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 accruals and earnings. The major benefit of accruals is to reduce timing and mismatching problems in the underlying cash flows. However, accruals accomplish this benefit at the cost of making assumptions and estimates about future cash flows, which implies that accruals include errors of estimation or noise. Since estimation noise reduces the beneficial role of accruals, this study suggests that the quality of accruals and earnings is decreasing in the magnitude of estimation noise in accruals. More specifically, we develop a simple model of working capital accruals where accruals correct the timing problems in cash flows at the cost of including errors in estimation. Based on the model, we derive an empirical measure of accrual quality as the residual from firm-specific regressions of changes in working capital on past, present, and future operating cash flow realizations. The study concludes with two empirical applications that illustrate the usefulness of our measure of accrual quality. First, we explore the relation of accrual quality to economic fundamentals. We find that accrual quality is negatively related to the magnitude of total accruals, length of the operating cycle, and the standard deviation of sales, cash flows, and earnings, while it is positively related to firm size. Second, we show a strong positive relation between accrual quality and earnings persistence.

1. Introduction

This paper suggests a new measure of one aspect of the quality of accruals and earnings. The intuition for our theory is based on the observation that accruals are essentially temporary adjustments that shift cash flows across time periods. The major benefit of this shifting is that the adjusted numbers present a more accurate picture of the economic performance of the firm (e.g., see FASB Statement of Accounting Concepts Number 1, paragraph 44). For example, recording a receivable accelerates the recognition of a future cash flow to the present. However, the benefits of accruals come at the cost of making assumptions and estimates that must be subsequently corrected in future accruals. For example, if the net proceeds from a receivable are less than the original estimate, this implies that the original estimate contained an estimation error, and the closing entry records both the cash flow realization and the correction of the realized estimation error. Since errors in estimation and their subsequent corrections are essentially meaningless noise in accruals, they reduce the beneficial role of accruals. Therefore, the quality of accruals and earnings is decreasing in the magnitude of accrual estimation errors. In other words, our measure of accrual quality is defined as the extent to which accruals map into cash flow realizations, where a poor match signifies low accrual quality.

Note that the intuition behind this study is already acknowledged and taught in accounting. Both theoretical and practical texts observe that the beneficial role of accruals is reduced by various limitations, including estimation errors. For example, Palepu, Healy, and Bernard (2000) explicitly discuss forecasting or estimation errors as a factor that reduces accounting quality, and suggest that forecasting accuracy depends on economic fundamentals like complexity of the business transactions, predictability of the firm's environment, and unforeseen economy-wide changes. The contribution of our paper is in formalizing and developing this existing intuition into a practical measure of accrual and earnings quality.

We begin our analysis with a model that formalizes this intuition by examining the origination and reversal of working capital accruals in a stylized firm. The model illustrates the difference between the components of accruals that resolve cash flow timing problems and the components of accruals that initiate and correct estimation errors. We use the results of the model to derive an empirical measure of the quality of working capital accruals. Our measure of accrual error is the residual from a firm-specific regression of change in working capital on last year, present, and one-year ahead cash flows from operations. By definition, these residuals are unrelated to cash flow realizations, and are largely due to estimation errors and their reversals. We use the standard deviation of these residuals as a firm-specific measure of quality of accruals and earnings, where a higher standard deviation signifies lower quality.

We illustrate the usefulness of our analysis with two empirical applications. First, we explore the relation between our measures of accrual quality and economic fundamentals. Consistent with economic intuition, we find strong evidence that accrual quality is negatively related to the absolute magnitude of accruals, the length of the operating cycle, the standard deviation of sales, cash flows, and earnings, and positively related to firm size. The reliable relations between accrual quality and economic fundamentals suggest that one can use firm fundamentals to compute ex ante measures of accrual quality, rather than relying on ex post identification dependent on observed cash flow realizations.

Second, we explore the relation between our measure of accrual quality and earnings persistence. Firms with low accrual quality have a high amount of accruals unrelated to cash flow realizations, and thus should have low earnings persistence. 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 level of accruals is negatively related to earnings persistence. Probing further, we find that our measure of accrual quality and level of accruals are incremental to each other in explaining earnings persistence, with accrual quality the more powerful determinant of persistence.

The remainder of the study is organized as follows. Section 2 presents our model of accrual quality. Section 3 describes the sample and provides descriptive statistics. Section 4 derives the empirical measure of accrual quality, explores the relation between accrual quality and economic fundamentals, and examines the relation between accrual quality and earnings persistence. Our conclusions are provided in section 5.

2. Theoretical measure of accrual and earnings quality

2.1 Model of accruals

We start with a simple model of working capital accruals that illustrates and formalizes the main ideas behind this paper. We concentrate on working capital accruals because cash flow realizations related to working capital generally occur within one year, which makes both the theory and the empirics more tractable. However, errors in estimation are likely to be important for long-term accruals as well, and the basic intuition is similar. We leave this topic for future research.

We build our accrual framework around the observation that earnings equals cash flows plus accruals, E = CF + Accruals. Note that cash flows for any given period t can be categorized in three groups:

Symbol	**Name**
CF_t^{PRE}	Cash Advances or Prepayments (net)
CF_t^{CUR}	Current Cash Flows (net)
CF_t^{POST}	Cash Collections or Payments (net)

From the point of view of the accounting system, there are two important events with respect to each cash flow, the receipt or disbursement of the cash flow and the recognition of that cash flow in earnings (either as revenue or as an expense). Here the time subscript refers to the time period the cash flow is received or disbursed, and the superscript refers to the timing of the cash flow with respect to when it is earned or expensed. For example, cash advances refer to the receipt of cash from customers before goods or services are delivered, and cash prepayments refer to the payments for inventory, that is not yet expensed. For both cash advances and prepayments the timing of the cash flows occurs *before* recognition in earnings, and therefore they are denoted with the superscript PRE. Current cash flows (superscript CUR) refer to cash flows that occur in the same period they are recognized in earnings. Cash collections and payments are marked with superscript POST to denote that the corresponding cash flow occurs *after* the corresponding amount is recognized in earnings. For example, cash collections on receivables refer to collections that occur in the period after the receivables are recorded and recognized in earnings. Cash payments refer to payments on all payables that occur after the payables are recorded. Summing up, total cash flow for period t is:

$$CF_t = CF_t^{PRE} + CF_t^{CUR} + CF_t^{POST} \qquad (1)$$

The accounting system resolves the mismatching in cash flows by adding accruals. Essentially, accruals are temporary adjustments that shift cash flows to the period where they are recognized in earnings. Each cash flow that is shifted to another time period creates two accrual entries, an opening and a closing accrual. The opening accrual is initiated when either (i) a revenue or expense is recognized before the cash is received or paid or (ii) the 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 original accrual entry. Below we provide the notation for the opening and closing accruals related to cash advances or prepayments:

Symbol	**Name**	**Amount**
$A_t^{PRE\text{-}O}$	Accrual for Cash Advances or Prepayments - Opening	$- CF_t^{PRE}$
$A_t^{PRE\text{-}C}$	Accrual for Cash Advances or Prepayments - Closing	$CF_{t-1}^{PRE} = (- A_{t-1}^{PRE\text{-}O})$

For accruals, the subscript refers to the period the accrual is recorded, while the superscript refers to the type of the corresponding cash flow and whether it is an opening or a closing accrual. Since for cash advances and prepayments cash flows occur *before* recognition, the accrual process involves no estimation, and accruals are a simple deferral of realized cash flows. In this case the opening accrual defers the corresponding cash flow, while the closing accrual recognizes in earnings the cash from the previous period. For example, a purchase of inventory initiates a positive accrual equal to the purchase price cash outflow, while sale of the inventory in the next period triggers a negative accrual equal in magnitude to the initial cash outflow or to the initial positive accrual. As mentioned before, we assume that all mismatches between cash flows are resolved within one period.

Next, we consider the situations where cash flows are received or paid *after* the corresponding revenues and expenses are recognized in earnings. In these cases managers must estimate the amount of cash flows they will receive or pay in the future. Since the eventual cash flow realizations usually differ from their accrual estimates, accruals that involve estimation include an estimation error at the time of the opening accrual, and a correction of the estimation error at the time of the closing accrual. For example, consider the accounting for a receivable. When the firm records a sale, the corresponding cash flow is earned but it has not been collected. Since collection involves uncertainties, there are inherent errors in the estimation of collectability, and a corresponding correction of such errors when the realized cash flows differ from the original projection.

We incorporate this intuition in our model using the following notation:

Symbol	**Name**	**Amount**
$A_t^{POST\text{-}O}$	Accrual for Collections and Payments - Opening	$CF_{t+1}^{POST} + \varepsilon_{t+1}^{POST}$
$A_t^{POST\text{-}C}$	Accrual for Collections and Payments – Closing	$- CF_t^{POST} - \varepsilon_t^{POST} = (- A_{t-1}^{POST\text{-}O})$

Similar to above, here the subscript refers to the period the accrual is recorded and the superscript refers to the type of the corresponding cash flow and whether it is an opening or a closing accrual. Here the opening accrual at time t reflects the expectation of the actual cash flow that will occur at time t+1. Since there is an error of estimation, the current accrual is equal to the actual cash flow realized at t+1 plus an error term that reflects the difference between the accrual expectation and realization. The closing accrual for cash collections and payments at time t offsets the opening accrual from the previous period, and is equal to the corresponding 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 there are two independent error terms. There is an estimation error for accruals made this period whose actual value will be determined next period (ε_{t+1}^{POST}), and there is the realized error that is determined from knowing actual cash flow realization today (ε_t^{POST}).

Note that the model and the discussions so far present the notion of estimation error as only referring to situations where the cash flows occur *after* the opening accrual. However, the notion of estimation error is more general in nature, and applies with similar logic for many cases where the relevant cash flows occur at the same time as the opening accrual. For example, consider a different inventory example where inventory is bought for $1,000, written down to $700 in the same period, and sold next period. The net result is a cash outflow of $1,000 and a net positive accrual of $700 in the first period, and a negative accrual of $700 in the second period. The difference of $300 is very much like an estimation error, only here it is the cash outflow that is the poor predictor of the accrual benefit of inventory. For the sake of parsimony, we do not explicitly include in our model the estimation errors for cases where the cash flows occur at the same time as the opening accrual. However, we refer the interested reader to Appendix 1, which provides a more comprehensive discussion and examples of possible accrual estimation errors. For our purposes, the bottom line is that estimation errors exist even when the relevant cash flows occur at the same time as the opening accrual, these estimation errors would enter the model the same way as the errors for receivables and payables, and lead to the same conclusions.

Continuing with the model, we derive an expression for earnings as equal to cash flows plus accruals. Cash flows for period t is equal to expression (1), and total accruals is equal to the sum of opening and closing accruals for both cash advances and cash collections. This allows us to express earnings as:

$$E_t = CF_t + Accruals_t$$

$$E_t = (CF_t^{PRE} + CF_t^{CUR} + CF_t^{POST}) + (A_t^{PRE\text{-}O} + A_t^{PRE\text{-}C} + A_t^{POST\text{-}O} + A_t^{POST\text{-}C})$$

$$E_t = (CF_t^{PRE} + CF_t^{CUR} + CF_t^{POST}) +$$

$$(- CF_t^{PRE} + CF_{t-1}^{PRE} + CF_{t+1}^{POST} + \varepsilon_{t+1}^{POST} - CF_t^{POST} - \varepsilon_t^{POST}) \quad (2)$$

Canceling out terms yields:

$$E_t = CF_{t-1}^{PRE} + CF_t^{CUR} + CF_{t+1}^{POST} + \varepsilon_{t+1}^{POST} - \varepsilon_t^{POST} \quad (3)$$

An examination of equation (3) reveals that earnings for a given period is a re-slicing and inter-temporal adjustment of past, present, and future net cash flows, plus an adjustment for estimation errors and their corrections. In other words, Equation (3) is a more formal expression of the main intuition of the paper. The inter-temporal shifting of cash flows reflected in the cash flow terms of equation (3) alleviates the timing problems of using current raw cash flows as a measure of performance. However, this benefit comes at the cost of using estimates. Thus, earnings includes errors in estimates and their corrections. These errors add noise and reduce the quality of earnings as a measure of current performance.

We extend our work with the model by deriving predictions about the relations between key variables of interest. Most of these predictions concern relations already studied by existing research. We include them here as evidence that our model embodies the intuitive and well-known properties of earnings, cash flows, and accruals, and as a benchmark and link with existing results. These predictions also serve as a bridge between the theory and the derivation of empirical measures of accrual quality in the next section of the paper. Using the definitions of cash flows, accruals, and earnings above, allows one to make the following predictions:

a) $Corr(E_t, CF_t) = +$

b) $Corr(E_t, A_t) = +$

c) $Corr(CF_t, A_t) = -$

The first three predictions concern the correlations between contemporaneous earnings, cash flows, and accruals. These predictions have been repeatedly confirmed in existing research (e.g., Dechow 1994, Dechow, Kothari and Watts 1998).

d) $Corr(E_t, CF_{t+1}) = +$

e) $Corr(A_t, CF_{t+1}) = +$

These two correlations suggest that earnings, and particularly the accrual portion of current earnings anticipates future cash flows. This is another well-known result (e.g., Finger 1994, and Barth, Cram, and Nelson 2001). Again, we offer it as a calibration of the model and as a link with existing results.

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

g) $Corr(A_t, CF_{t-1}) = +$

To our knowledge, the prediction that current earnings and particularly the accrual component of current earnings is positively correlated with past cash flows is novel. The intuition is that cash advances and pre-payments are not reflected in accruals and earnings until they are earned or expensed.

2.2 Deriving an empirical measure of quality of accruals and its relation to fundamentals

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

$$A_t = CF_{t-1}^{PRE} - (CF_t^{PRE} + CF_t^{POST}) + CF_{t+1}^{POST} + \varepsilon_{t+1}^{POST} - \varepsilon_t^{POST} \quad (4)$$

Equation (4) succinctly conveys the role and characteristics of accruals in the accounting process. First, accruals are essentially temporary adjustments that delay or anticipate realized cash flows plus an estimation error term. Second, accruals are negatively related to current cash flows and positively related to past and future cash flows. Third, the magnitude of the error term in equation (4) captures the extent to which accruals map into cash flow realizations, and can be used as a measure of accrual and earnings quality.

We use an empirical version of equation (4) to derive practical measures of accrual quality. Specifically, we use the following firm-level time-series regression:

$$\Delta WC_t = b_0 + b_1 {*} CFO_{t-1} + b_2 {*} CFO_t + b_3 {*} CFO_{t+1} + \varepsilon_t \quad (5)$$

Here, our measure of accruals is changes in working capital, and our proxies for cash flows related to accruals are realized cash flows from operations. The residuals from the regression reflect the magnitude of accruals unrelated to cash flow realizations, and the standard deviation of these residuals is a measure of accrual quality, where higher standard deviation denotes lower quality.[1] Note that the major difference between the theoretical specification in equation (4) and the empirical version in expression (5) is the definition of cash flows. Equation (4) uses *only* the portions of past, present, and future cash flows which are related to current accruals. However, the empirical version in expression (5) uses total cash flows because there is no reliable way to break down total cash flows into the cash flow components required by the theoretical specification in equation (4).[2] Thus, the independent variables in expression (5) are measured with noise. Later in the paper, we implement additional tests to control for the effect of such noise on our results.

After the derivation of practical measures of accrual quality, we turn our attention to exploring the link between accrual quality and economic fundamentals. This issue is important because it increases our understanding of the economic determinants of accrual quality. Note that while the realization of individual estimation errors is random, the average magnitude of estimation errors is likely to be systematically related to firm characteristics. For example, even with good skills and best intentions, managers of firms in volatile industries will make systematically larger accrual estimation errors. In addition, identifying a relation between accrual quality and economic fundamentals is a stepping stone before proceeding with certain empirical applications that require ex ante

[1] Note that alternatively one can rank on R^2, or the explained variation in the regression, as a measure of accrual quality. The major difference between these two approaches is that R^2 is essentially a measure of the relative explained variation, while standard deviation of the residuals is more of an absolute measure of unexplained variation. We choose to work with the residuals because their magnitude relates more directly and naturally to a reconciliation with the accrual effect in Sloan (1996) later in the paper.

determination of accrual quality. In other words, the regression approach to determining accrual quality is based on ex post identification. However, many applications require ex ante identification of accrual quality (e.g., abnormal return strategies based on quality of earnings), and economic fundamentals are the natural bridge between ex post and ex ante specifications.

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

- **Accrual quality is decreasing in the magnitude of total accruals.**

Everything else equal, more accruals indicate more estimation and errors of estimation, and therefore lower quality of accruals. Note that this conjecture could potentially provide an explanation for why Sloan (1996) finds that high level of accruals signals low persistence of earnings.

- **Accrual quality is decreasing in the length of the operating cycle.**

Longer operating cycles indicate more uncertainty, more estimation and errors of estimation, and therefore lower quality of accruals.

- **Accrual quality is decreasing in the standard deviation of sales and the standard deviation of cash flow from operations.** High standard deviation in sales indicates high uncertainty in the operating environment, and therefore large use of approximations and estimation, with corresponding large errors of estimation and low accrual quality. The standard deviation of cash flow from operations captures a similar idea, only this is a more specific measure of pre-accrual volatility. For example, a firm can have low volatility of sales but large volatility of cash flows from operations because of high fixed costs or because of poor cash management practices.

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[2] There are special cases like the insurance industry, where firms provide specific and comprehensive information about their accrual estimates, the revisions in accruals, and the subsequent cash flow

- **Accrual quality is decreasing in the standard deviation of earnings.** Volatility of sales and cash flows captures volatility in the underlying operations. However, volatility in operations can be highly predictable, and lead to few estimation errors (e.g., seasonality in sales). We posit that accruals smooth the predictable volatility of cash flows, so we expect that more volatile earnings are indicative of unpredictable cash flows and large estimation errors in accruals. Since volatility of earnings captures information about both the volatility and unpredictability of cash flows, we expect a strong negative relation between accrual quality and the standard deviation of earnings.

- **Accrual quality is increasing in firm size.** We expect that large firms have more stable and predictable operations, and therefore less estimation errors. In other words, firm size likely proxies for several of the fundamentals discussed above. 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.

3. 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 the years 1987 to 1999. We limit our attention to this period because we want precise measures of operating cash flows and related accruals. Collins and Hribar (2000) document that the popular balance-sheet approach to deriving cash flow from operations leads to noisy and biased estimates. Therefore, we use cash flow from operations using data from the Statement of Cash Flows reported under the Statement of Financial Accounting Standards No. 95 (SFAS

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realizations. We do not pursue this venue because our interest is in more generalizable results.

No. 95).[3] Further, we restrict ourselves to firms that have non-missing data for assets, earnings, cash flow from operations, changes in accounts receivable and changes in inventory. We require firms to have accounts receivable and inventory since we want to include firms where working capital accruals are important. Truncating the most extreme one percent of cash from operations, earnings, and changes in working capital and a requirement to have at least one year of past and future cash flows and earnings yields a sample of 30,317 firm-years. In addition, we require firms to have at least eight years of data because some of our main regressions are run on a firm-specific basis. This restriction further reduces our sample to 15,234 firm-year observations for 1,725 firms. For some of our industry-level analyses, the data restrictions are less stringent, yielding a sample of 27,204 firm-year observations over 136 three-digit SIC code industries.

We obtain cash flow from operations (CFO) (Compustat item 308) directly from the statement of cash flows. The change in working capital (ΔWC) is computed as:

$$\Delta WC = \Delta AR + \Delta Inventory - \Delta AP - \Delta TP + \Delta Other\ Assets\ (net)$$

Where AR is accounts receivable, AP is accounts payable, and TP is taxes payable. Specifically, ΔWC is calculated from Compustat Statement of cash flows items as:

$$\Delta WC = -\ (item\ 302 + item\ 303 + item\ 304 + item\ 305 + item\ 307).$$

From the preceding discussion it is clear that we are interested in earnings after short-term accruals but before long-term accruals (Earn). Using the statement of cash flows items allows us to compute a precise measure of this variable as:[4]

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[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.

[4] An alternative and equivalent way to define and derive Earn is:
Earn = Income before extraordinary items + Depreciation + Extraordinary items + Deferred taxes + Equity in net loss + Gain from sale of property, plant and equipment + Funds from Operations (other).
The specific Compustat items for this alternative derivation of Earn are:

$$Earn = CFO + \Delta WC$$

Following Sloan (1996), all variables are scaled by average total assets. We also calculate the length of the operating cycle as:

$$OC = (Sales/365)/(Average\ AR) + (Cost\ of\ goods\ sold/365)/(Average\ Inventory)$$

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 between the variables of our sample are provided in Table 2. In addition to the other variables described above, we include Earnings before extraordinary items (Prof) to provide comparability with other studies that use this definition of income. An examination of the descriptive statistics in Panel A of Table 2 reveals that they are in line with those of other studies using similar variables and time period (e.g., Barth, Cram, and Nelson 2001). Our sample consists of sizable firms with average total assets of $2,436 million and a median of $240 million. The fact that Earn is greater than CFO implies that short-term accruals are mostly positive. This is not surprising, given that most firms are growing, and therefore continuously increasing their stocks of net working capital. In contrast, long-term accruals are negative (Prof is lower than both Earn and CFO), which is expected because the main component of long-term accruals is depreciation, always a negative accrual.

The correlations in Panels B and C illustrate the relations between the variables of our sample, and provide comparability with existing research. These simple relations also provide a check for how well our model captures important properties of our sample. An examination of the results reveals that the empirical correlations are in general

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Earn = item 123 + item 125 + item 124 + item 126 + item 106 + item 213 + item 217.

agreement with existing findings and the predictions of the model. Table 2 presents both Pearson and Spearman correlations but since the results are similar, our discussion focuses on Pearson correlations only. Following the order specified earlier, first we document the expected strong positive contemporaneous correlation between Earn and CFO (0.73), a lower positive correlation between contemporaneous Earn and ΔWC (0.33), and a negative contemporaneous correlation between CFO and ΔWC (-0.41). Second, we find that present earnings and changes in working capital anticipate future cash flows from operations, consistent with Barth, Cram, and Nelson (2001). Note that the predicted positive relation between present accruals and future cash flows is not present in the simple correlation between ΔWC_t and CFO_{t+1} (-0.01 and statistically insignificant). The reason is that ΔWC_t is strongly negatively correlated to CFO_t, and CFO_t is positively correlated to CFO_{t+1} (0.56), which counteracts the expected positive relation between ΔWC_t and CFO_{t+1}. In Panel C, we report the partial correlation between ΔWC_t and CFO_{t+1}, controlling for CFO_t. As expected, the partial correlation is large, positive, and highly significant (0.29). Third, as predicted by the model, we find that present changes in working capital are positively related to past cash flows, which implies that accruals defer to the present the recognition of some past cash flows. Note that in this case the simple correlation between ΔWC_t and CFO_{t-1} in Panel B is again close to zero but the partial correlation controlling for CFO_t in Panel C is large, positive, and significant (0.31). Summarizing, our descriptive statistics and correlation results are in line with predictions and existing results, indicating that our simple model captures reasonably well some of the key features of accrual accounting.

4. Results

4.1 An empirical measure of accrual quality

Table 3 presents regressions of current working capital accruals on past, present and future cash flows from operations. Our main specification is firm-level regressions because our theory is defined and most naturally applied on a firm-level basis. However, we also present industry-specific and pooled results because our firm-specific time series is short, and we are concerned about noisy estimation at the firm level. An examination of the firm-specific specification in Panel A of Table 3 reveals that the results 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 of current cash flows is -0.62, while the mean coefficient on past cash flows is 0.17, and the mean coefficient on future cash flows is 0.09. 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. The results for medians and lower and upper quartiles also suggest that coefficient means are fair summaries of the cross-sectional distributions of the coefficients, and are not overly affected by extreme outcomes. Adjusted R^2s are on the magnitude of 50 percent, which indicates that this specification provides reasonable explanatory power for current changes in working capital.

Results for industry-specific and pooled regressions in Panels B and C are consistent with the firm-specific results. The coefficients on current CFO are negative and large, with a mean of –0.51 for industry-specific regressions, and a coefficient of –

0.51 for the pooled regression. 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. However, the adjusted R^2s are somewhat lower, with an average of 0.34 for the industry specification and 0.29 for the pooled regression, most likely because the implications of our firm-specific model are less descriptive in cross-sectional specifications. Summarizing, a comparison of the firm-specific, industry, and pooled results reveals consistency across these specifications. Based on better theoretical grounding and better empirical fit, we proceed further with the firm-level specification.

In addition to the three specifications in Table 3, we perform a variety of sensitivity tests to assess the robustness of our results. Recall that perhaps the major concern about the regression specification in Table 3 is that the total cash flow variables we use are noisy estimates of the theoretically prescribed cash flow variables (theoretically, the cash flow variables should include only cash flows related to accruals). The noise in the independent variables potentially leads to biased estimates of the coefficients of the cash flow variables, and more importantly for the task at hand, to biased estimates of the residuals. Our sensitivity checks rely on the observation that total cash flow are likely to be a good proxy for the theoretical cash flow variable when the firm is in a steady state. The reason is that when the firm is in a steady state, the cash flows related to accruals are likely to be a fairly constant proportion of total cash flows.

We implement this observation on two dimensions. First, we rerun the regressions in Table 3 controlling for the effect of sales growth. We control for sales growth by either including a growth term in the regression or by running the regression only on low-growth firms, where low-growth is defined as percentage sales growth between –5 and 5 percent. The tenor of the results in Table 3 remains the same for both of these specifications (actual results not included). In addition, controlling for growth does not appreciably affect the relations between accrual quality, economic fundamentals, and persistence of earnings (discussed in more detail later). Second, we investigate for the effect of cash flow volatility on accrual quality. If cash flow volatility is low, we expect a relatively stable relation between total cash flows and cash flows related to accruals. Similar to sales growth, we control for cash flow volatility by either including a cash flow volatility term in the regressions or by running the regression on low-volatility firms only. After running both of these specifications, we find that the results remain qualitatively unchanged.[5]

As a final robustness check, we investigate the effect of special items on the results. The potential problem with special items is that they often contain long-term accruals, which can possibly affect both our measure of short-term accruals and our measure of cash flow from operations (recall that we assume that cash flow from operations is only related to short-term accruals). For example, sometimes Compustat includes restructuring charges in "other assets and liabilities" (Data item 307), contaminating our measure of short-term accruals. In addition, a portion of the Compustat cash flows from operations can be related to restructuring charges, contaminating our measure of cash flows related to short-term accruals. Thus, the

[5] Note that an explicit control for cash flow volatility introduces a "throwing the baby with the bathwater" effect because, as discussed earlier, we have reasons to believe that accrual quality is theoretically negatively related to cash flow volatility. In other words, 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. As discussed earlier, theoretically, high cash flow volatility causes low accrual quality because of large forecast errors in volatile environments, and one does not want to exclude the effect of this causal variable from the empirical construct. For this reason,

presence of special items could lead to bias in our measure of short-term accrual estimation errors. We provide two tests to investigate the sensitivity of our results with respect to special items. First, we replicate the results in panel A of table 3 for firms with little of no special items (special items that are less than five percent of earnings and one percent of assets). The tenor of the results is unchanged. Second, we exclude "other assets and liabilities (data 307) from our measure of working capital accruals and cash flows and replicate all tests in the paper. Again, the tenor of the results is unchanged.

Summarizing, our regression specifications have good empirical fit, and all coefficients have the predicted sign. In addition, we find that the tenor of our results remains the same across firms-specific, industry, and economy-wide specifications and for sensitivity analyses accounting for growth, cash flow volatility, and special items.

4.2. The relation between accrual quality and economic fundamentals

We use the standard deviation of the residuals as a firm-specific measure of accrual quality, where higher standard deviation signifies lower quality.[6] 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. Such alternative tests can be potentially fruitful because existing tests of earnings management typically use empirical constructs like "discretionary

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we present the main results without a control for cash flow volatility. A similar argument applies for sales growth as well.

[6] An alternative firm-year specific measure of accrual quality is absolute value of the residual for that year. As one would expect, these two measures are closely related, and the tenor of the results is similar for this alternative specification. However, we find that the standard deviation of the residuals has moderately stronger relations to economic fundamentals and earnings persistence. Since these tests are essentially part of a identification process, we proceed with the more powerful empirical specification.

accruals", which can be problematic (e.g., Dechow, Sloan, and Sweeney 1995). Note that 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.[7]

For the purposes of this paper, we concentrate on two empirical applications. As discussed earlier, first we explore the relation between our measure of accrual quality and economic fundamentals. This investigation expands our understanding of the economic underpinnings of accrual quality, and suggests possible approaches for an ex ante identification of accrual quality. Table 4 provides the results about the hypothesized relations between accrual quality and selected economic fundamentals. Panel A of table 4 provides descriptive statistics where the variables are first averaged on a firm basis. Note that the distribution of the variable *Average operating cycle* (mean of 141 days, standard deviation of 62 days) indicates that the vast majority of the firms in our sample have an operating cycle of less than one year. Thus, our assumption that most accruals reverse within one year seems reasonable for this sample.

Panel B of table 4 presents the Pearson correlations between our measure of accrual quality (standard deviation of the residuals or *sresid*) and economic fundamentals. All of our predictions are supported by the results, with large coefficients and high statistical significance. The standard deviation of the residuals is increasing in the

[7] For the purposes of this paper, the difference between unavoidable errors in estimation and opportunistic accruals is largely irrelevant – both translate into low quality accruals and earnings. However, if the purpose is to derive a powerful measure of opportunistic accruals, a possible approach is to start with our measure of low-quality accruals and adjust it for the effect of unavoidable errors of estimation. For example, one can control for the effect of unavoidable errors of estimation by controlling for their economic determinants (as discussed earlier in this study).

average level of working capital accruals (correlation of 0.69), length of the operating cycle (0.28), standard deviations of sales (0.34), cash flow from operations (0.60), and earnings (0.82), and is decreasing in firm size (-0.55). The magnitude of these correlations suggests that quality of accruals is strongly related to economic fundamentals. In particular, note that standard deviation of earnings alone explains about 67 percent of the variation in accrual quality (the simple correlation between these two variables, squared). As discussed earlier, standard deviation of earnings probably has the largest explanatory power because it captures both the volatility and the unpredictability of cash flows from operations.

Panel C of table 4 presents the results from combining the explanatory power of these fundamentals in multiple regressions. We start with a regression of accrual quality on the four variables with relatively low individual correlations, average operating cycle, standard deviation of sales and cash flows, and size. The results show a good fit, where all variables have the predicted sign, highly significant t-statistics, and an adjusted R^2 of 0.44. However, adding the two remaining variables, mean level of accruals and standard deviation of earnings, leads to dramatic changes. The adjusted R^2 nearly doubles to 0.79, while all initial variables either lose significance (operating cycle and standard deviation of sales), switch signs (standard deviation of cash flows), or have a substantially lower coefficient and t-statistic (firm size). The overall impression from the second multiple regression is that mean level of accruals and standard deviation of earnings nearly subsume the explanatory power of the rest of the variables. The last multiple regression in Panel C confirms this impression. A parsimonious specification including only mean absolute level of accruals and standard deviation of earnings retains most of the explanatory power of the expanded regression, with adjusted R^2 dropping only 5 percent, from 0.79 to 0.74. Considering more closely the two remaining variables, standard deviation of earnings is incrementally more important than level of accruals. Having in mind the simple correlations in Panel B, note that adding level of accruals to standard deviation of earnings adds an incremental R^2 of only 7 percent, while adding standard deviation of earnings to level of accruals adds an incremental R^2 of 26 percent.

Summarizing, our measure of accrual quality has a strong relation to economic fundamentals, and even fairly simple specifications yield high explanatory power. These results suggest that one can use firm fundamentals to derive ex ante proxies for our measure of accrual quality.

4.3. The relation of accrual quality to earnings persistence

Our second area of empirical inquiry examines the relation between accrual quality and persistence of earnings. Intuitively, most practitioners and academics think of low-quality earnings as having low persistence. The theory in this paper provides a natural and specific link between our measure of accrual and earnings quality and earnings persistence. Firms with low quality accruals have a greater proportion of accruals that do not map into cash flow realizations. Thus, for such firms the accrual portion of current earnings is a poor predictor of future earnings, which implies lower persistence of earnings.

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 and Barth, Cram, and Nelson 2001) and to examine for potential non-linearities in the quality-persistence relation. In unreported tests, the results have the same tenor in a regression specification. In Panel A, firms are first sorted on the standard deviation of the firm-specific residuals (*sresid*) from Table 3 into quintile portfolios. Within each portfolio, we run a regression of future earnings on present earnings, and report the slope coefficient (called *Persistence*) and the adjusted R^2. An examination of Panel A reveals a strong negative relation between standard deviation of the residuals and persistence. The slope coefficient *Persistence* declines from 0.94 to 0.55 between quintiles 1 and 5. The decline in *Persistence* is monotonic but the relation is fairly flat in the middle and steeper in the tails. Since these are univariate regressions, the decline in adjusted R^2 from 0.83 to 0.28 closely follows that of the slope coefficient, displaying the same pattern of fairly flat middle and steeper tails. Thus, we find strong empirical evidence confirming the hypothesized positive relation between accrual quality and earnings persistence.[8]

Panel A also reports mean level of working capital accruals for each *sresid* portfolio. Similar to the results in Table 4, the portfolio results in Panel A reveal a strong 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 negatively related to earnings persistence. Thus, at this point it is difficult to distinguish empirically between the effect of accrual quality and level of accruals on earnings persistence.

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[8] From the definition of our measure of accrual quality, it is clear that it has some "look-ahead" bias in explaining earnings persistence. The reason is that good accrual quality in our paper means good relation between current accruals and future cash flows. Since both accruals and cash flows are part of earnings, one would expect that high accrual quality would be correlated with high persistence by construction. This concern is certainly valid. However, it does not seem to be overly important empirically. An alternative specification, which uses residuals from regressing accruals on only past and present cash flows produces almost the same portfolio results. This robustness in results is probably explained by the relative stability of accrual quality over time. Since the results are similar, we present the original specification to preserve continuity with the rest of the paper.

However, as mentioned earlier, there are a priori reasons to believe that our measure of accrual quality and level of accruals are really two sides of the same coin, while both proxy for the unobservable "true" accrual quality. Thus, regarding their relation to earnings persistence, the real question is only partly about which of these measures is "better" on some conceptual grounds. To a large extent, the real issue is which of these two measures performs better empirically, in this case in explaining earnings persistence.

As an aside, the interrelations between accrual quality, level of accruals, and earnings persistence are also intriguing because they suggest a reconciliation of the findings of Dechow (1994) and Sloan (1996). Although a full and specific reconciliation is beyond the scope of this study, it seems valuable to lay out the basic idea because the findings of these two studies concern basic properties of the accrual process, while they seem somewhat contradictory on the surface. As mentioned before, Dechow (1994) finds that accruals make earnings a better measure of firm performance than cash flows. However, 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, and questions the beneficial role of accruals.

Our reconciliation of these two studies is based on the observation that in a well-functioning system of accruals that involves estimation errors, a high level of accruals signifies both earnings which are a great improvement over underlying cash flows, and low-quality earnings. The reason is that a well-functioning system of accruals creates the most accruals when the underlying cash flows have the most timing and mismatching problems. Thus, a high level of accruals signifies a great improvement over the underlying cash flows. However, the first-order benefit of accruals comes at the cost of incurring estimation errors, and there will be a positive correlation between levels of accruals and magnitude of estimation errors. Thus, everything else equal, large accruals signify low quality of earnings, and less persistent earnings. In other words, the results in Dechow (1994) and Sloan (1996) are reconciled by the fact that level of accruals proxies for both the first-order benefit of accruals and for the correlated second-order cost of the accrual process.[9] Future research could provide more specific evidence about the validity of this reconciliation.

Returning to our main line of inquiry, we pursue two approaches to distinguish between the explanatory power of *sresid* and level of accruals with respect to earnings persistence. The first approach is provided in Panel B of table 5. We start with a simple portfolio ranking on the absolute magnitude of accruals.[10] An examination of Panel B confirms 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, the relative declines in slope coefficient and R^2 across extreme quintiles are less pronounced in Panel B as compared to those in Panel A. The relative decline in *Persistence* is 0.39 (0.55 for adjusted R^2) for the accrual quality quintiles vs. 0.26 (0.24 for adjusted R^2) for the level of accrual quintiles. In addition, the relation between level of accruals and persistence in Panel B is

[9] To explain the same point in a somewhat different way, consider an efficient accrual system, where accruals are recorded until the marginal benefit of accruals (resolving cash flow timing problems) equals the marginal cost of accruals (incurring errors of estimation). Optimizing over the level of accruals will result in the highest accruals for firms, which have the largest problems in their underlying cash flows. Thus, firms with the highest accruals will have the greatest benefit from accruals but also the greatest cost, and the lowest quality of earnings.

[10] Note that 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 of accruals is due to variation in accounts receivable and inventory (Sloan 1996, page 297), which implies that for our purposes these two measures of level of accruals are reasonably similar.

non-monotonic, and it is essentially flat for low to medium-level accruals. The overall impression from Panel B is that level of accruals is a signal of low earnings persistence only for high accrual realizations. Summarizing, portfolio results reveals that 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 to distinguish between the explanatory power of *sresid* and level of accruals with respect to earnings persistence is provided in Table 6. In Table 6 we offer portfolio results of the relation between *sresid* or the level of accruals to earnings persistence, holding the other variable constant. To illustrate our procedure, consider the portfolio results for *sresid* in Panel A of Table 6. To hold the level of accruals constant, first we sort the sample into decile portfolios based on level of accruals. 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). Then, we pool all ten subportfolios 1 together into one portfolio, all subportfolios 2 together into another portfolio, and so on. At the end, we have five portfolios, which have substantial variation of *sresid* but nearly the same level of accruals.

An inspection of Panel A in Table 6 reveals that this procedure performs empirically quite well. The two-pass portfolio construction controls for the level of accruals nearly perfectly, with mean ΔWC ranging only from 0.047 to 0.051 across portfolios 1 to 5. Note also that, despite the strong positive correlation between *sresid* and level of accruals at the firm level, the portfolios in Panel A exhibit a large variation in *sresid*. In fact, the conditional range between mean *sresid* of portfolios 1 and 5 in Table 6 of 0.55 is only marginally lower than the corresponding unconditional range in Table 5 of 0.63. This result indicates that the variation in *sresid* independent of level of accruals is substantial and empirically important. Further, a consideration of the regression results reveals that the conditional variation in *sresid* is strongly related to earnings persistence. The slope coefficient *Persistence,* varies from 0.91 in portfolio 1 to 0.60 in portfolio 5, and adjusted R^2 varies from 0.78 in portfolio 1 to 0.33 in portfolio 5. Remarkably, the variation of coefficients and R^2s across portfolios in the conditional specification of Table 6 is only marginally lower than that of the unconditional specification in Table 5 (differences in Persistence of 0.31 vs. 0.39, and differences in R^2s of 0.45 vs. 0.54). In other words, the main finding in Panel A of Table 6 is that most of the strength of the relation between accrual quality (*sresid*) and earnings persistence is preserved after controlling for 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. Portfolio derivation method in Panel B is similar to that of Panel A. First, we rank observations into 10 portfolios based on *sresid,* then within each decile portfolio we rank observations into 5 subportfolios on level of accruals, and finally we pool all subportfolios with the same rank together. At the end, we have five portfolios which preserve most of the variation in level of accruals, while holding *sresid* nearly constant across portfolios. An examination of the portfolio results reveals a slight decline in the variation of the slope coefficient *Persistence* across portfolios, with a difference between portfolios 1 and 5 of 0.22 in Table 6 vs. 0.26 in Table 5. However, there is a substantial erosion in the range of R^2, difference of 0.09 in Table 6 vs. 0.24 in Table 5. In addition, the differences in slope coefficients and R^2 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 reveals that our measure of quality of accruals captures variation in earnings persistence distinct from that due to the level of accruals. If anything, both the unconditional and the conditional specifications suggest that the relation between accrual quality and earnings persistence is stronger than that between level of accruals and persistence. We offer this evidence with two caveats. First, level of accruals is a measure that is simple, easy to use, and requires no extensive identification and prediction process. Thus, the comparison presented here is somewhat biased against the performance of level of accruals, especially for settings that require ex ante identification and prediction of quality of earnings measures (e.g., real-time trading strategies). Second, future research along the lines of this study could identify other empirical measures of accrual quality, focusing on those that capture earnings persistence better than the proxy used here.

5. Conclusion

This study suggests a new approach to assessing accrual and earnings quality. The key insight behind this approach is that accruals are temporary adjustments that resolve timing and mismatching problems in the underlying cash flows at the cost of making assumptions and estimates. High precision of estimation in the accrual process implies a good match between current accruals and past, present, or future cash flow realizations. However, imprecise or erroneous estimates are essentially noise in accruals, reducing the beneficial role of accruals. Following this insight, we define accrual quality as the extent to which accruals map into cash flow realizations.

We also investigate the implications of this theory in the empirical domain. Our empirical measure of accrual quality is equal to 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. We explore the characteristics and the role of this measure in two specific contexts. First, we document that accrual quality is strongly related to economic fundamentals. This analysis expands our understanding of the economic underpinnings of accrual quality, and suggests that fundamentals provide an alternative way to derive measures of accrual quality. Second, we find a strong negative relation between accrual quality and earnings persistence. This relation is robust to controlling for the level of accruals effect of Sloan (1996), and suggests that there are important practical benefits from identifying and measuring accrual quality.

The evidence in this paper also opens new possibilities for research. For example, it would be interesting to investigate whether the stock market understands and fully impounds the implications of accrual quality for earnings persistence. Another possibility is to examine whether the approach of this paper can be adapted to provide alternative measures of earnings management. A still different and much less structured possibility is to think more carefully about how to use this approach to accrual quality to enhance the rules for financial reporting. For example, one could argue that investors interested in earnings quality would welcome disclosure about what part of accruals is correcting timing discrepancies and what part is correcting estimation errors or other noise. Such disclosure would also increase the visibility of opportunistic accruals, and reduce the likelihood of earnings management. In this respect, our ideas about improving financial reporting are in the same spirit as Lundholm (1999), which argues that restating of old statements after observing ex post realizations creates better ex ante incentives for recording proper accruals.

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Appendix 1
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:

	*Cash flow occurs at **t-1*** *(**before** it is recognized in earnings)*	*Cash flow occurs at **t+1*** *(**after** it is recognized in earnings)*
*Recognized in earnings at t as **revenue***	Case (1) **Cash Inflow**: Advance **Accrual created and reversed**: Liability e.g., Deferred Revenue	Case (3) **Cash Inflow**: Collection **Accrual created and reversed**: Asset e.g., Accounts Receivable
*Recognized in earnings at t as an **expense***	Case (2) **Cash Outflow**: Prepayment **Accrual created and reversed**: Asset e.g., Inventory, Prepaid Rent	Case (4) **Cash Outflow**: Payment **Accrual created and reversed**: Liability e.g., Warranty Liability

Below we provide an example of each case, show the link between the accrual and the cash flow, and how an estimation error is corrected. We also include the notation introduced in section 2 to link the appendix with the paper.

Case (1): Cash received before it is recognized as revenue

Receive $100 for a prepaid magazine subscription

t-1	Dr	Cash (CF_{t-1}^{PRE})		100	
		Cr	Deferred Revenue $(A_{t-1}^{PRE\text{-}O})$		100

No error situation

t	Dr	Deferred Revenue $(A_t^{PRE\text{-}C})$		100	
		Cr	Sales Revenue		100

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

t	Dr	Deferred Revenue $(A_t^{PRE\text{-}C})$		100	
		Cr	Cash		10
		Cr	Sales Revenue		90

(In this case the increase in deferred revenue at t-1 equals cash flows at t-1. Therefore our model will not detect this type of error.)

Case (2): Cash paid before recognized as an expense

Pay $100 for inventory:

t-1	Dr	Inventory $(A_{t-1}^{PRE\text{-}O})$		100	
		Cr	Cash (CF_{t-1}^{PRE})		100

No error situation

t	Dr	Cost of goods sold		100	
		Cr	Inventory $(A_t^{PRE\text{-}C})$		100

Error situation: Write down of $20

t	Dr	Write down		20	
	Dr	Cost of goods sold		80	
		Cr	Inventory $(A_t^{PRE\text{-}C})$		100

In this case no error will be picked up by our model since the inventory accrual and cash flow at inception are equal. The only time we will pick up write-off errors is if they occur in the same year as the inventory is purchased:

t	Dr	Inventory $(A_t^{CUR\text{-}O})$		100	
		Cr	Cash (CF_t^{CUR})		100
	Dr	Write-down (ε_t^{CUR})		20	
		Cr	Inventory $(A_t^{CUR\text{-}C})$		20

(In this case the net inventory increase at t of $80 is not matched to the cash outflow of $100 occurring in year t so an error of $20 occurs). To simplify the discussion, this type of error is not included in our model described in section 2.

Case (3): Cash received after it is recognized as revenue

Record $100 of credit sales

t	Dr	Accounts Receivable (A_t^{POST-O})	100	
		Cr Sales Revenue		100

No error situation

t+1	Dr	Cash (CF_{t+1}^{POST})	100	
		Cr Accounts Receivable (A_{t+1}^{POST-C})		100

Error situation: an unanticipated $30 is not collected

t+1	Dr	Bad debt write-off (ε_{t+1}^{POST})	30	
	Dr	Cash (CF_{t+1}^{POST})	70	
		Cr Accounts Receivable (A_{t+1}^{POST-C})		100

(In this case cash goes up by $70 at t+1 but accounts receivable at t increases by $100. Therefore, there is an error of $30)

Case (4) Cash paid after the expense is recorded

Estimate $100 for warranty expense

t	Dr	Warranty Expense	$100	
		Cr Warranty Liability (A_t^{POST-O})		$100

No error situation

t+1	Dr	Warranty Liability (A_{t+1}^{POST-C})	100	
		Cr Cash (CF_{t+1}^{POST})		100

Error situation: Warranty work amounts to $135

t+1	Dr	Warranty Liability (A_{t+1}^{POST-C})	100	
	Dr	Warranty expense (ε_{t+1}^{POST})	35	
		Cr Cash (CF_{t+1}^{POST})		135

(In this case warranty liability increases by $100 at t and is not equal to the cash flow of $135 at t+1. The difference is $35 negative estimation error.)

Table 1
Derivation of Sample

Firm-years with available cash from operations, earnings, and changes in accounts receivable and inventory and total assets reported in the statement of cash flows	59,360
Firm-years after truncation of the most extreme 1% of earnings, cash from operations, and changes in working capital	55,850
Firm-years with both a lead and lag value of cash from operations	30,317
Firms with over 8 observations	1,725
Firm-years available for the 1,725 firms used in the remaining analysis	15,234
Three digit SIC groups with over 50 observations	136
Firm-years available for the 136 industries	27,204

Table 2
Descriptive statistics and correlations for 15,234 firm-year observations between 1987-1999.

Panel A: Descriptive statistics

	Mean	Standard Deviation	Lower Quartile	Median	Upper Quartile	Obs.
Cash flow from operations (CFO)	0.075	0.097	0.033	0.082	0.131	15,234
Change in working capital (ΔWC)	0.015	0.070	-0.015	0.010	0.044	15,234
Earnings before long-term accruals (Earn)	0.091	0.093	0.057	0.096	0.141	15,234
Earnings before extraordinary items (Prof)	0.030	0.113	0.009	0.042	0.081	15,234
Total Assets (in millions)	2,436	10,878	50	240	1,215	15,234

Panel B: Correlations: Pearson above the diagonal/ Spearman below

	$Prof_t$	$Earn_t$	CFO_t	ΔWC_t	CFO_{t+1}	CFO_{t-1}	$Earn_{t+1}$
$Prof_t$		0.816[a]	0.575[a]	0.292[a]	0.458[a]	0.470[a]	0.540[a]
$Earn_t$	0.827[a]		**0.728[a]**	**0.325[a]**	0.571[a]	0.575[a]	0.674[a]
CFO_t	0.551[a]	0.685[a]		**-0.411[a]**	0.558[a]	0.549[a]	0.597[a]
ΔWC_t	0.245[a]	0.253[a]	-0.425[a]		-0.011	0.008	0.072[a]
CFO_{t+1}	0.422[a]	0.539[a]	0.525[a]	-0.027[a]		0.482[a]	0.735[a]
CFO_{t-1}	0.479[a]	0.577[a]	0.527[a]	0.011[a]	0.465[a]		0.491[a]
$Earn_{t+1}$	0.591[a]	0.715[a]	0.582[a]	0.071[a]	0.692[a]	0.496[a]	

Panel C: Partial Correlations (controlling for the effect of CFO_t)

	Spearman Correlation	Pearson Correlation
	ΔWC_t	ΔWC_t
CFO_{t+1}	0.254[a]	**0.289[a]**
CFO_{t-1}	0.305[a]	**0.306[a]**

[a] Significant at the 0.0001 level.

Variable definitions:
Cash flow from operations (CFO) is item 308 from the Compustat Statement of Cash Flows.
Change in working capital (ΔWC) is equal to ΔAR + ΔInventory - ΔAP - ΔTP + ΔOther Assets (net), where AR is accounts receivable, AP is accounts payable, TP is taxes payable.
Earnings before long-term accruals (Earn) is equal to CFO + ΔWC.
Earnings before extraordinary items (Prof) is Compustat Earnings before extraordinary items.
All variables are scaled by average assets.

Table 3
Regressions of the change in working capital on past, current, and future cash flow from operations

$$\Delta WC_t = \alpha + \beta_1 CFO_{t-1} + \beta_2 CFO_t + \beta_3 CFO_{t+1} + \varepsilon_t$$

Panel A: Firm-specific regressions (1,725 firms)

	Intercept	β_1	β_2	β_3	Adjusted R^2
Mean	**0.04**	**0.17**	**-0.62**	**0.09**	**0.47**
(t-statistic)	(23.03)	(19.38)	(-57.06)	(10.38)	
Lower quartile	0.001	-0.02	-0.91	-0.10	0.23
Median	0.04	0.14	-0.65	0.09	0.55
Upper quartile	0.08	0.35	-0.35	0.28	0.80

Panel B: Industry-specific regressions (136 industries)

	Intercept	β_1	β_2	β_3	Adjusted R^2
Mean	**0.03**	**0.19**	**-0.51**	**0.15**	**0.34**
(t-statistic)	(16.09)	(21.10)	(-35.77)	(15.33)	
Lower quartile	0.01	0.11	-0.63	0.08	0.22
Median	0.03	0.18	-0.52	0.15	0.34
Upper quartile	0.04	0.26	-0.40	0.23	0.45

Panel C: Pooled Regression (15,324 firm-year observations)

	Intercept	β_1	β_2	β_3	Adjusted R^2
Coefficient	**0.03**	**0.19**	**-0.51**	**0.18**	**0.29**
(t-statistic)	(39.43)	(32.12)	(-78.29)	(29.18)	

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 as defined in Table 2.

Table 4
Descriptive statistics and the correlation between quality of working capital accruals with various determinants

Panel A: Descriptive statistics

	Mean	Std. Deviation	Lower Quartile	Median	Upper Quartile	Obs.
Standard deviation of residual (sresid)	0.028	0.025	0.011	0.020	0.037	1,725
Average Operating cycle	141.08	61.807	90.229	131.505	184.81	1,725
Average absolute value of ΔWC	0.048	0.033	0.023	0.040	0.067	1,725
Std. Dev of Sales	0.215	0.205	0.097	0.166	0.273	1,725
Std. Dev of CFO	0.060	0.040	0.031	0.051	0.078	1,725
Std. Dev of Earn	0.050	0.044	0.021	0.037	0.063	1,725

Panel B: Pearson correlations between the standard deviation of the residual (sresid) and economic fundamentals (N=1,725). All significant at the 0.0001 level.

Mean Abs(ΔWC)	Average Op. Cycle	Std. Dev. Sales	Std Dev. CFO	Std. Dev. Earn	Log(Total Assets)
0.69	0.28	0.34	0.60	0.82	-0.55

Panel C: Multivariate regressions of standard deviation of the residual (sresid) on economic fundamentals (N=1,725)

	Mean Abs (ΔWC)	Ave. Op. Cycle	Std. Dev. Sales	Std Dev. CFO	Std. Dev. Earn	Log (Total Assets)	Adj. R^2
Coefficients		0.00005	0.015	0.233		-0.003	0.44
(t-statistics)		(6.40)	(5.99)	(16.33)		(-11.32)	
Coefficients	0.36	$5*10^{-6}$	0.002	-0.24	0.46	-0.0006	0.79
(t-statistics)	(27.21)	(0.99)	(1.24)	(-19.40)	(47.20)	(-3.61)	
Coefficients	0.25				0.35		0.74
(t-statistics)	(22.99)				(42.56)		

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

$\Delta WC_t = \alpha + \beta_1 CFO_{t-1} + \beta_2 CFO_t + \beta_3 CFO_{t+1} + \varepsilon_t$

For this table, we use a log(Assets) specification to correct for right-tail skewness in Assets.

Operating cycle is equal to (Sales/365)/(Average Accounts Receivable) + (Cost of goods sold/365)/(Average Inventory). The rest of the variables are defined as in Table 2.

Table 5
The relative information content of accrual quality and level of accruals for earnings persistence

Panel A: Portfolios based on the magnitude of standard deviation of residuals

Portfolio	Std. Dev. Resid (*sresid*)	Absolute (ΔWC_t)	Persistence (δ_1)	Adj R^2	Number of observations
1	0.006	0.023	0.943	0.830	3,047
2	0.013	0.033	0.816	0.651	3,043
3	0.020	0.042	0.799	0.619	3,049
4	0.032	0.058	0.756	0.545	3,045
5	0.069	0.086	0.551	0.280	3,050

Panel B: Portfolios based on the level of accruals (ΔWC_t)

Portfolio	Absolute (ΔWC_t)	Std. Dev. Resid (*sresid*)	Persistence (δ_1)	Adj R^2	Number of observations
1	0.005	0.018	0.814	0.566	3,046
2	0.015	0.020	0.791	0.548	3,047
3	0.031	0.025	0.809	0.584	3,047
4	0.056	0.032	0.747	0.466	3,047
5	0.135	0.046	0.550	0.329	3,047

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

$$\Delta WC_t = \alpha + \beta_1 CFO_{t-1} + \beta_2 CFO_t + \beta_3 CFO_{t+1} + \varepsilon_t$$

Level of accruals is measured as the absolute value of current change in working capital.
Earnings persistence (δ_1) is measured for each portfolio from the following regression:

$$Earn_{t+1} = \alpha + \delta_1 Earn_t + v_t$$

All other variables are as defined in Table 2.

Table 6
The incremental information content of accrual quality and level of accruals for earnings persistence

Panel A: Portfolios based on the magnitude of the standard deviation of residuals (*sresid*), controlling for the absolute magnitude of (ΔWC_i)

Portfolio	Std. Dev. Resid (*sresid*)	Absolute (ΔWC_i)	Persistence (δ_1)	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 magnitude of absolute (ΔWC_i), controlling for the standard deviation of the residual (*sresid*)

Portfolio	Absolute (ΔWC_i)	Std. Dev. Resid (*sresid*)	Persistence (δ_1)	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 residual from the following firm specific regression:

$$\Delta WC_t = \alpha + \beta_1 CFO_{t-1} + \beta_2 CFO_t + \beta_3 CFO_{t+1} + \varepsilon_t$$

Level of accruals is measured as the absolute value of current change in working capital.
Earnings persistence (δ_1) is measured for each portfolio from the following regression:

$$Earn_{t+1} = \alpha + \delta_1 Earn_t + v_t$$

All other variables are as defined in Table 2.