The Quality of Accruals and Earnings: The Role of Accrual Estimation Errors

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ABSTRACT: This paper suggests a new measure of one aspect of the quality of working capital accruals and earnings. One role of accruals is to shift or adjust the recognition of cash flows over time so that the adjusted numbers (earnings) better measure firm performance. However, accruals require assumptions and estimates of future cash flows. We argue that the quality of accruals and earnings is decreasing in the magnitude of estimation error in accruals. We derive an empirical measure of accrual quality as the residuals from firm-specific regressions of changes in working capital on past, present, and future operating cash flows. We document that observable firm characteristics can be used as instruments for accrual quality (e.g., volatility of accruals and volatility of earnings). Finally, we show that our measure of accrual quality is positively related to earnings persistence.

Keywords: quality of accruals; earnings quality; estimation errors; earnings persistence.

Data Availability: Data are available from sources identified in the paper.

1. INTRODUCTION

This paper suggests a new measure of one aspect of the quality of working capital accruals and earnings. The measure is based on the observation that accruals shift or adjust the recognition of cash flows over time, so that the adjusted numbers (earnings), better measure firm performance (e.g., see Statement of Accounting Concepts

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No. 1, FASB 1978, para. 44). For example, recording a receivable accelerates the recognition of a future cash flow in earnings, and matches the timing of the accounting recognition with the timing of the economic benefits from the sale. However, accruals are frequently based on assumptions and estimates that, if wrong, must be corrected in future accruals and earnings. For example, if the net proceeds from a receivable are less than the original estimate, then the subsequent entry records both the cash collected and the correction of the estimation error. We argue that estimation errors and their subsequent corrections are noise that reduces the beneficial role of accruals. Therefore, the quality of accruals and earnings is decreasing in the magnitude of accrual estimation errors. Our empirical measure of accrual quality is the extent to which working capital accruals map into operating cash flow realizations, where a poor match signifies low accrual quality.

The intuition behind this measure is available in both theoretical and practical texts that observe that the beneficial role of accruals is reduced by various limitations, including estimation errors. For example, Palepu et al. (2000) discuss estimation errors as a factor that reduces accounting quality, and suggest that estimation accuracy depends on firm characteristics like complexity of transactions and predictability of the firm’s environment. We develop this existing intuition into a practical measure of accrual and earnings quality.

Our approach to estimating the quality of accruals is related to two streams of research. First, several studies document the benefits of the accrual process, finding that earnings is a better measure of performance than the underlying cash flows (e.g., Dechow 1994; Dechow et al. 1998; Liu et al. 2002). We build on this evidence by exploring the trade-offs inherent in the accrual process. Second, a number of studies use models of “discretionary accruals” to investigate the manipulation of accruals to achieve earnings management goals (see Healy and Wahlen [1999] for a recent review). These studies focus on the opportunistic use of accruals to window-dress and mislead users of financial statements. This stream of research suggests that managerial intent affects the incidence and magnitude of accrual estimation errors.

In contrast, we argue that even in the absence of intentional earnings management, accrual quality will be systematically related to firm and industry characteristics. This distinction is important because such characteristics are likely to be both observable and recurring (e.g., the volatility of operations is systematically related to the propensity to make estimation errors) as compared to the determinants of managerial opportunism that are often unobservable and/or sporadic (e.g., before stock offerings). For our purposes, we do not attempt to disentangle “intentional” estimation errors from unintentional errors because both imply low-quality accruals and earnings.

We develop a model that examines the origination and reversal of working capital accruals in a stylized firm. The model embodies the intuition that the timing of the firm’s economic achievements and sacrifices often differs from the timing of the related cash flows, and that the benefit of accruals is to adjust for these cash flow timing problems. However, the model also reveals that the benefit of using accruals comes at the cost of including accrual components that initiate and correct estimation errors. We focus on working capital accruals and operating cash flows for tractability: the initiation and reversal of these accruals occurs within a year. Our measure of accrual estimation errors is the residuals from firm-specific regressions of changes in working capital on last year, present, and one-year ahead cash flows from operations. These residuals are unrelated to cash flow realizations, and include the estimation errors and their reversals. The standard deviation of these residuals is our firm-specific measure of quality of accruals and earnings, where a higher standard deviation signifies lower quality.

We illustrate the usefulness of our analysis in two ways. First, we explore the relation between our measure of accrual quality and firm characteristics. The nature of the accrual
process suggests that the magnitude of estimation errors will be systematically related to business fundamentals like the length of the operating cycle and variability of operations. We find that accrual quality is negatively related to the absolute magnitude of accruals, the length of the operating cycle, loss incidence, and the standard deviation of sales, cash flows, accruals, and earnings, and positively related to firm size. Our results suggest that these observable firm characteristics can be used as instruments for accrual quality. This is important because the regression-based estimation of accrual quality demands long time-series of data and the availability of subsequent cash flows, which makes it costly or infeasible for certain practical applications (e.g., quality-of-accruals-based trading strategies).

Second, we illustrate the usefulness of our analysis by exploring the relation between our measure of accrual quality and earnings persistence. Firms with low accrual quality have more accruals that are unrelated to cash flow realizations, and so have more noise and less persistence in their earnings. Indeed, we find a strong positive relation between accrual quality and earnings persistence. However, our measure of accrual quality is theoretically and empirically related to the absolute magnitude of accruals, and Sloan (1996) documents that the level of accruals is less persistent than cash flows. Probing further, we find that accrual quality and level of accruals are incremental to each other in explaining earnings persistence, with accrual quality the more powerful determinant.

The remainder of the study is organized as follows. Section II presents our model of accrual quality. Section III describes the sample and provides descriptive statistics. Section IV derives the empirical measure of accrual quality and explores the relation between accrual quality and both firm characteristics and earnings persistence. Our conclusions are provided in Section V.

II. THEORETICAL MEASURE OF ACCRUAL AND EARNINGS QUALITY

Model of Accruals

Our model of accruals focuses on working capital accruals because cash flow realizations related to working capital generally occur within one year, making both the theory and the empirics more tractable. While the intuition about errors in estimation applies to all accruals, the long lags between noncurrent accruals and cash flow realizations practically restrict the application of our approach to only short-term accruals.

We build our accrual framework around the observation that earnings equals cash flows plus accruals, \( E = CF + \text{Accruals} \). Cash flows for any period \( t \) can be categorized into three groups:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>( CF_{t-1} )</td>
<td>Cash Collections or Payments of Amounts Accrued at ( t-1 ) (net)</td>
</tr>
<tr>
<td>( CF_t )</td>
<td>Current Cash Flows (net)</td>
</tr>
<tr>
<td>( CF_{t+1} )</td>
<td>Cash Flows Deferred to ( t+1 ) (net)</td>
</tr>
</tbody>
</table>

From an accounting perspective, for each cash flow, the two important events are the receipt or disbursement of the cash flow and the recognition of that cash flow in earnings (as revenue or expense). The subscript refers to the period the cash flow is received or disbursed, and the superscript refers to the period the cash flow is recognized in earnings. For example, \( CF_{t-1} \) denotes that the cash flow occurs after the corresponding amount is recognized in earnings (e.g., collection of an accounts receivable). \( CF_t \) refers to cash flows received or paid in the same period as the cash flows are recognized in earnings. Finally, \( CF_{t+1} \) refers to cash received or paid before the revenue or expense is recognized in earnings, such as cash payments for inventory.
Summing up, total cash flow for period $t$ is:

$$\text{CF}_t = \text{CF}_{t-1} + \text{CF}_t^o + \text{CF}_t^{+1}$$ \hfill (1)

The accounting system provides for accruals, temporary adjustments that shift the recognition of cash flows over time. When recognition of a cash flow is shifted, two accrual entries are created, an opening and a closing accrual. The opening accrual is initiated when either (1) revenue or expense is recognized before the cash is received or paid or (2) cash is received or paid before it is recognized in earnings. The closing accrual is recorded when the other element of this pair has occurred and reverses the accrual portion of the original entry.

When cash flows occur after the corresponding revenues and expenses are recognized in earnings, managers must estimate the amount of cash to be received or paid in the future. To the extent that cash flow realizations differ from their accrual estimates, the opening accrual will contain an estimation error that is corrected by the closing accrual.

We incorporate this intuition in our model using the following notation for opening and closing accruals related to future cash flows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Accrual</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accrual for future collections and payments—Opening</td>
<td>(\text{A}_{\text{CF}(t+1)/t}^o)</td>
<td>(\text{CF}<em>{t+1} + \varepsilon</em>{t-1} )</td>
</tr>
<tr>
<td>Same sign as related cash flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accrual for future collections and payments—Closing</td>
<td>(\text{A}_{\text{CF}(t)/t-1}^c)</td>
<td>(-\text{CF}<em>{t-1} - \varepsilon</em>{t-1} )</td>
</tr>
<tr>
<td>Opposite sign of related cash flow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For accruals, the subscript refers to the corresponding cash flow, while the superscript indicates opening or closing accruals. For example, \(\text{A}_{\text{CF}(t+1)/t}^o\) is an opening accrual related to cash flow \(\text{CF}_{t+1}\). The opening accrual at time $t$, which reflects the expectation of the $t+1$ cash flow, is equal to the actual $t+1$ cash flow plus an error term that reflects the difference between the accrual expectation and the cash flow realization. We assume that all accruals are resolved within one period so the closing accrual for cash collections and payments at time $t$ offsets the opening accrual from $t-1$. The closing accrual is equal to the actual cash flow collected or paid in $t$ plus an error term equal to the difference between last period’s expectation and this period’s cash flow realization. Thus, each period’s total accruals contain an estimation error in the opening accruals (the actual value of which is determined next period, $\varepsilon_{t+1}$) plus a realized error in the closing accruals (determined from current period cash flow realizations, $\varepsilon_{t-1}$).

We next provide the notation for situations where cash flows are received or paid before their recognition in earnings. In this case, the accounting system recognizes the amount of

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1 We assume that estimation errors are independent of each other and of the magnitude of the cash flow realizations, within the firm. While estimation errors can be correlated across firms (e.g., bad debt expense proves to be systematically understated in a recession), cross-firm dependencies are not a problem for our approach because our tests are at the firm level. Our approach also ignores estimation errors that are correlated at the firm level (e.g., an optimistic manager systematically underestimates expenses). This is one of the limitations of our approach.
the cash flow either as deferred revenue (for cash inflows) or a deferred cost (for cash outflows):

<table>
<thead>
<tr>
<th>Name</th>
<th>Accrual</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accrual that defers the recognition of cash flows—Opening</td>
<td>$A_{CF_t+1}^{O}$</td>
<td>$-CF_{t+1}^{i}$</td>
</tr>
<tr>
<td>Opposite sign of related cash flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accrual that defers the recognition of cash flows—Closing</td>
<td>$A_{CF_t}^{C}$</td>
<td>$CF_{t}^{i}$</td>
</tr>
<tr>
<td>Same sign as related cash flow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As before, accrual subscripts refer to the corresponding cash flows, while superscripts indicate opening or closing accruals. For example, $A_{CF_t}^{O}$ is an opening accrual related to cash flow $CF_{t}^{i+1}$. Since deferred cash flows occur before recognition, these accruals contain no estimation error (in the sense of our model). For example, an inventory purchase initiates a positive accrual equal to the purchase price cash outflow, while the sale of the inventory triggers a negative accrual equal in magnitude to the initial cash flow. Appendix A provides a discussion and examples of whether and how our model detects accrual estimation errors depending on the timing of related accruals and cash flows.

Using Expression (1), and defining total accruals as the sum of opening and closing accruals, allows us to express earnings as:

\[
E_t = CF_t + \text{Accruals}_t
\]

\[
E_t = (CF_t^{i-1} + CF_t^{i} + CF_t^{i+1}) + (A_{CF_t+1/2}^{O} + A_{CF_t}^{C} + A_{CF_t+1/2}^{C})
\]

\[
E_t = (CF_t^{i-1} + CF_t^{i} + CF_t^{i+1}) + (CF_t^{i-1} - \\
\varepsilon_{t-1}^{i} - CF_t^{i-1} - \\
\varepsilon_{t}^{i} - CF_t^{i+1} + CF_{t-1}^{i})
\]  \(2\)

Re-arranging yields:

\[
E_t = CF_{t-1}^{i} + CF_t^{i} + CF_{t+1}^{i} + \varepsilon_{t-1}^{i} - \varepsilon_{t}^{i}.
\]  \(3\)

Equation (3), which presents earnings as the sum of past, present, and future cash flows plus an adjustment for estimation errors and their correction, expresses the main intuition of the paper. The intertemporal shifting of cash flows reflected in the cash flow terms of Equation (3) alleviates the timing problems of using current cash flows as a measure of performance. However, this benefit comes at the cost of using estimates, with the result that earnings includes both errors in estimates and their corrections. Both errors and error corrections reduce the quality of earnings as a measure of performance.

Most of our predictions about the relations between the variables in Equations (2) and (3) concern relations studied by existing research. We include them to show that our model embodies the intuitive and well-known properties of earnings, cash flows, and accruals, and as a benchmark and link to existing results. Using Equations (2) and (3) allows one to make the following predictions:

a) \(\text{Corr}(E_t, CF_t) = +\)

b) \(\text{Corr}(E_t, \text{Accruals}_t) = +\)

c) \(\text{Corr}(CF_t, \text{Accruals}_t) = -\)
These predictions, concerning the correlations between contemporaneous earnings, cash flows, and accruals, have been confirmed by, for example, Dechow (1994) and Dechow et al. (1998).

d) \( \text{Corr}(E_t, CF_{t-1}) = + \)

e) \( \text{Corr}(\text{Accruals}_t, CF_{t-1}) = + \)

These correlations suggest that earnings, and particularly its accrual portion, anticipates future cash flows. This result has been confirmed by, for example, Finger (1994) and Barth et al. (2001). Note that these predictions are based on ceteris paribus assumptions, so there is a need to control for possible confounding factors. Specifically, in examining the relation between current accruals and future cash flows, one needs to control for the confounding effect of current cash flows. The reason is that current accruals are negatively related to current cash flows, and future cash flows are (empirically) positively related to current cash flows.

f) \( \text{Corr}(E_t, CF_{t-1}) = + \)

g) \( \text{Corr}(\text{Accruals}_t, CF_{t-1}) = + \)

To our knowledge, the prediction that current earnings, and particularly its accrual portion, is positively correlated with past cash flows is novel. The intuition is that accruals defer the recognition of some past cash flows into current earnings. As mentioned above, in examining this prediction, it is important to control for the confounding effect of current cash flows.

### Deriving an Empirical Measure of Quality of Accruals

We obtain an expression for accruals at time \( t \) by rearranging the accrual portion of earnings in Equation (2):

\[
A_t = CF_{t-1} - (CF_{t-1} + CF_{t-1}) + CF_{t-1} + \varepsilon_{t-1} - \varepsilon_t. \tag{4}
\]

Equation (4) conveys that (1) accruals are temporary adjustments that delay or anticipate the recognition of realized cash flows plus an estimation error term; (2) accruals are negatively related to current cash flows and positively related to past and future cash flows; and (3) the error term captures the extent to which accruals map into cash flow realizations, and can be used as a measure of accrual and earnings quality.

To derive practical measures of working capital accrual quality, we use the following firm-level time-series regression:

\[
\Delta WC_t = b_0 + b_1 \times CFO_{t-1} + b_2 \times CFO_t + b_3 \times CFO_{t+1} + \varepsilon_t. \tag{5}
\]

Relative to Equation (4), our measure of accruals is changes in working capital, and our proxies for cash flows related to accruals is cash flow from operations (CFO). The residuals from the regression reflect the accruals that are unrelated to cash flow realizations, and the standard deviation of these residuals is a firm-level measure of accrual quality, where higher standard deviation denotes lower quality.

The theoretical specification in Equation (4) uses only the portions of past, present, and future cash flows that are related to current accruals. Since we cannot identify these cash flows...
flow components, the empirical version in Expression (5) uses total CFOs. Thus, the independent variables in Expression (5) are measured with error, implying that the regression coefficients are likely to be biased toward 0, and the \( R^2 \) will be reduced. Since the theoretical values of the coefficients from Equation (4) are \( b_1 = 1, b_2 = -1, \) and \( b_3 = 1, \) we expect that \( 0 < b_1 < 1, \) and \( -1 < b_2 < 0, \) and \( 0 < b_3 < 1. \) Appendix B provides a more expansive treatment of this issue, including simulation results that confirm that the estimated coefficients and the \( R^2 \) will be biased toward zero. Appendix B also reveals that the bias is more severe for \( b_1 \) and \( b_3 \) as compared to \( b_2, \) because the error component in past and future cash flows is greater than the component in current cash flows. Later in the paper (Section IV), we implement additional tests to control for the effect of this measurement error on our results. Finally, we add an intercept to Expression (5) to capture possible nonzero average accruals (e.g., average positive working capital accruals due to firm growth).

III. SAMPLE SELECTION, DESCRIPTIVE STATISTICS, AND CALIBRATION TESTS

Table 1 summarizes our sample selection. Our sample is obtained from the Compustat annual industrial and research files over 1987 to 1999. Given Collins and Hribar’s (2002) result that the balance-sheet approach to deriving CFO leads to noisy and biased estimates, we use CFO as given in the Statement of Cash Flows reported under the Statement of Financial Accounting Standards No. 95 (SFAS No. 95, FASB 1987). The sample is restricted to firms with complete data for assets, earnings, cash flow from operations, changes in accounts receivable, and changes in inventory. The last two requirements ensure sample firms have significant working capital accruals. Truncating the most extreme 1 percent of cash from operations, earnings, and changes in working capital, and requiring at least one

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2 Property-casualty insurance firms provide information about their accrual estimates, the subsequent cash flow realizations, and the resulting estimation errors (e.g., Petroni 1992; Anthony and Petroni 1997; Beaver and McNichols 1998). We do not pursue an industry-specific analysis because the cross-industry variation in the magnitude of estimation errors is likely to be larger than the typical within-industry variation, and because our interest is in more generalizable results.

3 This Standard required the presentation of the statement of cash flows for fiscal years ending after July 15, 1988. However, some firms adopted this standard early in 1987.

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**TABLE 1**

**Derivation of Sample, 1987 to 1999**

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm-years with available cash from operations, earnings, and changes in accounts</td>
<td>59,360</td>
</tr>
<tr>
<td>receivable and inventory and total assets reported in the statement of cash flows</td>
<td></td>
</tr>
<tr>
<td>Firm-years after truncation of the most extreme 1 percent of earnings, cash from</td>
<td>55,850</td>
</tr>
<tr>
<td>operations, and changes in working capital</td>
<td></td>
</tr>
<tr>
<td>Firm-years with both lead and lag values of cash from operations</td>
<td>30,317</td>
</tr>
<tr>
<td>Firms with 8 or more annual observations</td>
<td>1,725</td>
</tr>
<tr>
<td>Firm-years available for the 1,725 firms used in the remaining analysis</td>
<td>15,234</td>
</tr>
<tr>
<td>Three-digit SIC groups with over 50 observations</td>
<td>136</td>
</tr>
<tr>
<td>Firm-years available for the 136 industries</td>
<td>27,204</td>
</tr>
</tbody>
</table>

All data is from Compustat.
year of past and future cash flows and earnings, yields a sample of 30,317 firm-years. In addition, we require at least eight years of data to estimate firm-specific regressions. This restriction reduces our sample to 15,234 firm-year observations for 1,725 firms.\footnote{481 firms have eight available observations, 1,054 have nine observations, and 190 firms have ten observations.} For some of our industry-level analyses, less stringent data requirements yield a sample of 27,204 firm-year observations over 136 three-digit SIC industries.

Cash flow from operations is Compustat item 308. The change in working capital from year \( t-1 \) to \( t \) (\( \Delta WC \)), is computed as \( \Delta AR + \Delta Inventory - \Delta AP - \Delta TP + \Delta Other Assets \) (net), where AR is accounts receivable, AP is accounts payable, and TP is taxes payable. Specifically, \( \Delta WC \) is calculated from Compustat items as \( \Delta WC = -(item\ 302 + item\ 303 + item\ 304 + item\ 305 + item\ 307) \).

We calculate earnings after short-term accruals but before long-term accruals (Earn) as Earn = CFO + \( \Delta WC \). We report Earnings before extraordinary items (Prof) as Compustat item 123, and Accruals (Prof-CFO) to provide comparability with other research. All variables are scaled by average total assets. We also calculate the length of the operating cycle (OC) as:

\[
\frac{360}{(Sales/Average\ AR)} + \frac{360}{(Cost\ of\ Goods\ Sold)/(Average\ Inventory)}
\]

where Sales is Compustat item 12, cost of goods sold is item 41, AR is item 2, and Inventory is item 3.

Descriptive statistics and correlations are provided in Table 2. An examination of Panel A reveals that descriptive statistics are in line with those of other studies using similar variables and time period (e.g., Barth et al. 2001). Earn exceeds CFO, implying that short-term accruals are mostly positive. This is not surprising, given that most firms are growing and therefore increasing their working capital. As expected, average accruals are negative \((-0.046)\), primarily because of depreciation.

The Pearson correlations in Panels B and C of Table 2 illustrate the relations between our sample variables and provide comparability with previous research (results for Spearman correlations are similar). These empirical correlations are in agreement with existing findings and the predictions of the model. Specifically, there is a positive contemporaneous correlation between Earn and CFO (0.73), and between Earn and \( \Delta WC \) (0.33), and a negative correlation between CFO and \( \Delta WC \) \((-0.41)\). We also find that Accruals and \( \Delta WC \) are highly positively correlated (0.75), suggesting that working capital accruals capture much of the variation in total accruals.

Consistent with Barth et al. (2001), we find that earnings and changes in working capital anticipate future cash flows from operations. Note that the simple correlation between \( \Delta WC \), and CFO\(_{t+1}\) is \(-0.01\) and statistically insignificant. As previously discussed, the reason is that \( \Delta WC \) is negatively correlated with CFO\(_t\), and CFO\(_t\) is positively correlated with CFO\(_{t+1}\) (0.56), which counteracts the expected positive relation between \( \Delta WC \) and CFO\(_{t+1}\). In Panel C of Table 2, we report that the partial correlation between \( \Delta WC \) and CFO\(_{t+1}\), controlling for CFO\(_t\), is 0.29 (significant at the 0.0001 level). We also find that working capital accruals are positively related to past cash flows, implying that accruals defer the recognition of some past cash flows. The simple correlation between \( \Delta WC \) and CFO\(_{t-1}\) in Panel B is only 0.008 but the partial correlation controlling for CFO\(_t\) in Panel C is 0.31 (significant at the 0.0001 level). Summarizing, our descriptive statistics and correlation results are in line with predictions and existing results, indicating that our model captures reasonably well some of the key features of accrual accounting.
TABLE 2
Descriptive Statistics and Correlations for 15,234 Firm-Year Observations
1987 to 1999

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Lower Quartile</th>
<th>Median</th>
<th>Upper Quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash flow from operations (CFO)</td>
<td>0.075</td>
<td>0.097</td>
<td>0.033</td>
<td>0.082</td>
<td>0.131</td>
</tr>
<tr>
<td>Change in working capital (ΔWC)</td>
<td>0.015</td>
<td>0.070</td>
<td>-0.015</td>
<td>0.010</td>
<td>0.044</td>
</tr>
<tr>
<td>Earnings before long-term accruals (Earn)</td>
<td>0.091</td>
<td>0.093</td>
<td>0.057</td>
<td>0.096</td>
<td>0.141</td>
</tr>
<tr>
<td>Earnings before extraordinary items (Prof)</td>
<td>0.030</td>
<td>0.113</td>
<td>0.009</td>
<td>0.042</td>
<td>0.081</td>
</tr>
<tr>
<td>Accruals (Prof-CFO)</td>
<td>-0.046</td>
<td>0.098</td>
<td>-0.084</td>
<td>-0.044</td>
<td>-0.0035</td>
</tr>
<tr>
<td>Total Assets (in millions)</td>
<td>2,436</td>
<td>10,878</td>
<td>50</td>
<td>240</td>
<td>1,215</td>
</tr>
</tbody>
</table>

Panel B: Pearson Correlations

<table>
<thead>
<tr>
<th>Earn</th>
<th>CFO</th>
<th>ΔWC</th>
<th>CFO</th>
<th>CFO</th>
<th>Earn</th>
<th>Accruals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof</td>
<td>0.816*</td>
<td>0.575*</td>
<td>0.292*</td>
<td>0.458*</td>
<td>0.470*</td>
<td>0.540*</td>
</tr>
<tr>
<td>Earn</td>
<td>0.728*</td>
<td>0.325*</td>
<td>0.571*</td>
<td>0.575*</td>
<td>0.674*</td>
<td>0.674*</td>
</tr>
<tr>
<td>CFO</td>
<td>-0.411*</td>
<td>0.558*</td>
<td>0.549*</td>
<td>0.597*</td>
<td>-0.327*</td>
<td>-0.327*</td>
</tr>
<tr>
<td>ΔWC</td>
<td>-0.011</td>
<td>0.008</td>
<td>0.072*</td>
<td>0.745*</td>
<td>-0.024</td>
<td>-0.024</td>
</tr>
<tr>
<td>CFO&lt;sub&gt;-1&lt;/sub&gt;</td>
<td>0.482*</td>
<td>0.735*</td>
<td>-0.001</td>
<td>0.031*</td>
<td>0.031*</td>
<td>0.031*</td>
</tr>
<tr>
<td>CFO&lt;sub&gt;-1&lt;/sub&gt;</td>
<td>0.491*</td>
<td>0.735*</td>
<td>-0.001</td>
<td>0.031*</td>
<td>0.031*</td>
<td>0.031*</td>
</tr>
</tbody>
</table>

Panel C: Partial Correlations (controlling for the effect of CFO<sub>_t</sub>)

<table>
<thead>
<tr>
<th>Pearson Correlation</th>
<th>CFO&lt;sub&gt;-1&lt;/sub&gt;</th>
<th>CFO&lt;sub&gt;-1&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔWC&lt;sub&gt;_t&lt;/sub&gt;</td>
<td>0.289*</td>
<td>0.306*</td>
</tr>
</tbody>
</table>

* Significant at the 0.0001 level.

Variable definitions:
- Cash flow from operations (CFO) = item 308 from the Compustat Statement of Cash Flows;
- Change in working capital (ΔWC) = ΔAR + ΔInventory − ΔAP − ΔTP + ΔOther Assets (net),
  where AR is accounts receivable, AP is accounts payable, and
  TP is taxes payable;
- Earnings before long-term accruals (Earn) = CFO + ΔWC;
- Earnings before extraordinary items (Prof) = Compustat item 123; and
- Accruals = Prof − CFO.

All variables are scaled by average total assets.

IV. RESULTS

An Empirical Measure of Accrual Quality

Table 3 presents results of regressions of working capital accruals on past, present, and future cash flows from operations. First, we present firm-level regressions (Panel A) because
Table 3: Regressions of the Change in Working Capital on Past, Current, and Future Cash Flow from Operations for Firm-Years between 1987 to 1999

\[ \Delta WC_t = b_0 + b_1CFO_{t-1} + b_2CFO_t + b_3CFO_{t+1} + \epsilon_t \]

Panel A: Firm-Specific Regressions (1,725 firms)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intercept</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>Adjusted R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.04</td>
<td>0.17</td>
<td>-0.62</td>
<td>0.09</td>
<td>0.47</td>
</tr>
<tr>
<td>(t-statistic)</td>
<td>(23.03)</td>
<td>(19.38)</td>
<td>(-57.06)</td>
<td>(10.38)</td>
<td></td>
</tr>
<tr>
<td>Lower quartile</td>
<td>0.001</td>
<td>-0.02</td>
<td>-0.91</td>
<td>-0.10</td>
<td>0.23</td>
</tr>
<tr>
<td>Median</td>
<td>0.04</td>
<td>0.14</td>
<td>-0.65</td>
<td>0.09</td>
<td>0.55</td>
</tr>
<tr>
<td>Upper quartile</td>
<td>0.08</td>
<td>0.35</td>
<td>-0.35</td>
<td>0.28</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Panel B: Industry-Specific Regressions (136 industries)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intercept</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>Adjusted R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.03</td>
<td>0.19</td>
<td>-0.51</td>
<td>0.15</td>
<td>0.34</td>
</tr>
<tr>
<td>(t-statistic)</td>
<td>(16.09)</td>
<td>(21.10)</td>
<td>(-35.77)</td>
<td>(15.33)</td>
<td></td>
</tr>
<tr>
<td>Lower quartile</td>
<td>0.01</td>
<td>0.11</td>
<td>-0.63</td>
<td>0.08</td>
<td>0.22</td>
</tr>
<tr>
<td>Median</td>
<td>0.03</td>
<td>0.18</td>
<td>-0.52</td>
<td>0.15</td>
<td>0.34</td>
</tr>
<tr>
<td>Upper quartile</td>
<td>0.04</td>
<td>0.26</td>
<td>-0.40</td>
<td>0.23</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Panel C: Pooled Regression (15,234 firm-year observations)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intercept</th>
<th>( b_1 )</th>
<th>( b_2 )</th>
<th>( b_3 )</th>
<th>Adjusted R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>0.03</td>
<td>0.19</td>
<td>-0.51</td>
<td>0.18</td>
<td>0.29</td>
</tr>
<tr>
<td>(t-statistic)</td>
<td>(39.43)</td>
<td>(32.12)</td>
<td>(-78.29)</td>
<td>(29.18)</td>
<td></td>
</tr>
</tbody>
</table>

The t-statistics in Panel A are determined based on the distribution of the 1,725 coefficients obtained from the firm-specific regressions requiring a minimum of eight observations per firm. T-statistics in Panel B are determined based on the distribution of the 136 coefficients obtained from three-digit SIC grouping regressions requiring a minimum of 50 observations per grouping. All variables are defined as in Table 2.

Our theory is defined and most naturally applied on a firm-level basis. In addition, we expect that a firm-level specification is superior to cross-sectional specifications because the regression coefficients are likely to differ across firms. The reason is that our operating cash flow proxies contain measurement error, which is likely to be systematically related to firm characteristics. For example, a long operating cycle implies that substantial future cash flows are recognized in current earnings (e.g., by accruing receivables). As a result, when future cash flows related to present accruals are a large part of total future cash flows, we expect that total future cash flows will load with a larger coefficient in Expression (5). Since such effects are likely related to firm-level characteristics, we believe that a firm-level specification is superior. However, we also present industry-specific and pooled results (Panels B and C), because our firm-specific time-series is short, and we are concerned about noisy estimation at the firm level.

Results for the firm-specific regressions in Panel A of Table 3 are consistent with the theory and the univariate results in Table 2. As predicted, current changes in working capital
are negatively related to current cash flow from operations, and positively related to past and future cash flow from operations. The mean coefficient on current cash flows is \(-0.62\), while the mean coefficients on past and future cash flows are 0.17 and 0.09, respectively. As discussed earlier (and detailed in Appendix B), the absolute magnitudes of the coefficients are less than the theoretical value of 1 because of the measurement error in the independent variables, and the downward bias is greater for the coefficients on past and future cash flows. Based on the cross-sectional distribution of the firm-specific coefficients, all of these means are highly statistically significant, with t-statistics ranging in absolute value from 10 to 57. Adjusted R^2's indicate that this specification provides reasonable explanatory power (mean R^2 = 0.47 and median R^2 = 0.55).

Results for industry-specific and pooled regressions in Panels B and C of Table 3 are consistent with the firm-specific results. The mean coefficients on current CFO are \(-0.51\) for both the industry-specific regressions and the pooled regression compared with \(-0.62\) for the firm-specific mean. The coefficients on past and future cash flows are also comparable in magnitude with the firm-specific results, on the magnitude of 0.15 to 0.19, and are reliably positive. The adjusted R^2's are lower, with an average of 0.34 for the industry specification and 0.29 for the pooled regression, perhaps because the implications of our firm-specific model are less descriptive in cross-sectional specifications. Summarizing, results for firm-specific, industry, and pooled specifications are similar. Based on better theoretical grounding and better empirical fit, we proceed with the firm-level specification.

We perform several tests of the robustness of our results. Recall that the cash flow variables (CFOs) are noisy estimates of the theoretical cash flow variables (cash flows related to accruals). Measurement error in the independent variables leads to both biased coefficient estimates and biased estimates of residuals. Our sensitivity checks rely on the observation that CFO is likely to be a good proxy for the theoretical cash flow variable when the firm is in a steady state, because in these circumstances, cash flows related to accruals are likely to be a fairly constant proportion of CFO.

We implement this observation on two dimensions. First, we rerun the regressions reported in Table 3, controlling for the effect of sales growth, either by including a growth term in the regression or by running the regression only on low-growth firms (defined as percentage sales growth between \(-5\) and 5 percent). The tenor of the results remains the same for both specifications (results not included). In addition, controlling for growth does not appreciably affect the relations between accrual quality, firm characteristics, and persistence of earnings (discussed later). Second, we analyze the effect of cash flow volatility on accrual quality. If cash flow volatility is low, then we expect a relatively stable relation between total cash flows and cash flows related to accruals. We control for cash flow volatility either by including a cash flow volatility term in the regressions or by running the regression on low-volatility firms only (firms with volatility in the lowest quintile). Results remain qualitatively unchanged for both of these specifications.\(^5\)

Finally, we investigate the effect of special items, which often contain long-term accruals, and therefore affect both our measure of short-term accruals and our measure of cash flow from operations (we assume that cash flow from operations is related only to short-term accruals). Specifically, sometimes Compustat includes restructuring charges in

\(^5\) Because we believe that accrual quality is theoretically negatively related to cash flow volatility, the results after controlling for cash flow volatility are probably more correctly interpreted to indicate that the quality of accruals concept has construct validity beyond that captured by cash flow volatility. However, that does not imply that one should control for cash flow volatility in deriving accrual quality. Theoretically, high cash flow volatility causes low accrual quality because of large forecast errors in volatile environments, and the effect of this causal variable should not be excluded from the empirical construct. For this reason, we present the main results without a control for cash flow volatility. A similar argument applies to sales growth.
“other assets and liabilities” (item 307), contaminating our measure of short-term accruals. A portion of the Compustat cash flows from operations can also be related to restructuring charges, contaminating our measure of cash flows. When we replicate the results in Panel A of Table 3 for firms whose special items are less than 5 percent of earnings and 1 percent of assets, the tenor of the results is unchanged. When we exclude “other assets and liabilities” (item 307) from our measure of working capital accruals, the tenor of the results is also unchanged.

The Relation between Accrual Quality and Firm Characteristics

We use the standard deviation of the residuals as a firm-specific measure of accrual quality, where a higher standard deviation signifies lower quality. This empirical measure of accrual quality can be utilized for a variety of purposes. For example, it can be used in market-based tests of the relation between stock prices and earnings. Another application is to adapt our measure of accrual quality to devise alternative tests of earnings management. Accruals manipulated by management in an opportunistic manner often behave empirically just like accruals that are the result of unavoidable errors in estimation. For example, from the point of view of the accounting system, booking a fictitious receivable and not collecting it looks similar to booking a regular receivable and not collecting it.

In this section, we illustrate two applications of our measure of accrual quality. First, we explore the relation between our measure and selected firm characteristics. While we assume that the realization of individual estimation errors is random, the average magnitude of these errors for a particular firm is likely to be systematically related to the firm’s characteristics such as the volatility of operations or the length of the operating cycle. For example, even with good skills and the best intentions, managers of firms in volatile industries are likely to make larger accrual estimation errors.

Mapping the relation between firm characteristics and estimation errors is important for research, practical, and pedagogical purposes. The reason is that a firm-specific regression estimate of the standard deviation of the residuals requires a lengthy time-series. In addition, the regression approach requires information about future cash flows, which reduces its usefulness in many settings (e.g., abnormal return strategies based on quality of earnings). Therefore, it is valuable to identify observable firm characteristics that act as instruments for the propensity to make estimation errors. We note that some firm characteristics we examine are likely to be correlated with the standard deviation of the residuals by construction (e.g., the standard deviation of accruals). This is not a concern, because our main interest is in identifying strong relations between the unobservable estimation errors and observable firm characteristics, regardless of the source of the relation.

Based on existing theory, results, and economic intuition, we expect that:

- The longer the operating cycle, the lower accrual quality.
  Longer operating cycles indicate more uncertainty, more estimation and errors of estimation, and therefore lower quality of accruals.
- The smaller the firm, the lower accrual quality.

---

6 An alternative measure of accrual quality at the firm-year level is absolute value of the residual for that year. The tenor of the results is similar for this alternative specification, but the relations to firm characteristics and earnings persistence are weaker.

7 Thus, as discussed earlier, the magnitude of estimation errors is also likely to be related to variables capturing managerial skill and managerial opportunism, e.g., meeting analysts’ forecasts, auditor quality, stock offerings, and closeness to debt covenants.
We expect that large firms have more stable and predictable operations and, therefore, fewer and smaller estimation errors. In addition, large firms are likely to be more diversified and various portfolio effects across divisions and business activities reduce the relative effect of estimation errors.

- **The greater the magnitude of sales volatility, the lower accrual quality**
  Sales volatility indicates a volatile operating environment and the likelihood of greater use of approximations and estimation, with corresponding large errors of estimation and low accrual quality.

- **The greater the magnitude of cash flow volatility, the lower accrual quality**
  High standard deviation of cash flows is another measure of high uncertainty in the operating environment.

- **The greater the magnitude of accrual volatility, the lower accrual quality**
  Since our measure of accrual quality is derived as a residual from accruals, accrual volatility and accrual quality are at least partly related by construction.

- **The greater the magnitude of earnings volatility, the lower accrual quality**
  Earnings is the sum of cash flows and accruals. Since the volatility of both components is predicted to be negatively related to earnings quality, we expect that greater volatility in earnings signifies lower accrual quality.

- **The greater the frequency of reporting negative earnings, the lower accrual quality**
  Losses are indicative of severe negative shocks in the firm’s operating environment. Accruals made in response to such shocks are likely to involve substantial estimation error (e.g., restructuring charges). Thus, losses are indicative of low accrual quality.

- **The greater the magnitude of accruals, the lower accrual quality**
  More accruals indicate more estimation and errors of estimation, and therefore lower quality of accruals.

Table 4 provides results for these hypothesized relations. Panel A presents descriptive statistics where some of the variables are first averaged on a firm basis to be consistent with the rest of the variables and our firm-level measure of accrual quality. The distribution of *Average operating cycle* (mean 141 days, standard deviation 62 days) indicates short operating cycles. (In unreported tests, we find that all firms in our sample have average operating cycles of less than one year.) Thus, our assumption that most working capital accruals reverse within one year seems reasonable for this sample.

Panel B of Table 4 presents Pearson correlations between our measure of accrual quality (*sresid*) and firm characteristics (results for Spearman correlations are similar). While all correlations have the predicted signs, and all are significant at the 0.0001 level, there is a large range of magnitudes. The correlations for length of the operating cycle (0.28) and standard deviation of sales (0.34) are comparatively low. The correlations for all remaining variables exceed 0.50, with highest correlations for the standard deviation of earnings (0.82), the standard deviation of accruals (0.75), and proportion of negative earnings (0.63). Such strong correlations suggest that these variables can be used as reliable instruments for accrual quality. The high correlation with the average level of working capital accruals (0.69) suggests a strong relation between *sresid* and the measure of accrual quality in Sloan (1996). We explore this relation in more detail later in the paper.

In Panel C of Table 4 we investigate whether parsimonious combinations of these firm characteristics capture accrual quality better than any individual variable. Our baseline specification regresses *sresid* on Std. Dev. Earn (the variable with the highest correlation in Panel B) and shows an adjusted R² of 0.67 (Model 1). Next, we decompose the volatility
TABLE 4  
Descriptive Statistics and the Correlation between Quality of Working Capital Accruals (sresid) and Selected Firm Characteristics for 1,725 Firms between 1987 to 1999

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Lower Quartile</th>
<th>Median</th>
<th>Upper Quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard deviation of the residuals (sresid)</td>
<td>0.028</td>
<td>0.025</td>
<td>0.011</td>
<td>0.020</td>
<td>0.037</td>
</tr>
<tr>
<td>Average operating cycle</td>
<td>141.08</td>
<td>61.807</td>
<td>90.229</td>
<td>131.505</td>
<td>184.81</td>
</tr>
<tr>
<td>Log (Total Assets)</td>
<td>5.50</td>
<td>2.16</td>
<td>3.88</td>
<td>5.44</td>
<td>7.06</td>
</tr>
<tr>
<td>Std. Dev. of Sales</td>
<td>0.215</td>
<td>0.205</td>
<td>0.097</td>
<td>0.166</td>
<td>0.273</td>
</tr>
<tr>
<td>Std. Dev. of CFO</td>
<td>0.060</td>
<td>0.040</td>
<td>0.031</td>
<td>0.051</td>
<td>0.078</td>
</tr>
<tr>
<td>Std. Dev. of ΔWC</td>
<td>0.056</td>
<td>0.038</td>
<td>0.025</td>
<td>0.045</td>
<td>0.076</td>
</tr>
<tr>
<td>Std. Dev. of Earn</td>
<td>0.050</td>
<td>0.044</td>
<td>0.021</td>
<td>0.037</td>
<td>0.063</td>
</tr>
<tr>
<td>Proportion of earnings that are negative for each firm</td>
<td>0.100</td>
<td>0.189</td>
<td>0</td>
<td>0</td>
<td>0.111</td>
</tr>
<tr>
<td>Average</td>
<td>0.048</td>
<td>0.033</td>
<td>0.023</td>
<td>0.040</td>
<td>0.067</td>
</tr>
</tbody>
</table>

Panel B: Pearson Correlations between the Standard Deviation of the Residuals (sresid) and Selected Firm Characteristics (p-values in parentheses)

| Average Op. Cycle | Log (Total Assets) | Std. Dev. Sales | Std. Dev. CFO | Std. Dev. ΔWC | Std. Dev. Earn | Prop. of Negative Earnings | Average | \(|ΔWC\) |
|-------------------|--------------------|----------------|---------------|----------------|----------------|---------------------------|---------|--------|
| 0.28              | (0.0001)           | 0.34           | 0.60          | 0.75           | 0.82           | 0.63                      | 0.69    | (0.0001) |

Panel C: Regressions Where the Dependent Variable is the Standard Deviation of the Residuals (sresid) and the Independent Variables are Firm Characteristics (n = 1,725)

<table>
<thead>
<tr>
<th>Intercept</th>
<th>Std. Dev. Earn</th>
<th>Std. Dev. ΔWC</th>
<th>Std. Dev. CFO</th>
<th>Adj. R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Coefficient (t-statistic)</td>
<td>0.004</td>
<td>0.462</td>
<td>(58.63)</td>
<td>0.67</td>
</tr>
<tr>
<td>(2) Coefficient (t-statistic)</td>
<td>0.001</td>
<td>0.480</td>
<td>(29.32)</td>
<td>0.57</td>
</tr>
<tr>
<td>(3) Coefficient (t-statistic)</td>
<td>−0.002</td>
<td>0.317</td>
<td>0.257</td>
<td>(36.73)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) Coefficient (t-statistic)</td>
<td>0.012</td>
<td>0.049</td>
<td>0.005</td>
<td>0.334</td>
<td>0.00</td>
<td>−0.001</td>
</tr>
</tbody>
</table>

(Continued on next page)
TABLE 4 (Continued)

The standard deviation of the residuals (sresid) is calculated based on the residuals from the following firm-specific regressions:

\[ \Delta WC_i = b_0 + b_1CFO_{i-1} + b_2CFO_i + b_3CFO_{i+1} + \epsilon_i \]

where:

- Cash flow from operations (CFO) = item 308 from the Compustat Statement of Cash Flows;
- Change in working capital (\(\Delta WC\)) = \(\Delta AR + \Delta Inventory - \Delta AP - \Delta TP + \Delta Other\) Assets (net), where AR is accounts receivable, AP is accounts payable, and TP is taxes payable; and
- Earnings before long-term accruals (Earn) = CFO + \(\Delta WC\).

All variables are scaled by average assets.

The standard deviations of Sales, Earn, CFO, and \(\Delta WC\) are calculated at a firm level. Operating cycle is equal to 360/(Sales Average AR) + 360/(Cost of Goods Sold)/(Average Inventory). Proportion of earnings that are negative is calculated as the number of firm-years with negative earnings divided by the total number of firm-years for each firm. For this table, we use a log(Total Assets) specification to correct for right-tail skewness in assets.

of earnings into cash flow and accrual volatility, both of which are highly correlated with sresid in Panel B. Model (2) indicates that Std. Dev. \(\Delta WC\) subsumes the explanatory power of Std. Dev. CFO. For a likely explanation, recall that sresid is defined as the variation of the component of accruals unrelated to cash flow realizations. Model (3) includes the volatility of working capital accruals and the volatility of earnings, with the \(R^2\) increasing to 0.76. Finally, Model (4) regresses sresid on all remaining firm characteristics. The \(R^2\) is 0.61, lower than the \(R^2\) for the baseline regression with earnings volatility (Model 1). Summarizing, a simple practical way to gauge the quality of accruals is to assess the volatility of both earnings and accruals.

The Relation between Accrual Quality and Earnings Persistence

Earnings persistence is frequently discussed as a measure of earnings quality (e.g., Penman 2001, 623; Revsine et al. 2002, 245). The theory in this paper provides a natural link between our measure of accrual quality and earnings persistence. Specifically, an examination of Equation (3) reveals that, holding the time-series properties of realized cash flows constant, adding more accrual errors results in lower earnings persistence. Thus, we expect that firms with low accrual quality will also have low earnings persistence.

The results on the empirical relation between accrual quality and earnings persistence are presented in Panel A of Table 5. We report portfolio results to maintain comparability with earlier studies (e.g., Sloan 1996; Barth et al. 2001) and to examine for potential nonlinearities in the quality-persistence relation. The results have the same tenor in a regression specification (not tabulated). In Panel A, firm-years are first sorted into quintile portfolios based on the standard deviation of the firm-specific regression residuals (sresid) from estimating Expression (5). Within each portfolio, we regress future earnings on current earnings, and report the slope coefficient (called Persistence) and the adjusted \(R^2\). We find a negative relation between standard deviation of the residuals and persistence; the slope coefficient declines from 0.94 to 0.55 between quintiles 1 and 5. This decline is monotonic but the relation is steeper in the tails. Since these are univariate regressions, the decline in adjusted \(R^2\) from 0.83 to 0.28 parallels that of the slope coefficient. Thus, these results
### TABLE 5
The Relative Information Content of Accrual Quality and Level of Accruals for Earnings Persistence for Firm-Years between 1987 to 1999

**Panel A: Portfolios Based on the Magnitude of the Standard Deviation of the Residuals (s resid)**

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Std. Dev. Resid (s resid)</th>
<th>Persistence (δ)</th>
<th>Earnings Persistence Regression Adj. R²</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.006</td>
<td>0.023</td>
<td>0.943</td>
<td>0.830</td>
</tr>
<tr>
<td>2</td>
<td>0.013</td>
<td>0.033</td>
<td>0.816</td>
<td>0.651</td>
</tr>
<tr>
<td>3</td>
<td>0.020</td>
<td>0.042</td>
<td>0.799</td>
<td>0.619</td>
</tr>
<tr>
<td>4</td>
<td>0.032</td>
<td>0.058</td>
<td>0.756</td>
<td>0.545</td>
</tr>
<tr>
<td>5</td>
<td>0.069</td>
<td>0.086</td>
<td>0.551</td>
<td>0.280</td>
</tr>
</tbody>
</table>

**Panel B: Portfolios Based on the Absolute Value of Accruals (|ΔWCᵢ|)**

| Portfolio | | ΔWCᵢ | Std. Dev. Resid (s resid) | Persistence (δ) | Earnings Persistence Regression Adj. R² | Number of Observations |
|-----------|---------------------------|----------------|---------------------|-----------------------------------------|------------------------|
| 1         | 0.005                     | 0.014          | 0.814               | 0.566                                   | 3,046                 |
| 2         | 0.015                     | 0.016          | 0.791               | 0.548                                   | 3,047                 |
| 3         | 0.031                     | 0.019          | 0.809               | 0.584                                   | 3,047                 |
| 4         | 0.056                     | 0.024          | 0.747               | 0.466                                   | 3,047                 |
| 5         | 0.135                     | 0.035          | 0.550               | 0.329                                   | 3,047                 |

Accrual quality is measured as the standard deviation of working capital residuals from the following firm-specific regression:

$$\Delta WC_i = b_0 + b_1CFO_{i-1} + b_2CFO_i + b_3CFO_{i+1} + \epsilon_i$$

Level of accruals is measured as the absolute value of current change in working capital.

Earnings persistence (δ) is measured for each portfolio from the following regression:

$$\text{Earnings}_t = \alpha + \delta_i \text{Earnings}_t + \nu_i$$

Cash flow from operations (CFO) = item 308 from the Compustat Statement of Cash Flows;

Change in working capital (ΔWC) = ΔAR + ΔInventory - ΔAP - ΔTP + ΔOther Assets (net), where AR is accounts receivable, AP is accounts payable, and TP is taxes payable; and

Earnings before long-term accruals (Earn) = CFO + ΔWC.

All variables are scaled by average assets.
confirm the hypothesized positive relation between accrual quality and earnings persistence.\(^8\)

Panel A of Table 5 also reports mean level of working capital accruals for each sresid portfolio. Similar to the results in Table 4, these portfolio results reveal a positive relation between standard deviation of the residuals and level of accruals. This relation is important because Sloan (1996) shows that level of accruals is less persistent than cash flows. Thus, at this point it is difficult to distinguish empirically between the effects of accrual quality and the level of accruals on earnings persistence. However, as mentioned earlier, there are a priori reasons to believe that our measure of accrual quality and the level of accruals are both proxies for the same aspect of the unobservable "true" accrual quality. Thus, to a large extent, the real issue is which of these two measures performs better empirically for the task at hand—in this case, explaining earnings persistence.

We pursue two approaches to distinguish between the explanatory power of sresid and level of accruals with respect to earnings persistence. In Panel B of Table 5, we form quintiles based on the absolute magnitude of accruals and measure persistence for each quintile.\(^9\) Results confirm the expected negative relation between the level of accruals and earnings persistence; the slope coefficient declines from 0.81 to 0.55, and the adjusted R\(^2\) from 0.57 to 0.33, between quintiles 1 and 5. However, these declines are less pronounced than those in Panel A. The relative decline in Persistence is 0.39 (0.55 for adjusted R\(^2\)) across the accrual quality quintiles vs. 0.26 (0.24 for adjusted R\(^2\)) across the level of accrual quintiles. In addition, the relation between level of accruals and persistence in Panel B is nonmonotonic, and essentially flat for low- to medium-level accruals. The overall impression from Panel B is that level of accruals indicates low earnings persistence only for extreme accrual realizations. Thus, the relation between accrual quality and earnings persistence is stronger than the relation between level of accruals and persistence, especially for firms with high accrual quality.

Our second approach is provided in Table 6, which reports portfolio results on the relation between sresid and earnings persistence, holding the level of accruals constant (Panel A); and the relation between the level of accruals and earnings persistence, holding sresid constant (Panel B). To hold the level of accruals constant (as in Panel A), we first sort the sample into decile portfolios based on level of accruals, and then within each level-of-accruals decile, we further sort the observations into five portfolios based on standard deviation of the residuals (subportfolios 1 to 5). We pool all ten subportfolios 1 together into one portfolio, all subportfolios 2 together into another portfolio, and so on. The result is five portfolios, with substantial variation of sresid but nearly the same level of accruals.

As shown in Panel A of Table 6, this two-pass portfolio construction controls quite well for level of accruals, with mean |ΔWC| ranging from 0.047 to 0.051 across portfolios 1 to 5. Despite the strong positive correlation between sresid and level of accruals at the firm level, the portfolios in Panel A exhibit large variation in sresid: the conditional range between mean sresid of portfolios 1 and 5 in Table 6 is 0.55 compared to the unconditional range of 0.63 in Table 5. This result indicates that the variation in sresid independent of

\(^8\) Our measure of accrual quality has some "look-ahead" bias in explaining earnings persistence because good accrual quality means a positive relation between current accruals and future cash flows. An alternative specification, which uses residuals from regressing accruals on only past and present cash flows produces similar portfolio results. This robustness in results is probably explained by the relative stability of our measure of accrual quality over time.

\(^9\) Our measure of accruals includes only changes in working capital, while the measure of accruals in Sloan (1996) includes both changes in working capital and depreciation. However, most of the variation in Sloan's measure is due to variation in accounts receivable and inventory (Sloan 1996, 297).
### TABLE 6
The Incremental Information Content of Accrual Quality and Level of Accruals for Earnings Persistence for Firm-Years between 1987 to 1999

**Panel A: Portfolios Based on the Magnitude of the Standard Deviation of the Residuals \(\text{(|sresid|)}\), Controlling for the Absolute Value of Accruals \(\text{(|\Delta WC|)}\)**

| Portfolio | Std. Dev. Resid (sresid) | \(|\Delta WC|\) | Persistence \(\hat{\delta}_i\) | Earnings Persistence Regression Adj. \(R^2\) | Number of Observations |
|-----------|--------------------------|----------------|------------------------|---------------------------------|-------------------------|
| 1         | 0.008                    | 0.047          | 0.913                  | 0.783                           | 3,044                   |
| 2         | 0.015                    | 0.047          | 0.819                  | 0.642                           | 3,049                   |
| 3         | 0.022                    | 0.047          | 0.742                  | 0.542                           | 3,046                   |
| 4         | 0.032                    | 0.049          | 0.666                  | 0.426                           | 3,052                   |
| 5         | 0.063                    | 0.051          | 0.602                  | 0.328                           | 3,043                   |

**Panel B: Portfolios Based on the Absolute Value of Accruals \(\text{(|\Delta WC|)}\), Controlling for the Standard Deviation of the Residuals (sresid)**

| Portfolio | \(|\Delta WC|\) | Std. Dev. Resid (sresid) | Persistence \(\hat{\delta}_i\) | Earnings Persistence Regression Adj. \(R^2\) | Number of Observations |
|-----------|----------------|--------------------------|------------------------|---------------------------------|-------------------------|
| 1         | 0.006          | 0.027                    | 0.788                  | 0.502                           | 3,042                   |
| 2         | 0.020          | 0.028                    | 0.762                  | 0.513                           | 3,049                   |
| 3         | 0.036          | 0.028                    | 0.743                  | 0.438                           | 3,050                   |
| 4         | 0.059          | 0.028                    | 0.707                  | 0.457                           | 3,049                   |
| 5         | 0.120          | 0.029                    | 0.574                  | 0.408                           | 3,044                   |

Accrual quality is measured as the standard deviation of working capital residuals from the following firm-specific regression:

\[
\Delta WC_i = b_0 + b_1CFO_{i-1} + b_2CFO_i + b_3\Delta CO_i + \varepsilon_i
\]

Level of accruals is measured as the absolute value of current change in working capital. Earnings persistence \(\hat{\delta}_i\) is measured for each portfolio from the following regression:

\[
\text{Earn}_{i+1} = \alpha + \hat{\delta}_i \text{Earn}_i + \nu_i
\]

Cash flow from operations (CFO) = item 308 from the Compustat Statement of Cash Flows;
Change in working capital (\(\Delta WC\)) = \(\Delta AR + \Delta \text{Inventory} - \Delta AP - \Delta TP + \Delta \text{Other Assets (net)}\), where AR is accounts receivable, AP is accounts payable, and TP is taxes payable; and

Earnings before long-term accruals (Earn) = CFO + \(\Delta WC\).

All variables are scaled by average assets.
the level of accruals is substantial and empirically important. Further, the regression results reported in Table 6, Panel A reveal that the conditional variation in sresid is strongly related to earnings persistence. The slope coefficient varies from 0.91 in portfolio 1 to 0.60 in portfolio 5, and adjusted R² varies from 0.78 in portfolio 1 to 0.33 in portfolio 5. These results compare well to those from the unconditional specification in Table 5 (differences in Persistence of 0.31 vs. 0.39, and differences in R²'s of 0.45 vs. 0.54). In other words, the relation between accrual quality (sresid) and earnings persistence is largely preserved after controlling for the level of accruals.

Panel B in Table 6 contains the results for the relation between level of accruals and earnings persistence after controlling for accrual quality, using the same portfolio derivation method as in Panel A. First, we rank all observations into ten portfolios based on sresid, then within each decile portfolio we rank observations into five subportfolios on level of accruals, and finally we pool all subportfolios with the same rank together. At the end, we have five portfolios that preserve most of the variation in level of accruals, while holding sresid nearly constant across portfolios. Results reveal a slight decline in the variation of the slope coefficient across portfolios; the difference between portfolios 1 and 5 is 0.22 in Table 6 vs. 0.26 in Table 5. However, there is a substantial erosion in the range of R², the difference is 0.09 in Table 6 vs. 0.24 in Table 5. In addition, the differences in slope coefficients and R² across portfolios for Panel B in Table 6 are substantially smaller than their counterparts for sresid in Panel A.

Summarizing, the combined evidence of Tables 5 and 6 suggests that our measure of accrual quality captures variation in earnings persistence incremental to the variation explained by level of accruals. In fact, our results suggest that the relation between accrual quality and earnings persistence is stronger than that between level of accruals and persistence. However, relative to our measure of accrual quality, level of accruals is simpler and easier to use, and requires no extensive identification and prediction process. Thus, the comparison presented here is biased against the performance of the level of accruals, especially for settings that require ex ante measures of quality of earnings (e.g., real-time trading strategies).

V. CONCLUSION

This study suggests a new approach to assessing accrual and earnings quality, based on the intuition that accruals are temporary adjustments that resolve timing problems in the underlying cash flows at the cost of making assumptions and estimates. Precise estimates imply a good match between current accruals and past, present, and future cash flow realizations, while imprecise or erroneous estimates reduce the beneficial role of accruals. Following this intuition, we define accrual quality as the extent to which accruals map into cash flow realizations. In the empirical domain, we operationalize this notion of accrual quality as the standard deviation of the residuals from firm-specific regressions of working capital accruals on last-year, current, and one-year-ahead cash flow from operations.

One important feature of our approach is that the notion of estimation errors includes both intentional and unintentional errors. This distinction is important because most existing research assumes that accrual and earnings quality is only affected by management intent to manipulate, while such intent is unobservable, and likely idiosyncratic and sporadic. In contrast, our approach reveals that accrual quality is likely to be systematically related to observable and recurring firm characteristics like volatility of operations because higher volatility is associated with higher incidence of unavoidable estimation errors.

A theoretical limitation of our approach is that it captures the extent to which accruals map into the related cash flows but it provides little insight into the proper timing of these
accruals with respect to the cash flows. For example, our approach cannot be used to decide whether to expense or capitalize R&D. Limitations in the empirical portion of our analysis include a restriction to working capital accruals and an assumption of no serial correlation in the estimation errors.

We illustrate the usefulness of our approach in two contexts. First, we document that observable firm characteristics can be used as instruments for accrual quality. Specifically, we find that earnings volatility and the volatility of accruals are good proxies for our measure of accrual and earnings quality. Second, we find a positive relation between accrual quality and earnings persistence, which remains after controlling for the level of accrual effect documented by Sloan (1996). This positive relation suggests there are important practical benefits from identifying and measuring accrual quality.

Our investigation of the interrelations between accrual quality, level of accruals, and earnings persistence also suggests a reconciliation of the findings of Dechow (1994) and Sloan (1996). Dechow (1994) finds that accruals improve earnings’ ability to measure performance relative to cash flows. Sloan (1996) finds that the accrual portion is less persistent than the cash flow portion of earnings, which suggests that firms with high levels of accruals have low quality of earnings. Our reconciliation is based on the observation that a high level of accruals signifies both earnings that are a greater improvement over underlying cash flows, and low-quality earnings. The reason is that accruals are largest when the underlying cash flows have the most timing and mismatching problems, so more accruals signify greater improvement over the underlying cash flows. However, this benefit comes at the cost of incurring estimation errors, and there will be a positive correlation between levels of accruals and the magnitude of these estimation errors. Thus, everything else equal, large accruals signify low quality of earnings, and less persistent earnings.

APPENDIX A
Examples of Cash Flows and Accruals Types, and the Resulting Estimation Errors
The following table outlines the recording conventions when cash is received or paid before or after it is recognized in earnings:

<table>
<thead>
<tr>
<th>Cash Flow Occurs at t+1 (after it is recognized in earnings)</th>
<th>Cash Flow Occurs at t-1 (before it is recognized in earnings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case (1)</td>
<td>Case (3)</td>
</tr>
<tr>
<td>Recognized in earnings at t as revenue</td>
<td>Recognized in earnings at t as an expense</td>
</tr>
<tr>
<td>Cash Inflow: Collection</td>
<td>Cash Inflow: Deferred Revenue</td>
</tr>
<tr>
<td>Accrual created and reversed:</td>
<td>Accrual created and reversed:</td>
</tr>
<tr>
<td>Asset</td>
<td>Liability</td>
</tr>
<tr>
<td>e.g., Accounts Receivable</td>
<td>e.g., Deferred Revenue</td>
</tr>
<tr>
<td>Case (2)</td>
<td>Case (4)</td>
</tr>
<tr>
<td>Recognized in earnings at t as an expense</td>
<td>Recognized in earnings at t as an expense</td>
</tr>
<tr>
<td>Cash Outflow: Payment</td>
<td>Cash Outflow: Deferred Cost</td>
</tr>
<tr>
<td>Accrual created and reversed:</td>
<td>Accrual created and reversed:</td>
</tr>
<tr>
<td>Liability</td>
<td>Asset</td>
</tr>
<tr>
<td>e.g., Warranty Liability</td>
<td>e.g., Inventory, Prepaid Rent</td>
</tr>
</tbody>
</table>

The examples below show the link between accruals and the related cash flows, and whether an estimation error will be detected by our model. We also include the notation introduced in Section II.
Case (1): Cash Receipt Follows Revenue Recognition
Record $100 of credit sales

\[\begin{array}{cccc}
t & \text{Dr} & \text{Accounts Receivable (} A_{CF_{t+1}} \text{o} \text{)} & 100 \\
 & \text{Cr} & \text{Sales Revenue} & 100 \\
\end{array}\]

No error situation

\[\begin{array}{cccc}
t+1 & \text{Dr} & \text{Cash (} CF_{t} \text{i) } & 100 \\
 & \text{Cr} & \text{Accounts Receivable (} A_{CF_{t+1}} \text{i) } & 100 \\
\end{array}\]

Error situation: an unanticipated $30 is not collected

\[\begin{array}{cccc}
t+1 & \text{Dr} & \text{Bad debt write-off (} e_{t+1} \text{i) } & 30 \\
 & \text{Dr} & \text{Cash (} CF_{t+1} \text{i) } & 70 \\
 & \text{Cr} & \text{Accounts Receivable (} A_{CF_{t+1}} \text{i) } & 100 \\
\end{array}\]

Cash increases by $70 at \( t+1 \) but accounts receivable at \( t \) increases by $100. Our model will detect an error of $30.

Case (2): Cash Payment Follows Expense Recognition
Estimate $100 for warranty expense

\[\begin{array}{cccc}
t & \text{Dr} & \text{Warranty Expense} & 100 \\
 & \text{Cr} & \text{Warranty Liability (} A_{CF_{t+1}} \text{o) } & 100 \\
\end{array}\]

No error situation

\[\begin{array}{cccc}
t+1 & \text{Dr} & \text{Warranty Liability (} A_{CF_{t+1}} \text{i) } & 100 \\
 & \text{Cr} & \text{Cash (} CF_{t+1} \text{i) } & 100 \\
\end{array}\]

Error situation: Warranty work amounts to $135

\[\begin{array}{cccc}
t+1 & \text{Dr} & \text{Warranty Liability (} A_{CF_{t+1}} \text{i) } & 100 \\
 & \text{Dr} & \text{Warranty expense (} e_{t+1} \text{i) } & 35 \\
 & \text{Cr} & \text{Cash (} CF_{t+1} \text{i) } & 135 \\
\end{array}\]

Warranty liability increases by $100 at \( t \), and is not equal to the cash flow of $135 at \( t+1 \). Our model will detect a $35 estimation error.

Case (3): Cash Receipt Precedes Revenue Recognition
Receive $100 for a prepaid magazine subscription

\[\begin{array}{cccc}
t-1 & \text{Dr} & \text{Cash (} CF_{t} \text{i) } & 100 \\
 & \text{Cr} & \text{Deferred Revenue (} A_{CF_{t-1}} \text{o) } & 100 \\
\end{array}\]

No error situation

\[\begin{array}{cccc}
t & \text{Dr} & \text{Deferred Revenue (} A_{CF_{t-1}} \text{i) } & 100 \\
 & \text{Cr} & \text{Sales Revenue} & 100 \\
\end{array}\]

Error situation: Customer demands a refund of $10 at time \( t \)

\[\begin{array}{cccc}
t & \text{Dr} & \text{Deferred Revenue (} A_{CF_{t-1}} \text{i) } & 100 \\
 & \text{Cr} & \text{Cash} & 10 \\
 & \text{Cr} & \text{Sales Revenue} & 90 \\
\end{array}\]
Our model will not detect an estimation error because the deferred revenue accrual and cash flow at t−1 are equal in magnitude, and the deferred revenue reversal at t is equal to the cash flow received at t−1. Note that accrual earnings contains no “error” since only $90 is recognized in earnings, while cash basis revenue recognition would overstate revenue (by $10) at t−1 and understate revenue by the same amount at t. This type of error will affect our empirical version of the model because we cannot identify specific cash flows relating to accruals, and our measure of cash flows at t will include the $10. This effect is similar to that induced by including cash expenses CF_{t}^{i}, in our measure of cash flows CFO_{t} (see Appendix B).

**Case (4): Cash Payment Precedes Expense Recognition**

Pay $100 for inventory

| t−1 | Dr | Inventory (A_{CF_{t−1}^{i}}) | 100 |
|     | Cr | Cash (CF_{t−1}^{i})         | 100 |

No error situation

| t   | Dr | Cost of goods sold | 100 |
|     | Cr | Inventory (A_{CF_{t−1}^{i}}) | 100 |

Error situation: Write down of $20

| t   | Dr | Write down          | 20  |
|     | Dr | Cost of goods sold  | 80  |
|     | Cr | Inventory (A_{CF_{t−1}^{i}}) | 100 |

Our model will not detect an estimation error for the write-down because the inventory accrual and cash flow at inception are equal, and the inventory reversal at t is equal to the cash flow paid at t−1. Our model, therefore, provides no insights into the *timing* of expense recognition.

**APPENDIX B**

**Simulations Examining the Effect of Mismeasuring Cash Flows in Our Regressions**

Our theoretical model of accruals listed in equation (4) is the following:

\[ A_{t} = CF_{t−1}^{i} − (CF_{t}^{i−1} + CF_{t}^{i−2}) + CF_{t+1}^{i} + \xi_{t+1}^{i} − \xi_{t}^{i}. \]  (4)

Our empirical approximation of this model is:

\[ \Delta WC_{t} = b_{0} + b_{2} * CFO_{t−1} + b_{2} * CFO_{t} + b_{3} * CFO_{t+1} + \varepsilon_{t}. \]  (5)

The cash flow terms in Equation (5) capture the constructs in Equation (4) with measurement error, where the measurement error is given by bolded components in parentheses reported below:

\[ CFO_{t−1} = CF_{t−1}^{i} + (CF_{t−1}^{i−1} + CF_{t−1}^{i−2}) \]
\[ CFO_{t} = (CF_{t}^{i−1} + CF_{t}^{i−2}) + (CF_{t}^{i}) \]
\[ CFO_{t+1} = CF_{t+1}^{i} + (CF_{t+1}^{i−1} + CF_{t+1}^{i−2}) \]
For CFO$_{t-1}$, the noise consists of cash flow received and recognized in earnings in the same period (CFO$_{t-1}^{*}$) plus cash payments/collections (e.g., receivables) for transactions recognized in earnings at $t-2$. For CFO$_{t}$, the noise stems from cash flows received and recognized in earnings in the same period and is CFO$_{t}$, the noise stems from cash flows received and recognized in earnings in the same period (CFO$_{t+1}^{*}$). Thus, with respect to current accruals, the noise component for CFO$_{t}$ is smaller than the noise component for CFO$_{t-1}$ and CFO$_{t+1}$.

We use simulations to examine the effect from this type of noise on the coefficients and $R^2$ in Equation (5). In these simulations there is no estimation error. All credit sales are collected, all deferred revenues are recognized the following period, and there are no write-downs of inventory. Thus, any change in the $R^2$ and the coefficients is entirely attributable to mismeasurement of the desired cash flows.

Our model firm generates sales in three ways:

(1) Credit sales are made at time $t$ and collected in $t+1$ (creates accounts receivable)

(2) Cash sales are made at time $t$

(3) Deferred revenue is recognized at time $t$ for cash received at $t-1$ (creates deferred revenue)

We use a random number generator to generate each type of sales for 200 periods. Sales randomly range from 0 to 200. The firm starts business with an initial endowment of inventory and shareholders’ equity. The inventory policy is to replace in period $t$ inventory sold in period $t-1$, and there are no price changes. For simplicity, we assume that the inventory required for cash sales at $t$ is purchased at $t$ so that cash from operations and earnings are the same for cash sales (i.e., no accruals are made for cash sales). The initial endowment is set large enough such that the firm never has stock-outs of inventory. In this firm:

$\text{Working capital} = \text{Accounts Receivable} + \text{Inventory} - \text{Deferred Revenue};$

$\text{Accruals} = \Delta \text{Accounts Receivable} + \Delta \text{Inventory} - \Delta \text{Deferred Revenue};$

$\text{Cash from operations in period } t \ (\text{CFO}_t) = \text{Cash from credit sales made at } t-1 \ (\text{CF}_t^{*}) + \text{Cash for cash sales made at } t \ (\text{CF}_t) + \text{Deferred Revenue (CF}_t^{*}) - \text{Cash outlays for inventory (CF}_t); \text{ and}$

$\text{Earnings} = \text{Cash from operations} + \text{Accruals} = \text{Sales} - \text{Cost of Goods Sold.}$

Exhibit 1 provides regression results for a benchmark case, where all cash flows are measured correctly, as in Equation (4). Since we have perfect knowledge of the related cash flows, and there is no estimation error, we expect that $b_1 = 1$, $b_2 = -1$, $b_3 = 1$, and the $R^2$ is 100 percent. The simulation confirms this intuition.

Exhibit 2 documents the effect of using cash flow from operations (CFO, as defined above) instead of the theoretically correct cash flow variables. Since the cash flow variables are measured with error, we expect $R^2$ and the coefficients to decrease in absolute magnitude. In addition, we expect that the larger measurement error for CFO$_{t-1}$ and CFO$_{t+1}$ will force $b_1$ and $b_2$ more toward zero as compared to $b_2$. These predictions are confirmed by the results in Exhibit 2.
## EXHIBIT 1

Regression Results of Simulations Where There Is No Mismeasurement of Cash Flows at t−1, t, or t+1

\[ \Delta WC_t = b_0 + b_1(CF_{t−1}^r) + b_2(CF_{t−1}^r + CF_{t−1}^r) + b_3(CF_{t−1}^r) + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Intercept</th>
<th>b₁</th>
<th>b₂</th>
<th>b₃</th>
<th>Adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p-value)</td>
<td>(0.00)</td>
<td>(1.00)</td>
<td>(−1.00)</td>
<td>1.00</td>
<td>(1.00)</td>
</tr>
</tbody>
</table>

## EXHIBIT 2

Regression Results of Simulations Where Cash Flows from Operations (CFO) for t−1, t, and t+1 Are Used in the Regressions

\[ \Delta WC_t = b_0 + b_1*CF_{t−1}^r + b_2*CF_{t−1}^r + b_3*CF_{t−1}^r + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Intercept</th>
<th>b₁</th>
<th>b₂</th>
<th>b₃</th>
<th>Adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p-value)</td>
<td>(0.623)</td>
<td>(0.49)</td>
<td>(−0.94)</td>
<td>0.49</td>
<td>(0.74)</td>
</tr>
</tbody>
</table>

Summarizing, our simulations confirm that using cash flow from operations (as in Equation (5)) instead of the theoretically prescribed cash flow variables (as in Equation (4)) results in reduced R² and regression coefficients biased toward zero, with less pronounced effect for the coefficient of current CFO.

## REFERENCES


