test our hypotheses, we use a non-parametric test, the Mann–Whitney U test, which is a more powerful test in larger samples than a t-test and does not require normality of the distribution [11]. We address the two hypotheses as set out in steps 3 and 4 in section 3 for each of the eight variables as follows:

H1. The global distribution of the actual data series is similar to that of the smoothed data series.

H2. The local distribution of the actual data series at zero is similar to that of the smoothed data series.

5. Empirical results

5.1 Descriptive statistics

Table 1 presents the descriptive statistics for the earnings level sample (Panel A) and the earnings change sample (Panel B). The number of observations with available data for E_t over the sample period 2000–2020 is 99,180 [12]. We find the mean (median) of E_t to be negative (positive) with a value of −44.586 (0.014). However, both the mean and median of NI_t are positive (172.197 and 0.695, respectively) as well as those for EPS_t (86.337 and 0.020, respectively). The non-discretionary earnings measure, NDE_t has a mean (median) of −0.867 (−0.018). The sample ranges between 82,427 observations for NDE_t and 110,615 for NI_t.

Panel B provides descriptive statistics for the earnings change sample. The mean (median) of the change in earnings scaled by market value of equity in year $t-1$ (ΔE_t) is −0.322 (0.004). The mean non–discretionary earnings changes (ΔNDE_t) is negative (−0.031). The sample ranges between 70,034 for ΔNDE_t and 110,610 for ΔNI_t.

In the paragraphs that follow, we present the empirical histograms of the variables under investigation. Any information implied from a visual inspection of the histograms provides

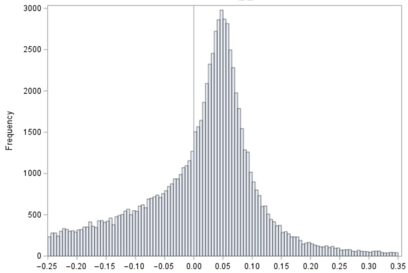
	N	Mean	Median	Std. Dev	25%	75%
Panel A: Descriptive statistics for earnings variables						
E_t	99,180	−44.586	0.014	12811.940	−0.138	0.063
NI_t	110,615	172.197	0.695	1445.310	−9.306	42.301
EPS_t	104,431	86.337	0.020	42431.860	−0.400	1.020
NDE_t	82,427	−0.867	−0.018	18.903	−0.321	0.105
Panel B: Descriptive statistics for changes in earnings variables						
ΔE_t	93,088	−0.322	0.004	410.761	−0.045	0.053
ΔNI_t	110,610	3.034	0.253	1021.500	−8.606	12.660
ΔEPS_t	104,221	48.771	0.020	67148.870	−0.310	0.380
ΔNDE_t	70,034	−0.031	0.000	17.544	−0.160	0.166

Note(s): E_t = Earnings in year *t* scaled by opening market value of equity
NI_t = Unscaled net income in year *t*, in millions
EPS_t = Diluted earnings per share excluding extraordinary items in year *t*
NDE_t = Non-discretionary earnings in year *t* scaled by opening total assets
ΔE_t = Change in earnings from year *t*–1 to year *t* scaled by opening market value of equity
ΔNI_t = Change in unscaled net income from year *t*–1 to year *t*, in millions
ΔEPS_t = Change in diluted earnings per share excluding extraordinary items from year *t*–1 to year *t*
ΔNDE_t = Change in non-discretionary earnings from year *t*–1 to year *t*, scaled by opening total assets

Table 1.
Descriptive statistics

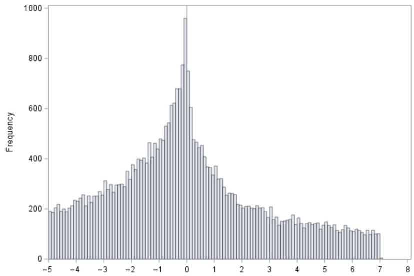
subjective evidence. Furthermore, the selection of the bin width can completely alter the visual interpretation of the histograms (Lahr, 2014). Thus, we present the empirical histograms in Figure 1 and present the statistical tests in Table 2. The alternative analyses conducted according to the proposed statistical procedure are presented in section 5.2.

Panel A: E_t: annual net income scaled by opening market value of equity



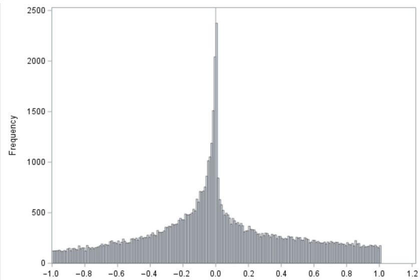
The distribution interval widths are 0.005 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are > 0 and ≤ 0.005. The vertical axis labelled frequency represents the number of observations in each scaled earnings interval. The outliers of the annual earnings scaled by opening market value of equity are not presented in the graph.

Panel B: NI_t: annual unscaled net income



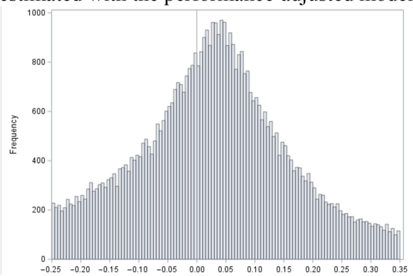
The distribution interval widths are 0.1 ($100,000) and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are > 0 and ≤ 0.1. The vertical axis labelled frequency represents the number of observations in each net income interval. The outliers of the annual net income in year t are not presented in the graph.

Panel C: EPS_t:annual earnings per share



The distribution interval widths are 0.01 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are > 0 and ≤ 0.01. The vertical axis labelled frequency represents the number of observations in each earnings per share interval. The outliers of the annual earnings per share in year t are not presented in the graph.

Panel D: NDE_t: annual non-discretionary earnings scaled by opening total assets estimated with the performance-adjusted model



The distribution interval widths are 0.005 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are > 0 and ≤ 0.005. The vertical axis labelled frequency represents the number of observations in each non–discretionary scaled earnings interval. The outliers of the annual non-discretionary earnings scaled by opening total assets are not presented in the graph.

Note(s): All variables are defined in Table 1

Figure 1.
The frequency distribution of earnings variables

Table 2.
Standardized differences in intervals around zero benchmark

Panel A: Earnings and non-discretionary earnings				
Interval	E_t	NI_t	EPS_t	NDE_t
−2	−0.639	−1.329*	−2.204**	−0.54
−1	−1.399*	5.435***	1.827**	1.464*
0	1.889**	−0.967	16.972***	−1.581*
1	−0.189	−0.266	−16.666***	−0.014

Panel B: Changes in earnings and non-discretionary earnings				
Interval	ΔE_t	ΔNI_t	ΔEPS_t	ΔNDE_t
−2	−1.433	−2.376***	−1.219	−1.218
−1	−1.195	2.018**	−11.832***	0.496
0	3.349***	5.754***	22.159***	−0.159
1	−0.153	−3.766***	−5.832***	−0.532

Note(s): Intervals −2, −1, 0 and 1 are as follows for the above variables
[−0.010,−0.005), [−0.005,0), [0,0.005) and [0.005,0.010), respectively for E_t and NDE_t
[−$200,000,−$100,000), [−$100,000,$0), [$0,$100,000) and [$100,000,$200,000), respectively for NI_t
[−0.02,−0.01), [−0.01,0), [0,0.01), [0.01,0.02), respectively for EPS_t
[−0.005,−0.025), [−0.025,0), [0,0.025) and [0.025,0.005), respectively for ΔE_t and ΔNDE_t
[−$100,000,−$50,000), [−$50,000,$0), [$0,$50,000) and [$50,000,$100,000), respectively for ΔNI_t
[−0.02,−0.01), [−0.01,0), [0,0.01), [0.01,0.02), respectively for ΔEPS_t
***, ** and * represents significance at the 1%, 5 and 10% levels, respectively
All variables are defined in Table 1

Figure 1, panel A, presents the frequency distribution of the earnings variable, E_t with bin widths of 0.005 ranging between −0.25 and 0.35. This shows a bell-shaped distribution with a single peak and some irregularities around zero; the number of observations just below zero is relatively small whereas the number of observations slightly greater than zero is larger.

Panels B and C of Figure 1 present frequency distributions of the alternative earnings measures, NI_t and EPS_t. These indicate similar distributions as in panel A but the peak seems to be around the zero benchmark.

Panel D of Figure 1 shows the distribution of annual non-discretionary earnings scaled by total assets at $t-1$, estimated with the performance-adjusted model during the period 2001–2020 (NDE_t) [13]. This reveals that NDE_t are spread more widely than scaled earnings. Moreover, discontinuities in the distribution around the benchmark are not as obvious.

We test the smoothness of the frequency distribution using the standardized differences as in Burgstahler and Dichev (1997) [14]. We must also assume that the standardized difference approximates the standard normal distribution. The results are presented in panel A of Table 2. For E_t, the standardized difference for the intervals [−0.005,0) and [0,0.005) are −1.399 and 1.889, significant at the 5 and 10% levels, respectively, which indicates that firms seem to shift from the interval to the immediate left of zero towards more positive earnings. These results are in line with Burgstahler and Dichev (1997) and can be interpreted as evidence of earnings management in those firms with earnings slightly below zero to reach the zero earnings benchmark.

The standardized differences in the second column of Table 2, panel A, indicate limited evidence of discontinuities for NI_t with only a significant positive difference in the bin immediately to the left of zero (standardized difference = 5.435, significant at the 1% level). In contrast, there is evidence of discontinuities using EPS_t in the third column with standardized differences of 1.827 and 16.972 (significant at the 5 and 1% levels, respectively) for the intervals immediately to the left and right of zero, respectively. However, this cannot be interpreted as evidence of firms shifting from small losses to small earnings or earnings management. This evidence is in line with findings in Durtschi and Easton (2005) indicating that earnings management evidence is not obvious using the distributional approach around zero benchmarks.

The standardized differences in the final column of panel A of Table 2 surprisingly reveal some discontinuities for the distribution of earnings after eliminating discretionary accruals, with a negative significant difference in the interval immediately to the right of zero (standardized difference = −1.581, significant at the 5% level), indicating less observations than expected.

Figure 2 presents the frequency distribution for all earnings change variables. Panel A displays the distribution of the change in annual net income scaled by market value of equity in year $t-1$, during the period 2001–2020 (ΔE_t). This shows a single peaked bell-shaped distribution. Similar to prior research, we find evidence of high frequency of small positive earnings changes, while there is less frequency of small negative earnings changes.

For the alternative earnings change variables in panels B and C, the peak seems to be higher closer to zero. For ΔNI_t and ΔEPS_t, there appears to be some abnormal frequencies in the two intervals that are adjacent to zero (to the right and left). The distribution of non-discretionary change in earnings presented in panel D of Figure 2 reveals that this is not bell shaped nor single peaked with limited discontinuities around any particular point.

To statistically test the smoothness of the distribution, we again calculate the standardized differences for intervals around zero and present the results in panel B of Table 2. The first column presents results for ΔE_t and this shows evidence of discontinuities around zero. The standardized difference in the intervals [−0.005, −0.025) and [0,0.025) is −1.195 and 3.349, but this is only significant at the 1% level for the interval to the right of zero, indicating some evidence of earnings management; specifically firms appear to shift towards the first interval to the right of zero. In contrast, discontinuities are found for ΔNI_t which are not in line with earnings management to achieve the zero earnings change benchmark. Specifically, the standardized differences in the intervals immediately to the left and to the right of zero are both positive (2.018 and 5.754, significant at the 5 and 1% levels, respectively).

Furthermore, evidence in column 3 for ΔEPS_t are in line earnings management with standardized differences of −11.832 and 22.159 for the intervals immediately to the left and right of zero, respectively (both significant at the 1% level).

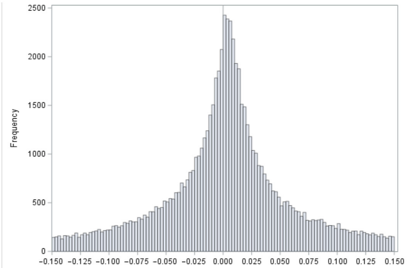
The final column does not indicate discontinuities around zero for the non-discretionary earnings change, ΔNDE_t; standardized differences are 0.496 and −0.159 for intervals immediately to the left and right of zero, respectively, both not significant.

Overall, some inconsistent results are found for alternative earnings variables. We cannot therefore interpret the full set of results as evidence of earnings management. The next section presents the findings from the statistical analysis based on our proposed methodology.

5.2 Results from the proposed statistical methodology

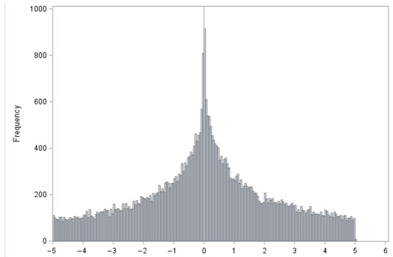
Table 3 presents the coefficient estimates of the polynomial regression in step 2 of our methodology to generate the smoothed series for the 8 variables under investigation. The smoothed series, $x_t^{(s)} \equiv \widehat{\beta}_0 + \sum_{j=1}^{k} \widehat{\beta}_j t^j$, represents the theoretical x_t in the absence of discontinuities in its distribution. All the coefficients are statistically significant for any level of significance. For all variables E_t, NI_t, EPS_t, NDE_t, , ΔE_t, ΔNI_t, ΔEPS_t and ΔNDE_t, the statistically significant orders are $k = 9$.

Panel A: ΔE_t: change in annual net income scaled by opening market value of equity



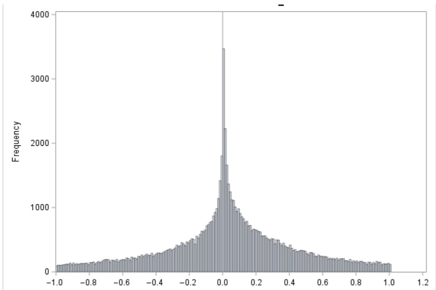
The distribution interval widths are 0.0025 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are >0 and ≤ 0.0025. The vertical axis labelled frequency represents the number of observations in each scaled earnings change interval. The outliers of changes in earnings scaled by opening market value of equity are not presented in this graph.

Panel B: ΔNI_t:change in annual unscaled net income



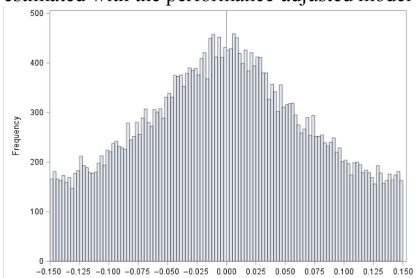
The distribution interval widths are 0.05 ($50,000) and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are >0 and ≤ 0.05. The vertical axis labelled frequency represents the number of observations in each unscaled earnings change interval. The outliers of changes in net income are not presented in this graph.

Panel C: ΔEPS_t:change in annual earnings per share



The distribution interval widths are 0.01 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are >0 and ≤ 0.01. The vertical axis labelled frequency represents the number of observations in each earnings per share change interval. The outliers of changes in earnings per share are not presented in this graph.

Panel D: ΔNDE_t: non-discretionary change in earnings scaled by opening total assets estimated with the performance-adjusted model



The distribution interval widths are 0.0025 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are >0 and ≤ 0.0025. The vertical axis labelled frequency represents the number of observations in each scaled non-discretionary earnings change interval. The outliers of changes in non-discretionary earnings scaled by opening total assets are not presented in this graph.

Note(s): All variables are defined in Table 1

Figure 2. The frequency distribution of changes in earnings variables

Table 4 presents the results from testing whether the distribution of the smoothed series and the actual data for all eight variables under investigation are globally identical as explained in step 3; as well as whether discontinuities exist around zero as explained in step 4. The first

	E_t	NI_t	EPS_t	NDE_t
Panel A: Earnings and non-discretionary earnings				
β_0	−3.006 (−2212.8)	−615.3 (−361.2)	−7.15 (−2614.7)	−9.67 (−1561.5)
β_1	0.0006 (1131.5)	0.17 (271.4)	0.001 (1220.1)	0.002 (882.4)
β_2	-7.23×10^{-8} (−786.6)	-2.34×10^{-5} (−252.3)	-1.41×10^{-7} (−842)	-3.90×10^{-7} (−642.7)
β_3	4.44×10^{-12} (624.2)	1.63×10^{-9} (253.2)	8.42×10^{-12} (685.6)	2.95×10^{-11} (522.2)
β_4	-1.65×10^{-16} (−529.8)	-6.60×10^{-14} (−261.9)	-3.06×10^{-16} (−599.7)	-1.33×10^{-15} (−488.9)
β_5	3.83×10^{-21} (468.5)	1.63×10^{-18} (274.8)	6.95×10^{-21} (546.1)	3.75×10^{-20} (399.5)
β_6	-5.61×10^{-26} (−425.8)	-2.48×10^{-23} (−289.1)	-9.94×10^{-26} (−510.8)	-6.62×10^{-25} (−363.9)
β_7	5.01×10^{-31} (394.6)	2.26×10^{-28} (305.4)	8.70×10^{-31} (488.0)	7.12×10^{-30} (337.0)
β_8	-2.49×10^{-36} (−371.0)	-1.14×10^{-33} (−322.8)	-4.25×10^{-36} (−474.1)	-4.25×10^{-35} (−316.1)
β_9	5.31×10^{-42} (352.7)	2.41×10^{-39} (341.5)	8.91×10^{-42} (467.4)	1.09×10^{-40} (299.4)
Panel B: Changes in earnings and non-discretionary earnings	ΔE_t	ΔNI_t	ΔEPS_t	ΔNDE_t
β_0	−1.65 (−1624.1)	−840.8 (−1447.5)	−7.50 (−2260.5)	−4.08 (−1477.3)
β_1	0.0004 (923.4)	0.20 (918.0)	0.001 (1147.3)	0.001 (773.9)
β_2	-5.39×10^{-8} (−690.0)	-2.26×10^{-5} (−714.2)	-1.66×10^{-7} (−814.9)	-2.08×10^{-7} (−555.9)
β_3	3.76×10^{-12} (584.9)	1.35×10^{-9} (616.9)	1.01×10^{-11} (671.3)	1.90×10^{-11} (462.4)
β_4	-1.58×10^{-16} (−528.4)	-4.85×10^{-14} (−564.7)	-3.71×10^{-16} (−594.7)	-1.06×10^{-15} (−415.6)
β_5	4.16×10^{-21} (495.6)	1.08×10^{-18} (535.6)	8.56×10^{-21} (549.4)	3.69×10^{-20} (390.0)
β_6	-6.86×10^{-26} (−476.3)	-1.52×10^{-23} (−519.7)	-1.25×10^{-25} (−521.8)	-8.13×10^{-25} (−376.4)
β_7	6.88×10^{-31} (465.6)	1.29×10^{-28} (512.3)	1.11×10^{-30} (505.4)	1.09×10^{-29} (370.7)
β_8	-3.85×10^{-36} (−460.8)	-6.13×10^{-34} (−510.8)	-5.49×10^{-36} (−496.8)	-8.17×10^{-35} (−369.7)
β_9	9.16×10^{-42} (460.4)	1.24×10^{-39} (513.8)	1.16×10^{-41} (494.0)	2.61×10^{-40} (372.5)

Note(s): The table presents the coefficient estimates of the model: $x_{(t)} = \widehat{\beta}_0 + \sum_{j=1}^{k} \widehat{\beta}_j t^j + \varepsilon_t$

The values in parentheses denote the coefficient to standard error ratios. The lag orders k have been selected according to the Schwarz information criterion

All variables are defined in Table 1

Table 3. Estimation of smoothed series for earnings variables

	Global distribution $H_0: f(\{x_t\}_{t=1}^{T}) = g(\{x_t^{(s)}\}_{t=1}^{T})$	Local distribution around zero benchmark $H_0: f(\{x_{t,0}\}_{t=0^-}^{0^+}) = g(\{x_{t,0}^{(s)}\}_{t=0^-}^{0^+})$
E_t	0.834	0.000***
NI_t	0.060	0.000***
EPS_t	0.407	0.000***
NDE_t	0.700	0.072*
ΔE_t	0.956	0.000***
ΔNI_t	0.356	0.000***
ΔEPS_t	0.475	0.000***
ΔNDE_t	0.995	0.159

Note(s): *** and * represent significance at the 1 and 10% level, respectively. Column 1 presents p-values from the tests of the overall distribution comparing the smoothed density function to the actual density function for the full sample. Column 2 presents results from the tests of the local discontinuities around the zero benchmark. All p-values are based on the Mann–Whitney U-statistic

All variables are defined in Table 1

When the p-value is less than 0.01 (0.10), then the null hypothesis is rejected at the 1% (10%) significance level

Table 4. Tests using proposed statistical methodology: the p-values for testing the null hypotheses in steps 3 and 4

column provides the p-values for the null hypothesis, $H_0 : f(\{x_t\}_{t=1}^{T}) = g(\{x_t^{(s)}\}_{t=1}^{T})$, that the density functions of the actual data series and the smoothed series (under the absence of discontinuity) are globally stochastically equal. The results indicate that globally, the actual and generated smoothed series have stochastically similar density functions (the p-values are larger than any reasonable level of significance for all 8 variables).

The second column presents the p-values for the null hypothesis, $H_0 : f(\{x_{t,0}\}_{t=0^-}^{0^+}) = g(\{x_{t,0}^{(s)}\}_{t=0^-}^{0^+})$, that the density functions of the actual data series and the smoothed series (under the absence of discontinuity) are stochastically equal around the point of discontinuity. These p-values are used to test whether discontinuities around zero earnings and zero changes in earnings exist.

The p-values in the second column show that locally, around zero, the earnings series do not have the same density function with the generated series (the p-values are close zero rejecting the null hypothesis for any reasonable level of significance) which is in line with discontinuities around the benchmarks identified with earnings management behavior.

More specifically, locally, for the series E_t, a p-value of 0.000 in Table 4 provides strong empirical evidence for the existence of discontinuities in the distribution of scaled earnings around zero earnings. The evidence indicates that earnings are managed to avoid losses.

For the unscaled earnings variable, NI_t, we also find evidence of discontinuities around zero with a p-value of 0.000. This also holds for EPS_t, with a p-value of 0.000. These results suggest that discontinuities of earnings distributions around zero are not the effect of the scaling of the variables.

As the p-value of NDE_t is 0.072, the null hypothesis of no discontinuity around zero cannot be rejected at 1 and 5% levels; therefore, the removal of discretionary accruals from earnings minimizes discontinuities around zero. This suggests that the power of the proposed test (rejecting null hypothesis of no discontinuities at zero) is not increased at the expense of increasing type I error (incorrectly rejecting a true null hypothesis).

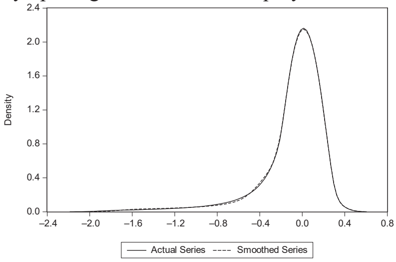
The results for the earnings change variables provide similar evidence. The zero p-value of ΔE_t shows a discontinuity confirming that US companies do manage earnings to avoid decreases in earnings compared to prior year earnings. For the alternative earnings variables, ΔNI_t and ΔEPS_t, evidence also points to discontinuities around zero with p-values of 0.000, for both.

Furthermore, the p-value for ΔNDE_t is 0.159, so we cannot reject the null hypothesis of no discontinuities around zero. This evidence suggests that non-discretionary scaled changes in earnings are spread differently from scaled changes in earnings. Similar to Donelson *et al.* (2013), discontinuities around zero earnings changes disappear due to the removal of discretionary accruals.

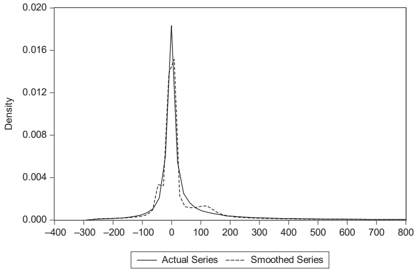
To sum up, the series E_t and ΔE_t as well as the alternative earnings variables, NI_t, EPS_t, ΔNI_t and ΔEPS_t exhibit points of discontinuity around zero, but the other two series after the removal of discretionary accruals, NDE_t and ΔNDE_t have locally equal density functions with the generated series. Overall, we can interpret the results as evidence of earnings management due to loss avoidance and to prevent declines in earnings. The comparison of the earnings and the two non-discretionary earnings distributions reveals that managers in the US use their discretion for the enhancement of the reported earnings. These findings are in line with Burgstahler and Dichev (1997) but not Gilliam *et al.* (2015) who find no evidence of discontinuities after 2002.

To further demonstrate the above visually, following Lahr (2014), Figure 3 plots the Epanechnikov kernel function for the actual x_t and the smoothed series $x_t^{(s)}$, whereas Figure 4 plots the kernel density function around the point of discontinuity, $x_{t,0}$. The Figures provide a visual interpretation of the findings, but, as Lahr (2014) explicitly states, the construction of histograms and kernel density figures are sensitive to the bin width selection (see Figures 1 and 2, as well).

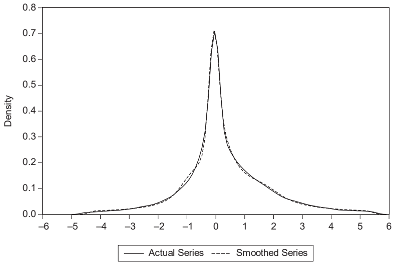
Panel A: E_t is the annual net income scaled by opening market value of equity



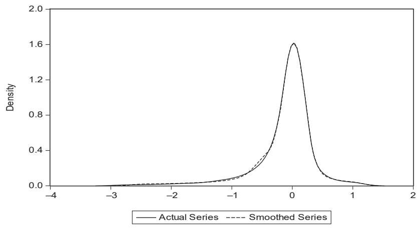
Panel B: NI_t is the annual unscaled net income



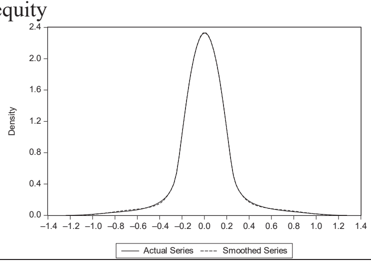
Panel C: EPS_t is the annual earnings per share



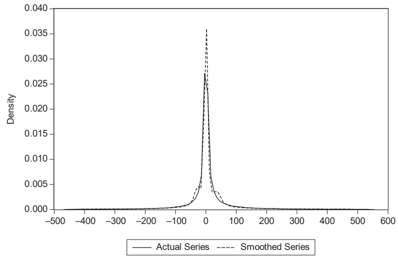
Panel D: NDE_t is the annual non-discretionary earnings scaled by opening total assets estimated with the performance-adjusted model



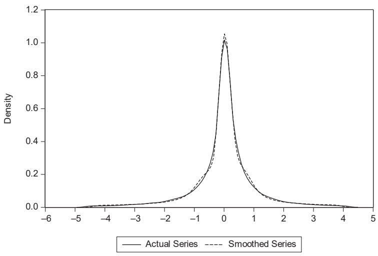
Panel E: ΔE_t is the change in annual net income scaled by opening market value of equity



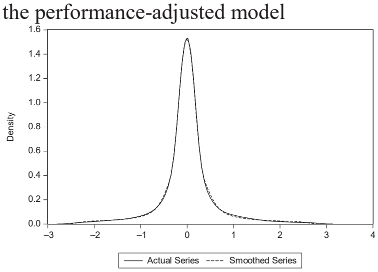
Panel F: ΔNI_t is the change in annual unscaled net income



Panel G: ΔEPS_t is the change in annual earnings per share



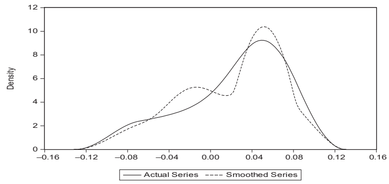
Panel H: ΔNDE_t is the non-discretionary change in earnings scaled by opening total assets estimated with the performance-adjusted model



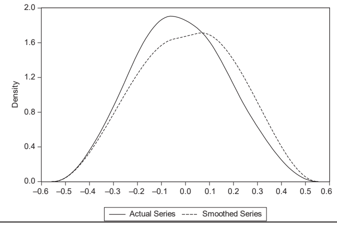
Note(s): All variables are defined in Table 1

Figure 3.
The Epanechnikov kernel global function for the actual x_t and the smoothed series $x_t^{(s)}$

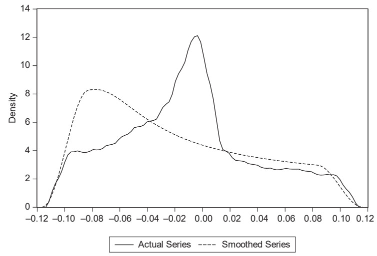
Panel A: E_t is the annual net income scaled by opening market value of equity



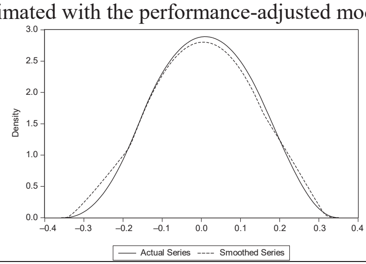
Panel B: NI_t is the annual unscaled net income



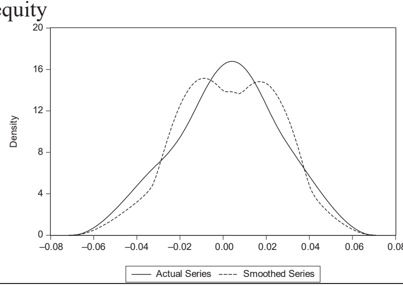
Panel C: EPS_t is the annual earnings per share



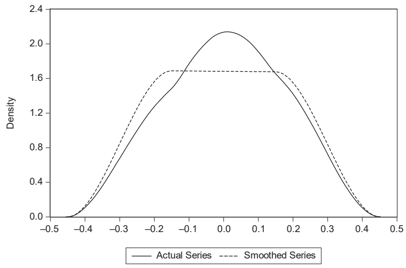
Panel D: NDE_t is the annual non-discretionary earnings scaled by opening total assets estimated with the performance-adjusted model



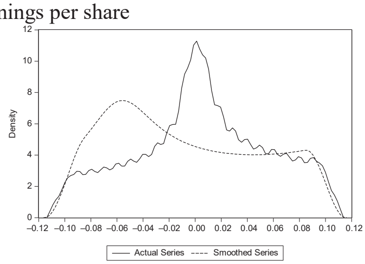
Panel E: ΔE_t is the change in annual net income scaled by opening market value of equity



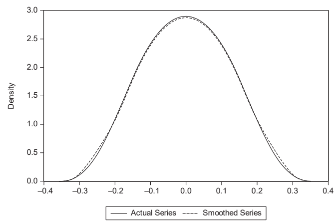
Panel F: ΔNI_t is the change in annual unscaled net income



Panel G: ΔEPS_t is the change in annual earnings per share



Panel H: ΔNDE_t is the non-discretionary change in earnings scaled by opening total assets estimated with the performance-adjusted model



Note(s): All variables are defined in Table 1

Figure 4.
The Epanechnikov kernel function around the point of discontinuity $x_{t,0}$, for the actual x_t and the smoothed series $x_t^{(s)}$

As proposed by Silverman (1986), the kernel density estimate of a series x_t at point x is estimated as $w(x) = (Th)^{-1}\sum_{t=1}^{T} K\left(\frac{x-x_t}{T}\right)$, where $K(u) = \frac{3}{4}(1-u^2)I(|u| \le 1)$ is the Epanechnikov weighting function for $I(.)$ denoting the indicator factor that takes a value of one if $|u| \le 1$, T is the number of observations, and h is the bandwidth or smoothing parameter.

All panels in Figure 3 show that the density function of the actual data series and the smoothed series for all tested variables are globally equal. Specifically, the actual data series (solid line) and smoothed data series (dotted line) overlap in all panels and do not show any significant differences.

Figure 4 shows the density functions at the point of discontinuity (around zero). Panels A (variable E_t) and E (variable ΔE_t) show significant differences between the actual data series (solid line) and smoothed data series (dotted line) around the zero benchmark. The same pattern exists for the remaining earnings and earnings change variables. However, panels D and H showing non-discretionary earnings and earnings changes do not exhibit any significant differences between the actual and smoothed data series. These Figures present a picture in line with the statistical results shown in Table 4.

5.3 Additional earnings benchmarks

As discussed in the literature review, in recent years, there is evidence that firms have shifted from accrual to real manipulation (Gilliam *et al.*, 2015; Cohen and Lys, 2022; Pincus *et al.*, 2022) and this can be used to beat earnings benchmarks (Gunny, 2010). Therefore, as an alternative benchmark, we use earnings less total manipulation (both accrual and real) and examine whether this measure exhibits discontinuities. We measure real manipulation as the sum of abnormal cash flows and abnormal discretionary expenses as in Liu and Espahbodi (2014) using the following regressions [15]:

$$CFO_t = \alpha_0 + \alpha_1(1/A_{t-1}) + \alpha_2(REV_t) + \alpha_3(\Delta REV_t) + \varepsilon_t, \tag{7}$$

$$DISX_t = \alpha_0 + \alpha_1(1/A_{t-1}) + \alpha_2(REV_t) + \varepsilon_t, \tag{8}$$

where CFO_t is cash from operations in year t (defined as net cash flows from operating activities), REV_t denotes the revenues in year t, ΔREV_t denotes the change in revenues which is measured as the revenues in year t less revenues in year $t-1$ scaled by total assets at $t-1$, $DISX_t$ denotes discretionary expenses in year t which is the sum of advertising expenses, research and development expenses and selling, general and administrative expenses, and ε_t denotes the normally distributed error term. All other variables are as previously defined. The regressions are run by industry-year groupings with at least 10 observations.

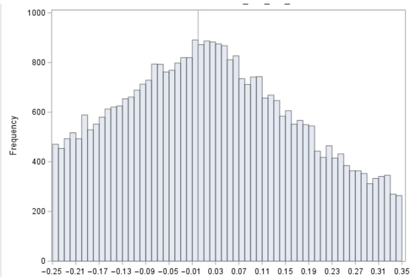
Abnormal cash flows and discretionary expenses are then computed as the difference between the actual values and the residuals from the above regressions; they are multiplied by -1 so that a higher value denotes income-increasing earnings management. Total real manipulation (REM_t) is measured as the sum of abnormal cash flows and discretionary expenses year t. We measure earnings and changes in earnings before total manipulation as follows:

$$PME_t = E_t - DA_t - REM_t, \tag{9}$$

$$\Delta PME_t = \Delta E_t - DA_t - REM_t, \tag{10}$$

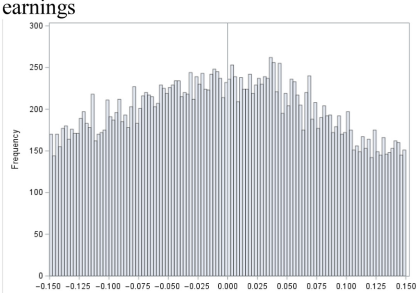
where PME_t is the pre-managed earnings in year t and ΔPME_t is change in pre-managed earnings in year t. We replicate the results using the Burgstahler and Dichev (1997) methodology as well as our alternative methodology as in sections 5.1 and 5.2. Figure 5 and Tables 5 and 6 present these results.

Panel A: PME_t: Pre-managed earnings



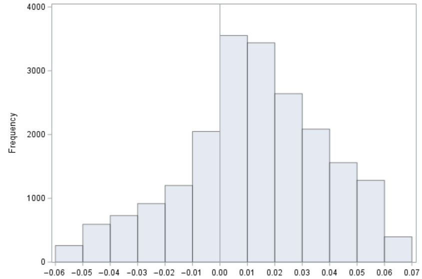
The distribution interval widths are 0.005 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are $>0 \leq 0.005$. The vertical axis labelled frequency represents the number of observations in each earnings interval. The outliers are not presented in the graph.

Panel B: ΔPME_t: Change in pre-managed earnings



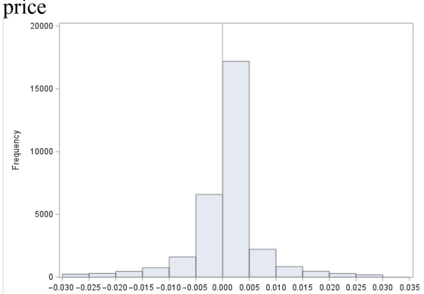
The distribution interval widths are 0.0025 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are $>0 \leq 0.0025$. The vertical axis labelled frequency represents the number of observations in each earnings change interval. The outliers are not presented in this graph.

Panel C: FE_t: Forecast error



The distribution interval widths are 0.01 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are >0 and ≤ 0.01. The vertical axis labelled frequency represents the number of observations in each forecast error interval. The outliers are not presented in the graph.

Panel D: FE_def_t: Forecast error scaled by price



The distribution interval widths are 0.005 and the location of zero on the horizontal axis is marked by the dashed line. The first interval to the right of zero contains all the observations that are >0 and ≤ 0.005. The vertical axis labelled frequency represents the number of observations in each forecast error interval. The outliers are not presented in the graph.

Note(s): Variables are defined in Table 5

Figure 5.
The frequency distribution of additional earning variables

First, we visually inspect the distribution of both variables in panels A and B of Figure 5 around zero earnings once accrual and real manipulation is excluded. There are no apparent discontinuities around zero and the histogram in panel B for ΔPME_t has several peaks which are not around the zero benchmark. We test the statistical significance in Table 5. The results in the first two columns indicate no significance in any of the standardized differences in the intervals around zero, Therefore, there is no evidence of discontinuities.

The results in Table 6 using our proposed methodology are in line with earlier results using non-discretionary accruals. Specifically, PME_t and ΔPME_t have similar global density functions for actual and generated smoothed series as shown by the insignificant p-values in

Interval	PME_t	ΔPME_t	FE_t	FE_def_t
−2	−1.013	−1.129	−6.553***	−38.035***
−1	1.252	0.378	−6.069***	−32.708***
0	−0.473	−0.345	12.277***	127.821***
1	0.263	0.806	5.168***	−105.341***

Note(s): Intervals −2, −1, 0 and 1 are as follows for the above variables
[−0.010,−0.005), [−0.005,0), [0,0.005) and [0.005,0.010), respectively for PME_t and FE_def_t
[−0.005,−0.025), [−0.025,0), [0,0.025) and [0.025,0.005), respectively for ΔPME_t
[−0.02,−0.01), [−0.01,0), [0,0.01), [0.01,0.02), respectively for FE_t
*** represents significance at the 1% level
PME_t = Pre-managed earnings, defined as earnings (net income) less total manipulation (sum of discretionary accruals and real manipulation), scaled by opening total assets
ΔPME_t = Change in pre-managed earnings from year $t-1$ to year t defined as change in earnings (net income) less total manipulation (sum of discretionary accruals and real manipulation), scaled by opening total assets
FE_t = Forecast error defined as actual earnings per share less analyst median forecast immediately prior to announcement, from I/B/E/S
FE_def_t = Forecast error deflated by price defined as actual earnings per share less analyst median forecast immediately prior to announcement, divided by end of year share price, from I/B/E/S

Table 5. Standardized differences in intervals around zero for pre-managed earnings and analyst forecast errors

	Global distribution $H_0 : f(\{x_t\}_{t=1}^{T}) = g(\{x_t^{(s)}\}_{t=1}^{T})$	Local distribution around zero benchmark $H_0 : f(\{x_{t,0}\}_{t=0^-}^{0^+}) = g(\{x_{t,0}^{(s)}\}_{t=0^-}^{0^+})$
PME_t	0.861	0.225
ΔPME_t	0.874	0.720
FE_t	0.979	0.006***
FE_t_def	0.810	0.000***

Note(s): *** represents significance at the 1% level. Column 1 presents p-values from the tests of the overall distribution comparing the smoothed density function to the actual density function for the full sample. Column 2 presents results from the tests of the local discontinuities around the zero benchmark. All p-values are based on the Mann–Whitney U-statistic
Variables are defined in Table 5
When the p-value is less than 0.01 (0.10), then the null hypothesis is rejected at the 1% (10%) significance level

Table 6. Tests using proposed statistical methodology: the p-values for testing the null hypotheses in steps 3 and 4

column 1 (0.861 and 0.874, respectively). Furthermore, the results in column 2 show that locally, around zero, there are no significant differences between the actual and generated series density functions (p-value = 0.225 and 0.720 for PME_t and ΔPME_t, respectively). Therefore, there is no evidence of discontinuities in earnings once total manipulation is taken into account. Collectively, these results indicate that the discontinuities are in line with an earnings management interpretation.

Finally, we use analyst forecast errors as an alternative benchmark. Evidence of discontinuities around zero analyst forecast error in the literature is inconclusive. This is because analyst forecast errors are influenced by both managers and analysts (Matsumoto, 2002; Gilliam *et al.*, 2015). As Burgstahler and Eames (2003) put it, when earnings are managed, whether there are significant discontinuities around zero analyst forecast errors (reported earnings less analyst forecast) is influenced both by the extent of earnings management by firms as well as how well the analysts anticipate this earnings management. Prior research finds discontinuities in the US context (e.g. Degeorge *et al.*, 1999; Burgstahler and Eames, 2003; Eames and Kim, 2012; Bird *et al.*, 2019) but there is also evidence of analysts anticipating earnings management, which can lead to modest discontinuities as well as either negative or positive forecast errors at zero reported earnings and zero forecasted earnings (e.g. Burgstahler and Eames, 2003; Eames and Kim, 2012). Therefore, *a priori*, it is difficult to hypothesize the effect of earnings management on the discontinuity around zero forecast errors. For the sake of completeness, we replicate the tests in sections 5.1 and 5.2 using the analyst forecast as a benchmark, testing whether there are any discontinuities around zero forecast errors (i.e. where reported earnings are exactly equal to analyst forecasts, what is termed "just-meet/beat"). We use reported and forecasted values of annual earnings per share (EPS) from I/B/E/S for firms that have at least three analysts following them and define the forecast error (earnings surprise) as the difference (in cents) between the firm's reported EPS in I/B/E/S and the median analyst forecast before the actual earnings announcement date similar to Habib and Hossain (2008) and Bird *et al.* (2019) as below [16]:

$$FE_t = EPS_t - AEPS_t, \tag{11}$$

where FE_{it} represents forecast error in year t, EPS_t is actual earnings per share as reported by I/B/E/S in year t and $AEPS_t$ represents the latest median analyst forecast before announcement in year t.

We also use an alternative forecast error measure deflated by end of year share price as suggested by Eames and Kim (2012) which we term FE_def_t.

We begin by replicating the results using the Burgstahler and Dichev (1997) methodology. The histograms in panels C and D of Figure 5 show evidence of a discontinuity at zero for both analyst forecast measures. Specifically in panel C, there is a marked increase in observations from the interval to the left of zero to that to the right of zero. The discontinuity is more apparent in panel D for the deflated analyst forecast error showing a large number of observations to the right of zero which coincides with the peak of the distribution. To determine whether these apparent discontinuities are significant, we examine the standardized difference in Table 5. We find a significant negative standardized difference in the intervals to the left of zero (−6.609 and −32.708 for FE_t and FE_def_t, respectively) and a significant positive standardized difference in the intervals to the right of zero (12.277 and 127.821 for FE_t and FE_def_t, respectively). These are in line with managers managing earnings in order to just-meet/beat the analyst forecast.

The results using our proposed methodology in Table 6 finds no difference in the global distribution comparing the actual and smoothed density function of FE_t and FE_def_t. However, locally around zero analyst forecast error, we find a significant difference between the actual and smoothed density function (p-value = 0.006 and 0.000 for FE_t and FE_def_t, respectively. Therefore, we find evidence in line with managers managing earnings towards the analyst forecast in our sample.

6. Robustness checks

For robustness, we proceed to the following assessments in order to investigate whether our findings are sensitive to the proposed computational techniques.

First, we investigate whether the results hold if we define outliers (observations that are excluded from our analysis), as observations that are four standard deviations outside the confidence interval; i.e. $\overline{x_t} \pm 4S_{x_t}$ rather than three standard deviations outside the confidence interval. The results are qualitatively similar.

Second, in step 2 of our methodology, following Lahr (2014), we construct another theoretical series based on the bootstrap procedure (see Table 7). We resample (draw repeated samples with replacement) from the empirical distribution of $x_t^{(s)}$ in order to subjoin uncertainty in the reference distribution. The bootstrapping technique generates the $x_t^{(B)}$

	Global distribution $H_0: f(\{x_t\}_{t=1}^{T}) = g(\{x_t^{(B)}\}_{t=1}^{T})$	Local distribution around zero benchmark $H_0: f(\{x_{t,0}\}_{t=0^-}^{0^+}) = g(\{x_{t,0}^{(B)}\}_{t=0^-}^{0^+})$
E_t	0.864	0.000***
NI_t	0.240	0.000***
EPS_t	0.215	0.000***
NDE_t	0.380	0.284
ΔE_t	0.383	0.000**
ΔNI_t	0.880	0.000***
ΔEPS_t	0.602	0.000***
ΔNDE_t	0.579	0.698

Note(s): *** and ** represents significance at the 1 and 5% levels, respectively
Column 1 presents p-values from the tests of the overall distribution comparing the smoothed density function to the actual density function for the full sample. Column 2 presents results from the tests of the local discontinuities around the zero benchmark. All p-values are based on the Mann–Whitney U-statistic
All variables are defined in Table 1
When the p-value is less than 0.01 (0.10), then the null hypothesis is rejected at the 1% (10%) significance level

Table 7. Tests using bootstrap procedure: the p-values for testing the null hypotheses in steps 3 and 4

series. The investigation of the hypotheses $H_0: f(\{x_t\}_{t=1}^{T}) = g(\{x_t^{(B)}\}_{t=1}^{T})$ and $H_0: f(\{x_{t,0}\}_{t=0^-}^{0^+}) = g(\{x_{t,0}^{(B)}\}_{t=0^-}^{0^+})$ state that x_t and $x_t^{(B)}$ have globally stochastically equal distributions; and around $x_{t,0}$ their distributions are stochastically different. Again, we find similar findings for all variables under investigation. Specifically, E_t, NI_t, EPS_t, ΔE_t, ΔNI_t and ΔEPS_t have points of discontinuity around zero, p-values are 0.000, 0.000, 0.000, 0.018, 0.000 and 0.000, respectively, but, the other two non-discretionary earnings variables have locally equal density functions with the generated series.

Third, we alternatively compute the kernel density for the Gaussian, $K(u) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2}$, and uniform, $K(u) = \frac{1}{2} I(|u| \leq 1)$, kernel weighting functions as in Lahr (2014) [17]. The results are similar to the main analyses.

7. Conclusion

The aim of this study is to test for the discontinuities in the density function of earnings variables around zero and contribute to the ongoing debate of whether these discontinuities are due to earnings management or other reasons such as scaling of the earnings variables or sample selection criteria. We do so by introducing an alternative statistical technique that does not require a subjective choice of bin width in the frequency distribution function; but relies on the data itself. Furthermore, our alternative statistical test is based on a non-parametric test, the U-Mann Whitney test and thus does not necessitate the normality of the distribution.

Under our proposed approach, we estimate the smoothed density function of the variables under investigation. Then the density function of the actual data is compared with the smoothed density function. If the discontinuity around zero does exist, then these two density functions are globally identical but locally (at zero) distinguishable.

We provide evidence of the frequency of earnings management around two benchmarks proposed by prior research, namely zero earnings levels and the previous year's earnings. We use the proposed methodology to test discontinuities for several scaled and unscaled variables on all available US data for the period 2000–2020. We also explore whether removing discretionary accruals reduces irregularities within cross sectional frequency distributions.

Our findings are in line with the interpretation in Burgstahler and Dichev (1997) of earnings management in earnings variables leading to discontinuities around zero. Specifically, we find that the firms in our sample are more likely to report small profits than small losses. These findings hold for scaled as well as unscaled earnings variables. Furthermore, firms are more likely to report small positive changes in earnings, compared to prior year earnings, than report small negative changes. Additionally, discontinuities are reduced when discretionary accruals are removed from earnings, providing evidence consistent with accrual manipulation. Taken together, these results suggest evidence of earnings management around zero earnings levels and changes.

In further tests, we investigate earnings and changes in earnings excluding total manipulation (both accrual and real) as well as analyst forecast errors. We find evidence in line with the earnings management interpretation.

These findings are important to investors, internal and external auditors as well as regulators in understanding the financial reporting environment. Furthermore, the development of the statistical methodology, in testing for discontinuities around specific benchmarks, is potentially significant not only in the earnings management literature but also in other areas such as testing for discontinuities in hedge fund returns (e.g. Bollen and Pool, 2009), shareholder votes (e.g. Listokin, 2009) or executive compensation (Jorgensen *et al.*, 2020). Similarly, the approach can be used in research on reference-dependent preferences (e.g. Allen *et al.*, 2017).

Our proposed approach to testing for discontinuities should allow future research to further investigate specific settings in which earnings management may have occurred. The methodology can also be used in other contexts examining discontinuities around a reference point.

As with all research, this study has limitations. We do not provide direct evidence of earnings management or investigate incentives underlying accrual or real manipulation. This can be examined in future research within specific contexts where earnings management is likely to occur, e.g. around announcements of mergers and acquisitions or linked to executive compensation.

Notes

1. Burgstahler and Chuk (2017) provide a review of the literature on discontinuities in earnings histograms and conclude that earnings management is the only feasible interpretation. See also the reviews by Xu *et al.* (2007), Habib and Hansen (2008) and Han (2013).

2. We also examine discontinuities around zero analyst forecast errors (earnings less analyst forecasts) in section 5.3 as robustness.

3. See Degeorge *et al.* (1999), Bhojraj *et al.* (2009), Iatridis and Kadorinis (2009), Chen *et al.* (2010), Hansen (2010), Donelson *et al.* (2013), Folsom *et al.* (2017), among others.

4. If capital markets incentives were the main reason for discontinuities, one might not find similar evidence in non-US markets. However, empirical evidence from other countries using the distributional approach is similar, e.g. in the UK (Peasnell *et al.*, 2000; Gore *et al.*, 2007), the EU (Daske *et al.*, 2006), Australia (Holland and Ramsay, 2003), Germany (Glaum *et al.*, 2004), Japan (Suda and Shuto, 2006) and Singapore and Thailand (Charoenwong and Jiraporn, 2009). Evidence in other types of firms include Coppens and Peek (2005) in private firms and Nguyen and Soobaroyen (2019) in charities.

5. Kernel density estimation is a non-parametric way to estimate the probability density function of a series. The kernel density is an adjusted histogram in which the boxes of the histogram are replaced by bumps that are smooth. Smoothing is done by putting less weight on observations that are further from the point being evaluated (Silverman, 1986).

6. The letter t in this context does not represent calendar time.

7. We also replicate all tests using total assets as the deflator with similar results.

8. Recent evidence from interviewing 12 chief financial officers of US firms finds that around 20% of firms manipulate earnings and that those firms manipulate EPS by about 10% (Dichev *et al.*, 2013).
9. We scale earnings by total assets rather than market value of equity in this case to be consistent with the discretionary accruals measure.
10. From this point forward, we omit the firm subscript, *i*, for simplicity.
11. The Mann–Whitney U test has some limitations, e.g. the two sampled groups should be randomly selected independent samples and the type I error (rejecting the null hypothesis when it is true) is amplified when the two samples have different variances. However, in the case of our methodology, the series x_t and $x_t^{(s)}$ are not paired samples or draw from the same population. Therefore, we do not believe the limitations will be an issue.
12. The sample period post-SOX used in Gilliam *et al.* (2015) overlaps ours (2003–2012 in Gilliam *et al.*, 2015 compared to 2000–2020 in our sample). However, descriptive statistics of both samples are quite different, e.g. Table 1 in Gilliam *et al.* (2015) on page 122 shows mean annual earnings scaled by market value of equity to be around 0 for all years in their sample whereas the mean in our sample for the similar measure is around −45 (see Table 1). Therefore, we cannot exactly compare our results to those in Gilliam *et al.* (2015).
13. For non-discretionary earnings variables, the sample period is 2001–2020 as one year of data is dropped due to calculation requirements.
14. We measure the standardized difference by subtracting the expected number of observations (average of two adjacent bins) within each bin from the actual number of observations and divide by estimated standard deviation of the difference.
15. Abnormal production costs are also typically included as part of real accounts manipulation but Liu and Espahbodi (2014) argue that including this can lead to double counting as the same activities that lead to abnormally high production costs also lead to abnormally low cash flows.
16. Bird *et al.* (2019) use the consensus or mean analyst forecast rather than the median. We use both the median and consensus as benchmarks and find similar results.
17. The Figures are qualitatively similar to those presented in the paper and are available upon request.

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(The Appendix follows overleaf)

Appendix

Reference	Sample	Variables used	Histogram bin widths	Findings
Panel A: Support for discontinuities around zero as evidence of earnings management				
Burgstahler and Dichev (1997)	US public firms during 1976–1994 excluding financial and regulated firms	Annual scaled net income (deflated by beginning market value of equity); Changes in scaled net income	Bin widths selected through visual inspection (0.005 for net income and 0.0025 for change in net income)	Discontinuities around zero for both net income and changes in income
Degeorge *et al.* (1999)	US public non-financial firms during 1974–1996 with fiscal year-ends of March, June, September, or December with analyst forecasts	Quarterly actual earnings per share (EPS), change in EPS ($EPS_t - EPS_{t-4}$); analyst earnings forecast errors (reported EPS – mean analyst forecast). These exclude extraordinary items	Bin widths based on formula 2(IQR)$n^{1/3}$ equivalent to 1 cent for change in EPS and analyst forecast error	Discontinuities for all three variables around zero
Brown (2001)	US public firms with available quarterly earnings forecasts during 1984–1999	Quarterly analyst forecast error (reported quarterly earnings before extraordinary items and discontinued operations per share less latest analyst forecast of earnings per share)	Bin widths of 1 cent	Discontinuities around zero; trend over time shows shift from small negative surprises to small positive surprises during the period 1984–1999
Beatty *et al.* (2002)	707 US Public and 1,160 private banks during 1988–1998	Annual changes in scaled net income (deflated by beginning total assets)	Bin widths based on formula 2(IQR) $n^{1/3}$equivalent to 0.0004 for change in net income	Discontinuities around zero for public banks but only weak evidence for private banks
Beaver *et al.* (2003)	US property-casualty firms during 1988–1998; further analyses comparing public, private and mutual insurers	Annual scaled net income (deflated by total assets); deflated by policyholders' surplus and earned premiums; annual scaled pre-managed income (scaled net income less discretionary loss accrual reserve)	Bin widths based on formula 2(IQR)$n^{1/3}$ equivalent to 0.006 for net income	Discontinuities for net income around zero for full sample as well as different type of insurers; pre-managed net income more dispersed than actual net income
Burgstahler and Eames (2003)	US public non-financial firms during 1986–1996 with analyst forecast data	Annual scaled earnings before extraordinary items (deflated by market value of equity); analyst earnings forecast error (actual reported earnings before extraordinary items less median analyst forecast or last analyst forecast scaled by market value of equity); annual change in scaled net income and forecast error	Bin widths of 0.005 for scaled net income and forecast errors; bin widths of 0.0025 for change in income and forecast error	Low frequencies of small losses; more negative forecast errors in the lower quartile of the distribution at zero earnings forecasts than for any other interval of earnings forecasts, implying that analysts anticipate earnings management behavior

Table A1.
Prior literature using distributional earnings approach

(*continued*)

Reference	Sample	Variables used	Histogram bin widths	Findings
Holland and Ramsay (2003)	Australian non-financial public firms during 1990–2000	Annual scaled net operating income after tax (deflated by beginning total assets) and cash from operations; annual change in scaled net operating income after tax and cash from operations	Bin widths of 0.01 for net operating income; bin widths of 0.005 for change in net operating income	Discontinuities around zero net operating income but limited evidence for change in net operating income or cash from operations
Glaum *et al.* (2004)	US and German public non-financial firms during 1991–2000	Annual net income (scaled by net sales); annual change in net income; analyst forecast error (earnings per share less consensus analyst forecast scaled by sales per share); other deflators used as robustness	Bin widths determined by visual inspection of 0.0025 for net income; used alternative bin widths visually but did not present results; bin widths of 0.0005 for change in net income; bin width of 0.0005 for forecast errors	Discontinuities for both US and German sample for net income and change in income; Discontinuities for US sample to avoid negative earnings forecasts but not for German sample
Brown and Caylor (2005)	US public firms with available quarterly earnings forecasts during 1984–2002 excluding financial and regulated firms	Quarterly scaled earnings (earnings per share deflated by price at beginning of quarter); change in income; analyst forecast error (reported earnings per share less latest individual forecast prior to announcement deflated by price at beginning of quarter t)	Bin widths of 0.0025 but histograms not shown	Evidence of discontinuities but found hierarchy for benchmarks changed from prior literature. Preference is as follows: avoidance of negative quarterly earnings surprises then avoidance of quarterly losses and quarterly earnings decreases
Coppens and Peek (2005)	Large private firms in 8 EU countries, excluding financial institutions and those in public administration during 1993–1999	Annual scaled net income (deflated by total assets); annual change in net income (deflated by average total assets)	Bin widths of 0.005 for scaled income and change in income	Discontinuities around zero profits indicating private firms manage earnings to avoid reporting losses; no evidence of private firms managing earnings to avoid profit decreases
Leone and Van Horn (2005)	1,204 US nonprofit hospitals that have issued public debt during 1990–2002	Annual scaled operating income (deflated by beginning total assets) and operating income before discretionary accruals; change in scaled operating income	Bin widths of 0.005 for scaled operating income and operating income before discretionary accruals; bin widths of 0.005 for change in operating income	Discontinuities at zero for operating income but not for operating income before discretionary accruals; no evidence of discontinuities for change in operating income

(*continued*)

Table A1.

Reference	Sample	Variables used	Histogram bin widths	Findings
Burgstahler and Eames (2006)	US public non-financial firms during 1986–2000 with analyst forecast data	Analyst earnings forecast error (realized annual scaled earnings less extraordinary items, calculated from actual EPS and deflated by beginning market value of equity, less latest analyst forecast or median analyst forecast)	Bin widths of 0.0002	Few small negative surprises and many zero surprises
Daske *et al.* (2006)	EU public firms from 14 EU countries during 1986–2001	Annual scaled net income (deflated by prior year sales, beginning total assets and market value of equity); changes in scaled net income; analyst forecast errors (actual EPS less consensus analyst forecast; deflated by opening price, total assets or absolute value of actual earnings)	Bin widths based on formula $2(\text{IQR})n^{1/3}$ equivalent to 0.005 for net income; bin widths of 0.005 for changes in income; bin widths of 0.0025 for analyst forecast errors (when using absolute value of actual earnings as deflator range is −0.5 to 0.5)	More firms than expected report small positive earnings and changes in earnings and have zero or small positive forecast errors; the avoidance of loss or earnings changes is more pronounced in countries which do not have a long history of accounting standard-setting
Roychowdhury (2006)	US public firms during 1987–2001 excluding financial and regulated firms	Annual net income (scaled by beginning total assets)	Bin widths of 0.005 for net income	Discontinuities in net income around zero
Gore *et al.* (2007)	UK public non-financial firms during 1989–1998	Annual scaled earnings measured as earnings before extraordinary items (before implementation of FRS3) and earnings before extraordinary and special or non-operating exceptional items (after implementation of FRS3) (deflated by beginning total assets); changes in scaled earnings; analyst forecast error (actual earnings less median forecast deflated by beginning total assets); scaled earnings and changes in earnings excluding discretionary working capital accruals	Bin widths of 0.01 for scaled earnings; bin widths of 0.005 for scaled changes in earnings; bin widths of 0.0025 for analyst forecast error	Discontinuities in earnings but not non-discretionary earnings; therefore, they argue that discretionary accruals are a significant cause of the discontinuity

Table A1. (*continued*)

Reference	Sample	Variables used	Histogram bin widths	Findings
Jacob and Jorgensen (2007)	US public firms during 1981–2001	Annualized scaled net income ending in each of the four-quarters, including fiscal year-end (deflated by beginning market value of equity); annualized change in scaled net income; unscaled annualized net income and earnings per share	Bin widths of 0.005 for scaled net income; bin widths of 0.0025 for change in scaled net income; bin widths of $100,000 from for unscaled net income	Discontinuities for annual fiscal net income but not for annualized net income ending in quarters 1, 2 and 3; evidence of discontinuities for all annualized change in net income variables; discontinuities in fiscal unscaled net income; evidence of shifting from zero to positive EPS
Kerstein and Rai (2007)	US public firms during 1976–2005 excluding financial and regulated firms	Annual scaled net income (deflated by beginning market value of equity); third quarter year-to-date scaled net income	Bin widths of 0.005 for scaled net income	Discontinuities for annual net income but not for quarter 3 year-to-date net income indicating earnings management in fourth quarter to report annual earnings
Habib and Hossain (2008)	Australian non-financial public firms during 1995–2004 with available analyst forecast data	Forecast errors (actual EPS are reported by I/B/E/S – excluding extraordinary items less mean consensus analyst forecast before announcement from I/B/E/S)	Bin widths of 0.01. Alternatives used as robustness were 0.005 and 0.02	Discontinuities around zero forecast error and evidence that firms that just meet analyst forecast have higher discretionary accruals than those just missing the forecast
Bhojraj *et al.* (2009)	US public firms during 1988–2006 with analyst forecast data	Annual analyst forecast error (reported earnings per share in fiscal year less consensus forecast during second month of fourth quarter)	Bin widths of 1 cent for analyst forecast errors	Discontinuities around zero forecast errors; firms that just meet analyst forecasts appear to reduce discretionary spending and increase accruals which leads to long-term underperformance compared to firms that just miss analyst forecasts
Charoenwong and Jiraporn (2009)	Public financial and non-financial firms on Singapore Stock Exchange during 1975–2003; public firms on Stock Exchange of Thailand during 1975–1999	Annual earnings per share ratio measured as net income before extraordinary items divided by number of shares outstanding; changes in earnings per share	Bin widths based on formula 2(IQR)$n^{1/3}$ equivalent to 2 cents for Singapore and 1 baht for Thailand for change in EPS	Evidence of discontinuities around zero for EPS indicating avoidance of reporting losses; Limited evidence to report profits that are higher than in prior year
Chen *et al.* (2010)	US public firms during 1984–2004 excluding financial and regulated firms	Annual scaled net income (deflated by beginning market value of equity); change in scaled net income; analyst forecast errors (reported earnings less mean analyst forecast deflated by beginning market value of equity)	Bin widths are not disclosed	Frequency of earnings management is the highest when firms try to meet analyst forecasts; more firms manage earnings to avoid earnings decreases, followed by avoiding negative earnings

(*continued*)

Table A1.

Reference	Sample	Variables used	Histogram bin widths	Findings
Eames and Kim (2012)	US public firms with available analyst data during 1983–2007, excluding financial firms and utilities	Forecast errors measured as difference between earnings and forecasts from I/B/E/S scaled by beginning of year market value. These exclude extraordinary items	Bin widths of 0.005 similar to Burgstahler and Eames (2003)	Evidence of greater forecast optimism (i.e. more negative forecast error) at zero earnings forecasts than for surrounding intervals of earnings forecasts
Donelson *et al.* (2013)	US public firms with securities class action litigation involving accounting fraud during 1996–2005 that resulted in restatement of quarterly earnings	Quarterly scaled reported and restated income (earnings before extraordinary items deflated by market value of equity at end of quarter); scaled reported and restated change in income; reported and restated analyst forecast error (earnings per share less consensus analyst forecast three days before earnings announcement); robustness for scaling income and change in income using total assets and post-litigation market value of equity	Bin widths of 0.005 for scaled income; bin widths of 0.0025 for scaled changes in income; bin widths of 1 cent for analyst forecast errors	Discontinuities in the distribution of analyst forecast errors and earnings changes for reported figures but not restated figures in line with earnings management explanation. Mixed evidence with the earnings level distribution as the evidence of earnings management driving the discontinuity is sensitive to the scaling variable
Jorgensen *et al.* (2014)	US public firms during 1980–2010 around introduction of mandatory reporting of EPS (SFAS 128)	Change in annual primary earnings per share excluding extraordinary items before SFAS128 and diluted earnings per share excluding extraordinary items after SFAS128 with reported EPS between -\$1 and \$2.5. Overlap period between December 1995 and November 1997 includes reported primary EPS and restated diluted EPS	Bin width of 1 cent	Discontinuities in distribution of change in EPS consistent with avoidance of reporting decreases in EPS. Evidence of discontinuities in reported change in EPS but not restated change in EPS under SFAS128

Table A1.

(*continued*)

Reference	Sample	Variables used	Histogram bin widths	Findings
Burgstahler and Chuk (2015)	US public firms during 1990–2009 excluding financial and regulated firms	Annual unscaled earnings (net income); earnings per share (EPS); scaled earnings (net income deflated by beginning market value of equity)	Bin widths of $2.5 M for unscaled earnings; bin widths of $100,000 for unscaled earnings or 0.25% of median of market value of equity; bin widths of $0.07 and 1 cent for EPS or 0.25% of median price per share; bin widths of 0.005 for scaled earnings	Discontinuities in distribution of unscaled earnings is more prominent in smaller firms; significance of the discontinuity varies by bin width and range of histogram; discontinuities for EPS at zero but significance varies by price of firm as well as bin width and range of histogram; discontinuities in distribution of scaled earnings more prominent in small and medium-sized firms
Gilliam *et al.* (2015)	US public firms during 1976–2012 excluding financial and regulated firms and observations with exactly zero net income	Annual scaled net income (deflated by beginning market value of equity); earnings before taxes	Bin widths of 0.005 for scaled net income; as robustness, untabulated results use alternative bin widths based on formula $2(IQR)n^{1/3}$ with similar results; bin widths of 0.10 for scaled net income	Evidence of discontinuities before 2002 but not after enactment of the Sarbanes-Oxley Act of 2002 (SOX); in line with constraints in managing accruals in the post-SOX period
Burgstahler and Chuk (2017)	US public firms during 1990–2013	Annual scaled measures of several earnings variables such as earnings before special items (deflated by beginning market value of equity), earnings after special items, earnings before research and development expenditures, earnings before extraordinary items and discontinued operations and net income	Bin widths of 0.005 for earnings measures	Discontinuities at zero for earnings measures that stakeholders would pay attention to, e.g. net income, but not for measures that stakeholders would not be concerned with, e.g. earnings before research and development expenses; no evidence for banks and firms in regulated industries
Bird *et al.* (2019)	US public firms with available analyst forecast data on I/B/E/S	Analyst forecast error measured as the difference (in cents) between a firm's actual EPS as reported in I/B/E/S and the consensus forecast	Bind widths of 0.01 and 0.05 using polynomial, empirical and latent distributions	Discontinuities at zero forecast error in line with earnings management explanation
Byzalov and Basu (2019)	US public non-financial firms during 1988–2015	Net income scaled by the lagged market value of common equity	Alternative methodology with bin widths based on formula $2(IQR)n^{1/3}$ rounded to 0.0025 and as robustness 0.001	Discontinuities at zero earnings; statistical power improvement on previous findings

(continued)

Table A1.

Reference	Sample	Variables used	Histogram bin widths	Findings
Panel B: No support for discontinuities around zero or alternative explanations to earnings management				
Dechow *et al.* (2003)	US public firms during 1988–2000 excluding financial firms	Annual scaled net income (deflated by beginning market value of equity); earnings per share; unscaled net income; earnings per share; unscaled cash from operations; change in scaled net income and EPS	Bin widths of 0.005 for net income; bin widths of 1 cent for EPS; bin widths of $100,000 for net income and cash from operations	Discontinuities in scaled net income at zero; discontinuities for cash from operations found which is inconsistent with earnings management explanation
Coulton *et al.* (2005)	Australian public non-financial firms during 1993–2002 with available data to calculate accruals	Annual operating earnings (deflated by opening total assets) as well as changes in operating earnings	Bin width of 0.01 for levels and changes	Discontinuities at zero but further analysis shows that although benchmark beaters have larger positive unexpected accruals than other firms, a similar result holds when firms with small losses or earnings declines are compared with other firms
Durtschi and Easton (2005)	US public firms during 1983–2002 excluding financial and regulated firms; further tests require analyst forecasts during 1983–2003	Annual scaled net income (deflated by beginning market value of equity); reported diluted earnings per share (EPS); unscaled net income; analyst forecast errors (reported EPS less mean analyst forecast)	Bin widths of 0.005 for scaled net income and 1 cent for EPS; bin widths of $100,000 for net income; bin widths of 0.0025 for change in scaled net income and 1 cent for change in EPS; bin widths of 1 cent for analyst forecast error	Evidence of discontinuities around zero earnings is found to be an artifact of scaling (market value of equity vs price), sample selection criteria and/or difference in characteristics between firms just above and below zero earnings
Beaver *et al.* (2007)	US public firms during 1976–2001 excluding financial and regulated firms	Annual scaled net income (deflated by beginning market value of equity); scaled pre-tax income; scaled income before special ítems; unscaled net income	Bin widths of 0.005 for scaled earnings from; bin widths of $100,000 for unscaled earnings	Evidence of discontinuities at zero for net income explained by income taxes and special items. Income taxes draw profit observations towards zero while negative special items pull loss observations away from zero
Durtschi and Easton (2009)	US public firms during 1976–2006 excluding regulated firms	Annual unscaled net income (and sum of four-quarter net income figures); scaled net income (deflated by market value of equity)	Bin widths of $100,000 for net income; bin widths of 0.005 for scaled net income	Evidence of discontinuities at zero for net income explained by the different relation between earnings and price across positive and negative earnings

Table A1. (*continued*)

Reference	Sample	Variables used	Histogram bin widths	Findings
Lahr (2014)	US public firms during 1976–2010 excluding financial and regulated firms and observations with scaled net income less than −1 or greater than 1 or exactly equal to zero; tests using analyst forecasts during 1986–2010	Annual scaled net income (deflated by beginning market value of equity); changes in scaled earnings; scaled analyst forecast error (reported EPS less median analyst EPS 1 month or 3 months before the announcement deflated by beginning share price)	Bin widths determined by bootstrap test for histogram and Kernel Density Estimation method of 0.00096 (as robustness present results for bin width of 0.005) for scaled net income; bin widths of 0.0002 for analyst forecast errors	Discontinuities in distribution of zero earnings for full sample but not in many yearly sub-samples; No evidence of discontinuities in analyst forecast errors with prior results driven by mis-specifying the reference distribution

Table A1.

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