Seasonal Variation in Cash Flows and the Timing Role of Accruals*

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Abstract

We study how seasonal variation affects quarterly accruals and cash flows. We first extend the framework of Dechow, Kothari, and Watts (1998) and analytically show how seasonal variation in operating cash flows and accruals is determined by the seasonality in sales and firms' working capital policies. Next, we empirically find that quarterly working capital accruals play a pronounced role in offsetting cash flows noise and document that this timing role varies predictably with seasonal cash flow variation. The timing role of quarterly accruals becomes somewhat less pronounced over time, which relates to a systematic decline in seasonal cash flow variation and changes in the determinants of seasonal variation—primarily reductions in firms' inventory holdings and lengthier payment delays to suppliers. Our results add to the recent debate on the significance of the noise-reducing role of accruals, the literature on the economic determinants of accruals, and the literature on the time-series properties of earnings, cash flows, and accruals.

Keywords: Accrual accounting, cash flows, earnings, seasonality, quarterly reporting, working capital, trade credit.

JEL Classifications: G11, M41, M48.

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1. Introduction

Firms can experience substantial seasonal fluctuations in their operating cash flows. Given inventory holding policies and the terms of trade with customers and suppliers, this seasonal variation in cash flows does not necessarily coincide with the seasonal peaks and troughs in the demand for a firm's products and services. The significance of the seasonality in firms' operations and cash positions is relevant from a risk-management and investment perspective (e.g., Minton and Schrand 1999; Bates et al. 2009; Almeida et al. 2024), and supports the SEC's choice to retain the disclosure requirement on material business seasonality in its update to Regulation S-K Item 101 (SEC 2020).

Seasonal variation in operating cash flows differs from the seasonality in earnings (e.g., Griffin 1977; Chang et al. 2017), because a key role of accrual accounting is to shift the recognition of cash in- and outflows in earnings over time. The objective of this "timing role" of accrual accounting is to offset transitory noise in operating cash flows and to provide a more informative and less volatile measurement of economic performance with accrual-based earnings (Dechow 1994; Dechow et al. 1998). In this paper, we examine seasonal variation as a unique form of transitory shocks to cash flows, induced by the seasonality in demand and firms' working capital management, and provide evidence on the significance of the timing role of accruals in offsetting these shocks.

By studying quarterly accruals and cash flows, our study contributes to an ongoing debate on the timing role of accruals. Bushman et al. (2016) find a substantial weakening in the timing role of annual accruals and conclude this is driven by increased recognition of transitory nonoperating items and losses over time. Green et al. (2022) conclude that the time trend is driven by increased intangible investments. Related work debates whether earnings are truly more informative than operating cash flows for the prediction of future cash flows (Nallareddy et al. 2020; Ball and Nikolaev 2022; Casey and Ruch 2024). We focus on quarterly accruals and cash flows to study the role of seasonal variation, which is obscured by annual performance measurements. Also, the timing role of accruals should become more pronounced as the reporting period shortens relative to the firm's operating cycle (Dechow 1994). Most firms' operating cycles are much shorter than a year, which implies that the cash in- and outflows linked to an economic event often materialize—and their associated accruals originate and reverse—within the year.

To illustrate the importance of studying the timing role of accruals based on quarterly performance measurements, consider the example of Amazon in Figure 1 for the 100 fiscal quarters between 1998 and 2022. Amazon's operating cash flows are highly seasonal with clear peaks (lows) in the fourth (first) fiscal quarter. This seasonal variation in cash flows is an outcome of peak demand in the fourth fiscal quarter and Amazon's specific working capital policies. In contrast to operating cash flows, earnings display much weaker volatility over time. The difference in the volatility of earnings versus operating cash flows is explained by the accrual component of earnings, which offsets the noise induced by seasonal variation in cash flows. Appendix A illustrates how this offsetting of seasonal variation is not visible in annual performance measurements.

We build on the analytical framework of Dechow et al. (1998, hereafter DKW) to model the quarterly accrual process and the determinants of seasonal variation in cash flows. The DKW framework models the accrual process based on assumptions about working capital policies and a random walk in sales. We extend the framework to the quarterly setting by introducing a seasonality parameter that captures the incremental sales expected in a firm's peak seasonal quarter. Our framework shows how seasonal variation in operating cash flows is determined by the interaction between sales seasonality and the specific parameters of firms' working capital policies. The seasonal variation in cash flows triggers variation in accruals in the opposite direction, such that the effects of seasonality and working capital policies are dampened in earnings.

Our empirical tests rely on firms in Compustat and CRSP during the period 1989–2022. We measure the timing role of accruals based on the notion that when accruals offset noise in cash flows to reduce the variance of earnings (as in the Amazon example discussed above), the covariance between accruals and cash flows should be negative. Accordingly, we identify the timing role of accruals based on the contemporaneous correlation between operating accruals and cash flows (e.g., Bushman et al. 2016; Green et al. 2022). An important consideration with this measurement is that accruals are the outcome of a firm-level process that shifts the recognition of cash flows across periods, not across firms (Dechow 1994; Gerakos 2012; Ball and Nikolaev 2022). Our empirical tests therefore control for unwanted cross-sectional variation in accruals and cash flows by demeaning variables by firm (Ball and Nikolaev 2022; Breuer and deHaan 2023) or by using change variables following the theoretical foundations of DKW and Frankel and Sun (2018).

When variables are demeaned by firm, we find that the coefficient and R^2 obtained from a regression of quarterly operating accruals on operating cash flows equal -0.671 and 0.347, respectively. This result suggests that quarterly accruals play a nontrivial timing role. The R^2 increases to 0.494 when we focus on working capital accruals, for which the timing role of accruals should be most important (Dechow 1994). In fact, we find no clear evidence of a timing role for the non-working capital component of operating accruals. The estimates become even stronger when we focus on changes in quarterly working capital accruals and cash flows or when we focus only on the within-firm-year variation in accruals and cash flows (the R^2s are equal to 0.702 and 0.655, respectively).

Although we find that the quarterly accrual-cash flow relation becomes weaker over time, the time trend is substantially less dramatic than that observed for annual measurements (Bushman et al. 2016). For example, by the end of our sample period we find that changes in quarterly operating cash flows still explain 62 percent of the variation in changes in working capital accruals. The results suggest that, despite a weakening in the relation over time, accruals continue to play a pronounced role in reducing cash flow noise. This timing role becomes evident when examined using (i) working capital accruals, (ii) tests that account for cross-sectional variation, and (iii) performance measurement intervals that help to better capture the seasonal variation in cash flows.

To infer the importance of seasonal variation for the timing role of accruals, we measure the seasonal variation in operating cash flows in two ways. First, we measure the difference between the maximum and minimum cross-sectional ranks of operating cash flows in each firm-year. Second, we rely on estimates of past seasonality following Chang et al. (2017). For both measures, we find that the negative relation between accruals and cash flows strengthens dramatically with the seasonal variation in cash flows. For example, the R^2 from a firm-demeaned regression of operating accruals on operating cash flows ranges from 0.036 to 0.161 for firms with low seasonal variation, but ranges from 0.626 to 0.710 for firms with high seasonal variation. These results suggest that accruals play a nontrivial role in offsetting seasonal shocks in cash flows. We find similar insights based on industry-level analyses, with high-seasonal-variation industries displaying a much stronger timing role than industries with low seasonal variation in cash flows.

To ensure these results do not simply capture previously-documented effects of transitory cash flow shocks on accruals (e.g., Dechow 1994; Frankel and Sun 2018), we additionally condition our tests on measures of non-seasonal cash flow shocks. First, we sort firms based on the magnitude of within-firm-year variation in seasonally-adjusted operating cash flows. Within each portfolio, we next sort firms based on seasonal variation in cash flows. Second, we take a similar approach by initially sorting firms on a proxy for the negative serial correlation in cash flow changes from Frankel and Sun (2018). With both double-sorting procedures, we find that the seasonal variation in cash flows plays a much stronger role in explaining differences in the negative quarterly accrual-cash flow relation than the non-seasonal variation in cash flows.

Given the strong link between the accrual-cash flow relation and seasonal variation in cash flows, we next examine time trends in seasonal cash flow variation and related cash flow properties. Our tests reveal a strong decline in seasonal cash flow variation over time. Based on annual cross-sectional percentile ranks of quarterly operating cash flows, we find that the average of the within-firm-year difference in the extreme-quarter ranks is about 50 at the beginning of the sample. By the end of the sample period, this difference drops to slightly above 20. This decline in seasonal cash flow variation is much stronger than the contemporaneous reduction in earnings seasonality over time.

Our modeling of the quarterly accrual process provides a framework to help explain the decline in seasonal cash flow variation based on trends in sales seasonality and working capital policies. The increases in size, maturity, and scope of U.S. listed firms (Kahle and Stulz 2017; Hoberg and Phillips 2024) may have dampened the magnitude of seasonal shocks and increased the market power of firms over their suppliers. At the same time, increases in the intangible intensity of investments help explain the reduced holdings of physical assets such as inventories (Srivastava 2014). Moreover, changes in financial constraints (Murfin and Njoroge 2015; Costello 2020) and the growth in supply chain finance (Chuk et al. 2024) have likely changed the average length of outstanding trade credit. Over the sample period, we find declines in average sales seasonality, days receivable outstanding, and inventory holdings, and a systematic increase in days payable outstanding. A model-implied measure of expected seasonal cash flow variation based on these factors is strongly correlated with our measure of realized seasonal variation and displays a similar time trend.

To examine whether the changes in seasonal cash flow variation help explain the weakening of the quarterly accrual-cash flow relation over time, we follow the approach of Bushman et al. (2016) and Nallareddy et al. (2020). Consistent with the time trend in seasonal cash flow variation playing a key role, the time trend in R^2s from annual regressions of quarterly accruals on cash flows turns insignificant after we control for measures of seasonal variation in cash flows. We further find that this result is explained by the behavior of two specific determinants of seasonal variation in cash flows: reductions in inventory holdings and increases in payment delays to firms' suppliers. Additional tests reveal that the inventory reductions capture the effects of newly listed firms (a cohort effect), while the increases in days payable outstanding appear to capture a more general macroeconomic trend and are strongest for the most seasoned firms in our sample.

Finally, we study the effect of accruals offsetting cash flow seasonality based on the ability of operating cash flows and accruals to predict future operating performance (e.g., Barth et al. 2001; Nallareddy et al. 2020; Ball and Nikolaev 2022). We find that the predictive ability of operating cash flows decreases when seasonal variation in cash flows increases. Consistent with the timing role of accruals, however, the predictive ability of cash flows recovers substantially when we account for the additional information contained in working capital accruals. For firms with the most seasonal cash flows, the R^2 increases by a factor 3.5 (4.8) when we control for working capital accruals in regressions explaining future operating cash flows (future operating earnings). Because operating cash flows and working capital accruals sum to operating earnings (Dechow and Dichev 2002), these results are consistent with the notion that the accrual component of operating earnings improves performance measurement relative to operating cash flows. This improvement in performance measurement is strongest for firms with the most seasonal operating cash flows.

Our paper makes the following contributions. First, it contributes to the literature on the properties and noise-reducing role of accruals. Understanding the prominence and effectiveness of the role of accruals in offsetting cash flow noise is key to understanding how accruals vary with underlying economics and in the absence of manipulation (e.g., Allen et al. 2013; Frankel and Sun 2018; Larson et al. 2018; Nikolaev 2018; Dichev and Owens 2024). By focusing on quarterly intervals and by modifying the analytical framework of DKW, we conceptually and empirically identify the role of accruals in offsetting noise induced by seasonal variation in operating cash flows. The nontrivial variation induced by this role of accruals suggests that models of non-discretionary quarterly working capital accruals (e.g., Collins et al. 2017) may benefit from including contemporaneous operating cash flows.

Second, the paper contributes to the evidence on time trends in the properties of earnings, cash flows, and accruals (e.g., Collins et al. 1997; Givoly and Hayn 2000; Dichev and Tang 2008; Rajgopal and Venkatachalam 2011; Srivastava 2014; Christensen et al. 2023). We document that the properties of accruals and cash flows, as well as their relation, change because of systematic shifts in economics that reduce the extent of seasonal variation in cash flows. We therefore also contribute to the literature that examines changes in the timing role of accruals over time (e.g., Bushman et al. 2016; Nallareddy et al. 2020; Ball and Nikolaev 2022; Green et al. 2022; Dutta et al. 2024). By focusing on quarterly intervals and the role of seasonal variation in cash flows, we provide evidence on the nontrivial role of accruals in offsetting noise induced by seasonal cash flow variation, even in recent years. This unique role of quarterly accruals is largely obscured in the annual measurements of performance explored in prior research.

2. Conceptual framework and predictions

2.1. Cash flow versus earnings and the timing role of accruals

A fundamental principle in financial accounting is that accrual-based measurements should capture a firm's economic performance better than net cash flows for the period (e.g., FASB 2021). Cash flows suffer from timing and matching problems, which introduce noise in performance measurement that becomes more severe with shorter measurement intervals and longer operating cycles (Dechow 1994). Timing problems arise because the cash receipts and payments associated with a firm's operating activities can occur in periods that differ from the timing of the economic value added or lost, while matching problems arise because the cash receipts and payments associated with an economic event can occur in different periods. The "timing role" of accrual accounting is to offset this noise by shifting the recognition of cash in- and outflows over time and by making accrual-based earnings a less volatile and more informative measure of periodic firm performance.

Following the extant literature, we define accruals as the net changes in non-cash assets and liabilities. We focus on operating accruals, which explain the difference between earnings and operating cash flows for the period. Consistent with the timing role of accruals, Dechow (1994) finds that earnings are more strongly associated with stock returns than cash flows, particularly over shorter measurement intervals and when the length of the operating cycle increases. Dechow (1994) also concludes that working capital accruals play a more important timing role than long-term operating accruals. DKW develop a theoretical framework that captures the timing role of accruals and its consequences for the relations between earnings, accruals, and cash flows. They predict and find that accrual-based earnings are more predictive of future cash flows than operating cash flows.[1]

Several studies link the timing role of accruals to a negative contemporaneous relation between accruals and cash flows (DKW; Dechow and Dichev 2002; Frankel and Sun 2018; Larson et al. 2018). For example, Dechow (1994) finds that because accruals offset the negative serial correlation in cash flow changes, accruals are negatively correlated with cash flow changes. This negative correlation is stronger for shorter measurement intervals, where timing and matching problems are more severe. The negative correlation between accruals and cash flows is therefore commonly used as a basis for empirical investigations into differences or trends in the importance of the timing role of accruals.[2]

Differences or time trends in the accrual-cash flow relation can be driven by a variety of factors. For example, inventory write-downs weaken the negative relation between operating accruals and cash flows when these write-downs are triggered by negative current-period cash flow shocks (Ball and Shivakumar 2006). The negative relation can similarly weaken as a result of other one-time items recognized in earnings (Bushman et al. 2016), due to intangible investments that are included in operating cash flows but excluded from accruals (Green et al. 2022), or because of operating accruals that are unrelated to current-period operating cash flows (e.g., depreciation or stock-based compensation expense).[3] At the same

[1]Related work by Barth et al. (2001) finds that the disaggregation of accruals into its major components further increases the incremental predictive value of earnings for future cash flows.

[2]It is important to note that although studies often cite Dechow (1994) as a basis for investigating the relation between the levels of accruals and cash flows, the tests presented by Dechow (1994, Table 3) focus on the relation between the levels of accruals and changes in cash flows. Frankel and Sun (2018) provide a conceptual basis for the relation between accruals and changes in cash flows.

[3]Depreciation is a negative operating accrual that does not have an operating cash flow counterpart (Ball and Nikolaev 2022). Instead, depreciation is linked to past investing cash flows. Stock-based compensation expense is a negative accrual that similarly has no operating cash flow counterpart. Because firms tend to award relatively more stock-based incentives to employees when their cash flows are weaker, the relation between stock-based compensation expense and operating cash flows is expected to be positive.

time, economic shifts such as changes in cash flow volatility (Srivastava 2014; Christensen et al. 2023), operating cycles (Nallareddy et al. 2020), and working capital intensity (Dutta et al. 2024) can change the prominence of the timing role of accruals.

Bushman et al. (2016) find that the negative contemporaneous relation between annual accruals and cash flows has weakened dramatically in recent decades. They conclude that this result is most likely explained by the increased recognition of one-time nonoperating items and the frequency of losses, and suggest that the increased frequency and magnitude of these "nontiming accruals has increasingly obscured the expected negative accrual-cash flow relation" (Bushman et al. 2016, p.44). Green et al. (2022) challenge this conclusion and posit that the rise in intangible investments over time explains the weakening of the negative coefficient obtained from annual regressions of accruals on cash flows.

A related literature examines the timing role of accruals based on the ability of earnings versus operating cash flows to predict future performance. Nallareddy et al. (2020) challenge the notion that earnings have superior predictive ability and conclude that when measured using information from the statement of cash flows, operating cash flows outperform earnings in the prediction of future cash flows. Ball and Nikolaev (2022) instead find that when earnings are defined in a manner consistent with the composition of operating cash flows, and the research design accounts for heterogeneity across firms, operating earnings outperform operating cash flows in their predictive ability. By comparing earnings components measured on an accrual basis and a cash basis, Casey and Ruch (2024) conclude that the relative predictive ability is more nuanced and varies with the earnings component being examined.

2.2. Predictions

This section builds on the DKW framework to form our predictions. While prior research primarily focuses on the timing role of annual accruals, accruals should play a particularly important role in absorbing quarterly cash flow shocks because firms' operating cycles are often substantially shorter than a year (Dechow 1994).[4] In addition, our focus on quarterly measurement intervals facilitates the identification of a source of transitory shifts in cash flows that has received limited attention in the literature: seasonal variation.

The strong market emphasis on quarterly earnings announcements also highlights the relevance of examining how accrual accounting helps to improve quarterly performance measurement.[5] Research by Miao et al. (2016) further suggests that investors significantly rely on quarterly cash flow statement information to identify and value the accrual and cash flow components of quarterly earnings. At the same time, despite the common practice of applying seasonal adjustments to quarterly performance measurements, Chang et al. (2017) and Choy et al. (2023) find that investors and analysts fail to completely anticipate the seasonal components in quarterly earnings, cash flows, and accruals.

2.2.1. The DKW framework and the accrual-cash flow relation

In the DKW framework, working capital accruals arise from firms' purchases and sales on credit and nonzero inventory holdings at the end of the reporting period. Given the assumption that sales follows a random walk process, the model implies that the combination of firms' working capital policies and periodic sales shocks induces a negative serial correlation for changes in cash flows. Working capital accruals absorb this inter-temporal variation in cash flows and ensure that changes in earnings, which is the sum of cash flows and accruals, are serially uncorrelated.

Given the assumed random walk process, the sales of firm i in period t are defined as:

$$S_{it} = S_{it-1} + \varepsilon_{it}, \tag{1}$$

[4] In contrast to their main results based on annual measurements, Nallareddy et al. (2020) find that quarterly earnings outperform cash flows in predicting one-quarter-ahead cash flows.

[5] Firms often disclose cash-based measures of performance in their earnings announcements. Based on all 8-K filings with Item 2.02 for our sample firms around the quarterly earnings announcements of fiscal 2022, we find (untabulated) that 32% of firms mention a free cash flow measure in earnings announcements (in line with Adame et al. 2023). This percentage increases to 52% for firms in the manufacturing industry. These descriptive statistics suggest it is common for firms to disclose quarterly performance measures for which timing and matching problems are likely material.

where ε_{it} is the period-t sales shock, with variance equal to σ_ε^2 and no serial correlation. With additional assumptions about profit margin (π), the fraction of periodic sales that remains uncollected at period-end (α), firms' target inventory as a fraction of next period's expected cost of sales (γ_1), and the fraction of purchases that remains unpaid at period-end (β), the end-of-period balances of accounts receivable, inventory, and accounts payable can be depicted as:[6]

$$AR_{it} = \alpha S_{it} \tag{2a}$$
$$INV_{it} = \gamma_1(1-\pi)S_{it} \tag{2b}$$
$$AP_{it} = \beta(1-\pi)S_{it} + \beta\gamma_1(1-\pi)\varepsilon_{it} \tag{2c}$$

With the operating cash cycle defined as $\delta = \alpha + \gamma_1(1-\pi) - \beta(1-\pi)$, a firm's cash flows for period t can be depicted as:

$$CF_{it} = \pi S_{it} - \delta\varepsilon_{it} + \gamma_1(1-\pi)\beta\Delta\varepsilon_{it}, \tag{3}$$

where πS_{it} equals earnings for the period. Assuming the last term in equation (3) equals zero, DKW simplify this expression to $CF_{it} = \pi S_{it} - \delta\varepsilon_{it}$. Accruals are determined by the changes in the working capital accounts and defined as the difference between earnings (πS_{it}) and cash flows (CF_{it}):

$$A_{it} = \delta\varepsilon_{it}. \tag{4}$$

This framework helps to link the timing role of accruals to the negative relation between accruals and cash flows. Given the definitions of cash flows and accruals in equations (3) and (4), the expected correlation between changes in accruals and cash flows equals:[7]

$$\rho(\Delta A_{it}, \Delta CF_{it}) = \frac{\delta(\pi - 2\delta)}{\sqrt{2\delta^2(\pi^2 - 2\pi\delta + 2\delta^2)}} \tag{5}$$

[6] DKW additionally model a parameter γ_2 that captures the speed with which firms adjust their inventory to the target inventory level given current period sales shocks (Bernard and Stober 1989). Following DKW, we set this parameter to zero.

[7] See Appendix B for the derivation of this equation. This expression differs from that presented by DKW (pp. 142-143), as the first term in the denominator in their equation (18) should be equal to $2\delta^2$ instead of 2. Alternatively, the correct expression for the correlation can be found by setting $\theta_1 = \theta_2 = 0$ in the expanded expression for the correlation in Table 1 of DKW (p. 143). Throughout their analyses, DKW use the appropriate expression for the correlation between *changes* in accruals and cash flows.

Because for most firms δ is positive and $\pi < 2\delta$, DKW explain that the expected correlation between changes in accruals and cash flows is negative. The mechanism underlying this negative correlation is the inter-temporal variation in cash flows—induced by firms' working capital policies and the resulting mismatch between cash in- and outflows—which is offset by accruals (DKW; Frankel and Sun 2018).

2.2.2. *Seasonal variation in cash flows and the timing role of accruals*

Firms can experience substantial seasonal variation in their operating cash flows. As we show below, this variation can be viewed as an outcome of the interaction between seasonality in sales and firms' working capital policies.

An extension of the DKW framework helps to formalize this idea and its consequences for the timing role of accruals. Consider the following adjustment to the sales-generating process of equation (1), where we treat each time period t as a fiscal quarter and assume that the fourth fiscal quarter is associated with a seasonal increase in sales:[8]

$$S_{it} = S_{it-1}\left(1 + \psi Q4_{it} + \left(\frac{1}{(1+\psi)} - 1\right) Q1_{it}\right) + \varepsilon_{it}, \tag{6}$$

where variable $Q4_{it}$ ($Q1_{it}$) is an indicator equal to 1 for the fourth (first) fiscal quarter, and 0 otherwise, and ψ is a seasonality factor that takes on non-negative values. For example, with $\psi = 0$, there is no seasonality. With $\psi = 1$, expected Q4 sales will equal 40 percent of annual sales (i.e., double the expected sales of that in Q1 through Q3).

How this seasonality in sales affects quarterly operating cash flows and accruals depends on firms' working capital policies. For example, given the expected increase in sales in Q4, firms have relatively lower cash flows in Q3 when the target inventory rate (γ_1) increases. Simultaneously, accounts payable rise with higher target inventory rates when firms purchase on credit (β). With more lenient credit terms for the firm's customers (α), part of the operating cash flows stemming from peak-season sales will be realized in Q1 of the following

[8] The choice to focus on the fourth quarter is consistent with the observation that sales peak in the fourth quarter for the majority of firms (see Table 2). However, note that the predictions regarding seasonal variation that emanate from our modeling do not require the fourth fiscal quarter to be the peak quarter.

year. When firms receive trade credit on terms that are more lenient than those with their own customers ($\beta > \alpha$), credit purchases can lead to high cash flows in Q4 and low cash flows in Q1 of the following year.[9]

To formalize these conjectures, we apply the seasonal sales-generating process from equation (6) to the DKW framework and the expressions for working capital accounts in equations (2a)–(2c). We obtain the following expressions for quarterly accruals (see Appendix B):

$$A_{it}^{Q1} = \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \delta\psi' S_{it-1} - \gamma_1(1-\pi)(1-\beta)\psi' S_{it-1} \tag{7a}$$
$$A_{it}^{Q2} = \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} \tag{7b}$$
$$A_{it}^{Q3} = \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \gamma_1(1-\pi)(1-\beta)\psi S_{it} \tag{7c}$$
$$A_{it}^{Q4} = \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \delta\psi S_{it-1} + \gamma_1(1-\pi)(1-\beta)(\psi'\varepsilon_{it} - 2\psi S_{it-1}), \tag{7d}$$

where $\psi' = \frac{1}{(1+\psi)} - 1$. Quarterly cash flows are equal to the difference between earnings (πS_{it}) and accruals. With nonzero seasonality in sales (i.e., $\psi > 0$), cash flows in quarters Q1, Q3, and Q4 differ from the cash flows defined in equation (3). This seasonal variation in cash flows depends on the parameters of firms' working capital policies and differs from the non-seasonal variation induced by periodic sales shocks (ε_{it}). Accruals offset this variation in the opposite direction, such that earnings equals πS_{it} in each quarter.

Panel A of Table 1 summarizes the implications of our modeling with expressions for the expected values of quarterly cash flows and accruals. Panel B presents expressions for the expected values for cases where we set two of the working capital policy parameters to zero.

[9] The following examples support these links between working capital policies and seasonal cash flow variation. Deere & Co. disclosed in its 2023 10-K filing: "Seasonal patterns in retail demand for agricultural equipment can result in substantial variations in the volume and mix of products sold to retail customers during the year. Seasonal demand must be estimated in advance, and equipment must be manufactured in anticipation of such demand to achieve efficient utilization of personnel and facilities throughout the year. The PPA and SAT segments can incur substantial seasonal variations in cash flows to finance production and inventory of agricultural and turf equipment. The segments also incur costs to finance sales to dealers in advance of seasonal demand." Amazon disclosed in its third-quarter 2022 10-Q filing: "We generally have payment terms with our retail vendors and sellers that extend beyond the amount of time necessary to collect proceeds from our consumer customers. As a result of holiday sales, as of December 31 of each year, our cash, cash equivalents, and marketable securities balances typically reach their highest level (other than as a result of cash flows provided by or used in investing and financing activities). This operating cycle results in a corresponding increase in accounts payable as of December 31. Our accounts payable balance generally declines during the first three months of the year, resulting in a corresponding decline in our cash, cash equivalents, and marketable securities balances."

These stylized cases facilitate the derivation of expressions for seasonal variation in cash flows as a function of sales seasonality and working capital policies. The expressions show how sales seasonality affects seasonal variation in cash flows in different ways depending on the working capital policy parameters.

Panels C and D of Table 1 present numerical examples based on the expressions in Panel A. Panel C presents a hypothetical firm with a combination of working capital policy parameters such that the operating cash cycle is positive, while Panel D presents an example where the operating cash cycle is negative due to lenient terms of trade credit (i.e., high β). The results illustrate how seasonality increases the variation in expected cash flows across fiscal quarters. At the same time, these transitory shifts in cash flows are offset by accruals in the opposite direction, and this offsetting role becomes stronger as seasonality increases. In other words, holding working capital policies constant, greater seasonality in sales causes accruals to reduce more noise in cash flows. The results in Panels C and D also highlight how different working capital policy parameters lead to markedly different patterns in cash flows and accruals across the fiscal quarters.

Figure 2 further illustrates how the effect of sales seasonality on seasonal variation in cash flows is conditional on firms' working capital policies. Given the expressions in Panel A of Table 1, we construct a grid of unique combinations of seasonality (ψ), credit terms with customers (α), target inventory rate (γ_1), and credit terms with suppliers (β). We compute the four expected values of quarterly cash flows for each combination of the parameters and then measure the within-year variation in cash flows as the difference between the highest and the lowest expected values. Figure 2 plots this difference for alternative values of ψ and the operating cash cycle (δ), which is implied by the values of π, α, γ_1, and β. The figure shows how seasonal variation in cash flows is determined by the interaction between the operating cash cycle and the seasonality in sales.

To summarize, we define the seasonal variation in cash flows as the transitory shifts in cash flows that arise from the interaction between firms' working capital policies and the seasonality in sales. This variation introduces noise in periodic performance measurement. We predict that accruals offset this noise introduced by seasonal variation to produce a more informative summary measure of performance (i.e., accrual-based earnings). Our framework suggests that this effect of seasonal variation is incremental to the effects of the operating cash cycle and non-seasonal cash flow shocks on the timing role of accruals (Dechow 1994; DKW; Frankel and Sun 2018).[10]

3. Data and variable measurement

3.1. Data

Our sample consists of U.S. listed firms in the intersection of CRSP and Compustat. The sample spans the period from 1989 to 2022, since 1989 is the first full year for which quarterly data is available from cash flow statements for all fiscal quarters. We obtain quarterly and annual accounting data from the Compustat Fundamentals Quarterly and Fundamentals Annual tables, respectively. Because firms report cash flow statements in their 10-Q and 10-K filings in cumulative year-to-date values, the quarterly cash flow and accrual variables are measured based on changes in the year-to-date Compustat values for fiscal quarters two through four (Collins and Hribar 2000). We restrict the sample to firm-year observations for which data is available for all four fiscal quarters.

We require observations to have non-missing values for average annual and quarterly total assets, average market value of equity, cash flows from operations, earnings before extraordinary items from the cash flow statement, changes in other assets/liabilities in the cash flow statement, and average book value of common equity. Following Green et al. (2022), we further restrict the sample to observations with average total assets and average

[10] Our analytical framework does not model the additional complexity that expense recognition under U.S. GAAP can be subject to the integral approach of interim reporting, where some seasonal expenses are spread out over the year based on expectations of full-year performance (Mendenhall and Nichols 1988; Rangan and Sloan 1998). Because this accounting treatment smooths the recognition of cash expenditures within the fiscal year, it is likely to further contribute to a negative relation between quarterly cash flows and accruals when a firm experiences significant seasonal variation.

equity market value above \$10 million and an average stock price of at least \$1.[11] Financial firms are excluded from the analysis (firms with one-digit SIC code of 6).

3.2. Measurement of key variables

We measure operating cash flows, operating accruals, and working capital accruals using information from the statement of cash flows. Operating accruals are defined as income before extraordinary items less cash flow from operations. Following Dechow and Dichev (2002), working capital accruals are defined as the change in accounts receivable plus the change in inventory, less the change in accounts payable and taxes payable, plus the net change in other assets and liabilities.[12] The difference between operating accruals and working capital accruals is due to depreciation and amortization, deferred taxes, gains and losses on the sale of assets, and items included in Compustat's funds from operations (FOPO), such as provisions for losses on accounts receivable, inventory writedowns, and stock-based compensation expense (e.g., Dechow et al. 2022). All variables are scaled by average total assets for the period. Following Bushman et al. (2016) and Green et al. (2022), we winsorize all continuous variables at the 1st and 99th percentiles by fiscal year.[13]

We measure seasonal variation in two ways. Each measurement has its own advantages and drawbacks. First, we annually rank quarterly operating cash flows in percentiles and compute the difference between the highest and lowest ranks within each firm-year. This measure ($SVCF^R$) captures the within-firm-year variation in operating cash flows. Greater seasonal variation in cash flows should lead to a larger difference between the highest and lowest cash-flow quarters and thus higher values of $SVCF^R$.[14] The benefit of this measure

[11]Because we do not test the effects of the scaling of variables by the book value of equity, we do not follow Green et al. (2022) in requiring firms to have average common equity of at least \$10 million. Our results are not sensitive to this design choice.

[12]Given Compustat's coverage of these variables, we require data on the net change in other assets and liabilities and set to zero all other components of working capital accruals when missing. The only additional restriction we impose is that we drop observations for which all working capital accrual components are zero, since we observe these are cases where firms did not disclose the information in their 10-K or 10-Q.

[13]We winsorize variables by fiscal year for consistency with prior research. Our results are not sensitive to the choice to winsorize by fiscal year or based on the pooled sample distributions.

[14]As an alternative, we also estimate the standard deviation of quarterly cash flows within each firm-year

is that it is simple, does not impose strong data requirements, and allows for a time-series examination because its values are firm-year specific. The downside is that quarterly cash flows can be high or low within a firm-year for reasons other than seasonality.

Second, we follow the procedure from Chang et al. (2017) to identify seasonal variation in operating cash flows.[15] For each firm-quarter, we identify the string of 20 firm-quarters from quarter $q-23$ through quarter $q-4$ and rank these from low (rank 1) to high (rank 20) in terms of operating cash flows. For each quarter, we then compute the average rank of the current fiscal quarter in the previous five years. For the Amazon example presented in Appendix A, Q1 of 2022 would have an average rank of 3 because the previous five first-quarter cash flows rank 1–5 out of 20. For each firm-year, we then estimate the seasonal variation in cash flows ($SVCF^{CHSS}$) as the difference between the maximum and minimum average ranks of the four fiscal quarters in that year. The benefits of this measure are that it identifies seasonal patterns more precisely and it relies on past information only. Its downside is that it imposes stronger data requirements and is less suitable for time-series analyses. Given the requirement of cash flow data for quarters $q-23$ through $q-4$, analyses based on this measure are restricted to the 1995-2022 period.

3.3. Measuring the accrual-cash flow relation

While prior studies often infer the timing role of accruals based on the relation between the levels of accruals and cash flows, a theoretical foundation is available only for tests of the correlation between changes in accruals and cash flows (DKW, see eq. (5)) or between levels of accruals and changes in cash flows (Frankel and Sun 2018). In Appendix B, we derive the following expression for the expected correlation between the levels of accruals and cash

and find similar results. The benefit of our use of within-year differences in cash flow ranks is that it accounts for the general volatility of cash flows in the economy in a particular year.

[15] Choy et al. (2023) use the same approach to identify the seasonal component of quarterly accruals, while Almeida et al. (2024) use it to identify a firm's "main quarter" based on seasonally high operating income before depreciation.

flows implied by the DKW framework discussed in Section 2.2.1:

$$\rho(A_{it}, CF_{it}) = \frac{\delta(\pi - \delta)}{\sqrt{\delta^2(\pi^2 t - 2\pi\delta + \delta^2)}} \tag{8}$$

This expression suggests that the correlation between the levels of accruals and cash flows not only depends on the operating cash cycle and profit margin, but also on parameter t because the variance of cash flows is a function of prior-period sales shocks through t (t is the length of the random walk process in equation (1)). That is, given the random walk assumption, the expected variance of cash flows increases in the length of the time-series that generates S_{it}.[16] The implication of this result is that for two samples of firms with different values of t (e.g., samples of firms with differences in age), the cross-sectional correlation between accruals and cash flows will be smaller for the sample with higher t, even though δ and π are constant and there is no difference in the timing role of accruals.

The above suggests that variation in the correlation between the levels of accruals and cash flows may capture differences in firm characteristics that are unrelated to the timing role of accruals. As a result, it can be difficult to draw clear inferences from the correlation between levels of accruals and cash flows about differences or changes in the timing role of accruals. The same conclusion applies to inferences drawn from regressions of accruals on cash flows.[17] This concern does not arise when the timing role is identified based on the correlation between *changes* in accruals and cash flows (see eq. (5)).

A related empirical concern is that the timing role of accruals is a firm-level dynamic process that shifts the recognition of cash flows across periods, not across firms. Hence, empirical tests of the timing role of accruals should focus on isolating the within-firm variation

[16] The variance of accruals does not depend on t, because accruals only respond to the current-period sales shock in the model.

[17] Bushman et al. (2016, p. 58) make a related point that the coefficient and R^2 from a regression of accruals on cash flows become smaller when the variance of cash flows increases. Although we draw a similar conclusion for the correlation between accruals and cash flows (which extends to the coefficient and regression R^2), our derivation illustrates the underlying economics based on the DKW framework. Moreover, it is important to emphasize that the correlation becomes smaller as the *cross-sectional* variance of cash flows increases. A greater cross-sectional variance implies that firms' cash flows are more diverse, but this does not necessarily imply that firms' cash flows are more volatile or subject to stronger economic shocks. The magnitude of economic shocks is captured by the variance of ε_{it} (σ_ε^2) in equation (1), which does not affect the correlation in equation (8).

in accruals and cash flows. To support this argument, consider the following modification of the sales-generating process in equation (1):

$$S_{it} = S_{it-1} + \varepsilon_{it} = S_{i0} + \sum_{\tau=1}^{t} \varepsilon_{i\tau}, \tag{9}$$

where S_{i0} captures firm i's sales at the start of the random walk process. While the derivations in Section 2.2.1 implicitly assumed that S_{i0} is a cross-sectional constant, setting S_{i0} equal to a firm-specific value allows us to model the effect of firm heterogeneity on the correlation between accruals and cash flows. Assuming S_{i0} has variance equal to σ_S^2, the expected correlation between the levels of accruals and cash flows becomes (see Appendix B):

$$\rho(A_{it}, CF_{it}) = \frac{\delta(\pi - \delta)\sigma_\varepsilon^2}{\sqrt{\delta^2\sigma_\varepsilon^2(\pi^2\sigma_S^2 + (\pi^2 t - 2\pi\delta + \delta^2)\sigma_\varepsilon^2)}} \tag{10}$$

This expected correlation is a function of the cross-sectional variance of cash flows via parameters t, σ_S^2, and σ_ε^2. All else equal, equation (10) illustrates that the greater the cross-sectional variation in sales (σ_S^2) and cash flows (because it depends on S_{it}), the smaller the correlation between the levels of accruals and cash flows. This result suggests that firm-level heterogeneity induces differences in correlations across samples, or across time periods, that do not necessarily indicate differences in the timing role of accruals.

In our research design, we account for firm heterogeneity that is unrelated to the timing role of accruals in two ways. First, we demean accruals and cash flows at the firm level, which is equivalent to estimating regressions with firm fixed effects (Ball and Nikolaev 2022; Breuer and deHaan 2023). Second, because S_{i0} cancels out when measuring changes in cash flows, we also examine the correlation between changes in accruals and cash flows.

4. Empirical results

4.1. Descriptive statistics and the baseline accrual-cash flow relation

Panel A of Table 2 reports summary statistics for our quarterly cash flow and accrual variables, measures of seasonal variation, and firms' working capital policy parameters. On average, operating accruals are negative due to the non-working capital accrual component, while average operating cash flows and working capital accruals are positive. For the median firm, the operating cash cycle is 62.3 days and sales are 13.1 percent higher in the peak seasonal quarter compared to other quarters (as captured by ψ). The measures of seasonal variation display substantial variation across firms that we exploit in our empirical tests.

Panel B of Table 2 presents results from regressing quarterly accruals on operating cash flows using alternative design choices. Consistent with the timing role of accruals, the coefficient on cash flows is negative with a value of -0.342 and R^2 of 0.150. The R^2 rises to 0.265 when we focus on quarterly working capital accruals instead of total operating accruals. By contrast, and consistent with Bushman et al. (2016), we find a coefficient (R^2) of -0.019 (0.001) when we estimate a regression of annual accruals on cash flows (untabulated).

Given the firm-specific component in cash flows (see Section 3.3), we next examine the effects of demeaning cash flows by firm.[18] After accounting for cross-sectional differences in quarterly cash flows, the coefficient (R^2) decreases (increases) from -0.342 to -0.671 (0.150 to 0.314). The R^2 increases slightly to 0.347 when we also account for cross-sectional differences in accruals, while the coefficient is econometrically equivalent. The results are similar when we focus on working capital accruals and become even stronger when we examine changes in accruals and cash flows. For example, the coefficient (R^2) equals -0.843 (0.702) for regressions of changes in quarterly working capital accruals on changes in cash flows. We also examine the effect of firm-year demeaning, which helps us keep the firm-year levels of accruals and cash flows constant and focus only on the within-firm-year variation. The results closely mirror those based on the change variables. These results highlight the importance of accounting for cross-sectional variation when identifying the timing role of accruals.

We next explore the importance of focusing on working capital accruals. When we ex-

[18]Similar to Ball and Nikolaev (2022), we explore the prominence of cross-sectional heterogeneity in accruals and cash flows. The untabulated Adjusted R^2 from a regression of annual (quarterly) operating cash flows on firm fixed effects equals 0.670 (0.438), which suggests there are systematic differences in average cash flows across firms. The pooled sample standard deviation of annual (quarterly) operating cash flows drops from 0.179 to 0.095 (0.058 to 0.043) when we demean the cash flow variable by firm. For both operating accruals and working capital accruals, the firm-specific component explains much less of the overall variation in accruals.

amine non-working capital accruals, there is little evidence of a negative relation between accruals and cash flows. All R^2s are close to zero. This result is consistent with the importance of focusing on the accruals that are conceptually most closely linked to the smoothing of inter-temporal variation in operating cash flows (see Dechow 1994, DKW, and Section 2). However, for consistency and comparison with prior research (e.g., Bushman et al. 2016; Green et al. 2022), we present results for both operating accruals and working capital accruals in the remainder of the paper.

Figure 3 presents time trends in the quarterly accrual-cash flow relation for firm-demeaned and change variables. The accrual-cash flow relation is strongest in the earliest years of our sample, with the coefficient (R^2) of the firm-demeaned regression changing from -0.870 to -0.504 (0.701 to 0.167) between 1989 and 2022. However, the changes are much smaller when we focus on changes in working capital accruals. By the end of the sample period, changes in quarterly operating cash flows still explain 62.2 percent of the variation in changes in working capital accruals. The results thus suggest a weakening of the quarterly accrual-cash flow relation that is consistent with Bushman et al. (2016), but less dramatic than that observed for annual accruals and cash flows. The result of a strong negative relation between quarterly working capital accruals and cash flows suggests that accruals continue to serve a pronounced role in smoothing inter-temporal variation in cash flows.

4.2. Descriptive statistics on seasonal variation

The remainder of Table 2 presents insights on the seasonality in sales and operating cash flows. Panel C explores how seasonality clusters in specific fiscal quarters. Consistent with our modeling choice in Section 2.2, the fourth fiscal quarter is associated with the highest sales activity during the year. On average, 26.8 percent of annual sales are realized in the fourth quarter, and roughly half of all fourth quarters in our sample have the highest sales of the fiscal year. Operating cash flows display a similar pattern, with 38 percent of fourth fiscal quarters having the highest operating cash flows of the fiscal year. Operating cash flows are highest (lowest) in the fourth (first) fiscal quarter (Frankel et al. 2017).

Panel D of Table 2 provides insights on the link between the seasonality in sales and operating cash flows. First, for annual quartile portfolios formed based on an estimate of sales seasonality (ψ), we find that the within-firm-year standard deviation of cash flows doubles from the lowest to the highest quartile portfolio of sales seasonality. Similarly, the $SVCF^R$ variable increases monotonically across the portfolios of sales seasonality. Second, because seasonal variation in cash flows is predicted to be a function of sales seasonality and the parameters of firms' working capital policies (see Section 2.2), we examine whether the association between seasonality in sales and cash flows varies with the operating cash cycle. In the bottom rows of Panel B of Table 2, we separately report the portfolio-average $SVCF^R$ for firm-years with long versus short operating cash cycles (δ). Consistent with Figure 2, average seasonal variation is stronger, and the effect of sales seasonality on seasonal variation is stronger, when the operating cash cycle is longer.[19]

4.3. Seasonal variation in cash flows and the timing role of accruals

This section presents evidence on the effect of seasonal cash flow variation on the timing role of accruals. Table 3 presents results from estimating firm-demeaned accrual-cash flow regressions for annual quartile portfolios formed based on seasonal variation. For both operating accruals and working capital accruals and both measures of seasonal variation in cash flows, we find that the timing role of quarterly accruals is much stronger when firms experience greater seasonal variation. For example, the R^2 of the operating accruals regression in Panel A equals only 0.036 for firms with low $SVCF^R$, but increases to 0.626 for firms with high $SVCF^R$. These results are consistent with accruals playing a nontrivial role in offsetting seasonal variation in cash flows.

Because firms have systematic differences in sales seasonality and working capital poli-

[19] Although most firms in our sample have a positive operating cash cycle, Figure 2 shows that the effect of sales seasonality on seasonal cash flow variation also strengthens when the operating cash cycle becomes more negative. Results (untabulated) are similar when we restrict this analysis to firms with positive operating cash cycle or focus on the absolute value of δ.

cies, the seasonal variation in cash flows is likely to vary predictably across firms. Because seasonality and working capital policies vary across industries, in Figure 4 we examine how industry-level seasonal variation in cash flows relates to industry-level estimates of the timing role of accruals. We plot the average $SVCF^R$ and estimates of the accrual-cash flow relation for 63 two-digit SIC industries. The results confirm the importance of seasonal variation in cash flows for the timing role of accruals: greater industry-level seasonal variation is associated with higher (more negative) R^2 (coefficient) estimates.

In untabulated analyses, we explore the industries with the strongest seasonal variation in cash flows. The three two-digit SIC industries with the strongest seasonal variation are legal services (81), leather products and footwear (31), and a variety of businesses in the retail trade and services sectors (57). For these industries, the average quarterly operating cash flows are 8.3 percent of total assets in the peak seasonal quarter and -0.3 percent of total assets in the other quarters. Sales in the peak quarter are an average 28.9 percent of annual sales (in our framework, this translates to $\psi = 0.228$) and the median operating cash cycle equals 93 days, substantially longer than the median operating cash cycle of 62 days in the full sample. In the firm-demeaned operating accrual-cash flow regressions, the average coefficient on cash flows equals -0.966 and the average R^2 equals 0.840.

4.4. Accounting for nonseasonal cash flow shocks

Because the inferences from Table 3 and Figure 4 are drawn from splits of the data based on a single variable, it is important to evaluate how seasonal variation in cash flows compares to previously documented determinants of the timing role of accruals. For example, our measure of seasonal variation based on the within-firm-year variation in cash flows ($SVCF^R$) might pick up other, non-seasonal, transitory timing shocks to cash flows that are known to be associated with offsetting accruals. Frankel and Sun (2018) predict and find that firms with a stronger negative serial correlation in operating cash flow changes have more timing and matching problems, which leads to a stronger negative relation between accruals and changes in cash flows.

Table 4 presents results from double-sorting firm-years based on $SVCF^R$ and a similar measure based on the within-firm-year variation in *seasonally-differenced* operating cash flows ($CFVOL$). Each year, we first sort firms into quartiles based on the within-firm-year difference between the maximum and minimum ranks of seasonally-differenced operating cash flows. Within each $CFVOL$ quartile, we next sort firms into quartiles of $SVCF^R$ and estimate the quarterly accrual-cash flow relation for each subgroup. Table 5 presents a similar analysis using a proxy for the negative serial correlation in cash flow changes from Frankel and Sun (2018) as the conditioning variable ($\Delta OCFSC$).[20]

The results in Tables 4 and 5, for firm-demeaned regressions with operating accruals (Panel A) and working capital accruals (Panel B) as dependent variable, suggest that the effect of seasonal variation on the noise-reducing role of accruals is incremental to the effect of non-seasonal variation in cash flows. While the R^2s increase with both $CFVOL$ and $\Delta OCFSC$, the R^2s increase more strongly with seasonal variation in cash flows after conditioning on the effects of $CFVOL$ and $\Delta OCFSC$. Conclusions are similar when we focus on the magnitude of the negative coefficient on cash flows.[21]

In sum, in support of our conceptual predictions in Section 2, the results from the current and previous subsection highlight the importance of accruals in reducing noise that is caused by seasonal fluctuations in operating cash flows. This role of quarterly accruals is different from, and incremental to, the timing role of accruals that is triggered by non-seasonal transitory noise in operating cash flows.

[20]Informed by the DKW framework, Frankel and Sun (2018) construct this variable based on the average of (a) the reverse percentile rank of average profit margin over the last three years and (b) the percentile rank of average operating cash cycle over the last three years.

[21]Also, inferences are similar when we focus on changes in quarterly accruals and cash flows instead of firm-demeaned variables.

4.5. *Tests of time trends*

4.5.1. *Trends in the volatility and seasonal variation of operating cash flows*

The weakening of the quarterly accrual-cash flow relation in Figure 3 suggests that the role of accruals in offsetting cash flow shocks has become less pronounced over time. To better understand this result, we next examine changes in the volatility and seasonality of cash flows over time. One explanation for the weakening accrual-cash flow relation could be an increase in the cross-sectional variance of cash flows, which can lower the R^2 from accrual-cash flow regressions (see Section 3.3 and Bushman et al. 2016). For example, Srivastava (2014) finds that newly listed firms have more volatile cash flows, which increases the heterogeneity of firms in the cross-section. The weakened relation could also relate to changes in firm-specific cash flow volatility (Irvine and Pontiff 2009; Christensen et al. 2023) that affect the prominence of timing-related accruals. Alternatively, given the documented importance of seasonality in the previous section, the change in the accrual-cash flow relation could relate to systematic changes in the seasonality of cash flows over time.

We conjecture that the seasonal variation in cash flows may have changed over time because its determinants have altered as a result of systematic changes in the economy. For example, the size, maturity, and scope of U.S. listed firms have changed significantly over time (e.g., Kahle and Stulz 2017; Hoberg and Phillips 2024). These changes may have dampened the magnitude of seasonal business shocks and increased the market power of firms over their suppliers. At the same time, increases in the intangible intensity of firms' investments help explain the reduced holdings of physical assets, such as inventories (Srivastava 2014). In addition, changes over time in firms' financial constraints (Murfin and Njoroge 2015; Costello 2020) and the recent growth in supply chain finance (Chuk et al. 2024) have likely changed the average credit terms between customers and suppliers.

We first examine the time trend in the cross-sectional variance of operating cash flows in Figure 5. We plot the variance of cash flows before (Panel A) and after (Panel B) accounting for firm fixed effects in cash flows. For comparison purposes, we plot the variance of both annual and quarterly cash flows. The differences between the annual and quarterly cash flow variance are striking. While the variance of annual cash flows increases by a factor 4.6 from 1989 to 2022 in Panel A, the variance of quarterly cash flows increases much less dramatically by a factor 1.8. Panel B reveals that the increase in the variance of annual cash flows is much smaller after accounting for firm fixed effects in cash flows, which suggests that the increase in variance is largely driven by increased heterogeneity of firms in the cross-section. This result again underscores the importance of adjusting the cash flow variable for this unwanted heterogeneity. For quarterly firm-demeaned cash flows, we find that the cross-sectional variance *decreases* over time.

The divergence in the trends of the variance of annual versus quarterly cash flows hints at a potential change in seasonality. The reason is that, for a given year, the cross-sectional variance of annual cash flows is determined by the sum of the variances of the four quarterly cash flows plus the covariances between the individual fiscal quarters. A stronger (weaker) seasonality in cash flows should lead to a more (less) negative covariance between individual fiscal quarters. Here, the trends in Figure 5 suggest that the covariance between individual fiscal quarters increases over time, as the variance of annual firm-demeaned cash flows increases while the variance of quarterly firm-demeaned cash flows decreases. This result is consistent with a potential reduction in seasonal variation.[22]

To examine seasonality more directly, the first column of Table 6 presents annual estimates of average seasonal variation based on $SVCF^R$. The results confirm that there is a substantial decline in seasonal variation over time. In the earliest sample years, the difference in the percentile ranks between the quarters of a firm-year with the highest and lowest cash flows is around 50. By the end of the sample period, this difference declines to 21. The time trend is statistically highly significant and a calendar-year variable explains 81 percent of the variation in annual estimates of seasonal variation. Given our result that accruals play a key

[22] In untabulated analyses, we examine annual estimates of the pairwise correlations among all six combinations of the four fiscal quarters in the year. In the early sample years, these correlations are close to zero. However, by the end of the sample period these increase to 70-80 percent.

role in offsetting seasonal variation in cash flows, this result provides a potential explanation for the observed weakening of the quarterly accrual-cash flow relation.

Figure 6 visualizes the time trend in seasonal cash flow variation. To highlight the unique nature of seasonal variation in cash flows, we compare the time trend with that observed for a similar measure based on earnings. The results suggest that, first, earnings are substantially less seasonal than operating cash flows. This result is consistent with the role of accruals in offsetting seasonal cash flow shocks and with the result of Choy et al. (2023) that seasonality in earnings differs from seasonality in the accrual and cash flow components of earnings. Second, the results suggest that although earnings become somewhat less seasonal over time, the reduction is much weaker than that observed for operating cash flows.

We next turn to the determinants of seasonal cash flow variation identified in Section 2. The middle five columns of Table 6 present average annual estimates of sales seasonality (ψ), the operating cash cycle (δ), days receivables outstanding (α), days inventory outstanding (γ_1), and days payable outstanding (β). Consistent with these parameters potentially playing a role in explaining the decline in seasonal variation, we find statistically significant declines in sales seasonality, operating cash cycle, days receivable, and days inventory outstanding, and a significant increase in days payable. The increase in days payable is statistically most significant, with 73 percent of the variation explained by a time trend variable.

In Figure 7, we visualize the time trends in the predicted determinants of seasonal cash flow variation. The results confirm the time trends in sales seasonality, the operating cash cycle, and its components. When we explore the difference between days receivable and days payable outstanding, the trend is even more dramatic than when days receivable and payable are examined separately. The median annual difference drops from around 17 days in 1989 to less than 5 days in 2022, suggesting almost equal terms of trade with customers and suppliers. We find that 90 percent of the variation in the annual estimates is explained by a time trend variable (untabulated).

We also combine the annual estimates of sales seasonality and working capital policies

(ψ, α, γ_1, and β) to obtain a proxy for expected seasonal variation in cash flows. Similar to Figure 2, we use the expressions for expected quarterly cash flows from Table 1 to obtain four quarterly expected values of cash flows for each sample year based on the annual averages of parameters ψ, α, γ_1, and β. Our annual estimate of expected seasonal variation in cash flows ($SVCF^{EXP}$) is then derived based on the difference between the highest and lowest of the four quarterly expected cash flow values. The final column of Table 6 shows that the measure of expected seasonal variation displays a strong negative time trend, similar to our measure of actual within-year cash flow variation.

4.5.2. Explaining the time trend in the accrual-cash flow relation

In this section, we examine the connection between the temporal declines in seasonal cash flow variation and the quarterly accrual-cash flow relation. We follow the approach of Bushman et al. (2016) and Nallareddy et al. (2020) to explain the time trend in the accrual-cash flow relation. We estimate time-series regressions in which the dependent variable is the R^2s from annual regressions of quarterly accruals on cash flows (measured after firm-demeaning or in changes). We focus on the estimates based on working capital accruals, although inferences are the same when using total operating accruals (untabulated). The main test variable is $Time$, which is a variable equal to the number of years since 1989 divided by 100. We add explanatory variables to examine whether they change the coefficient on the time trend variable. Note that this analysis should be interpreted with caution given the high correlations between explanatory variables and the small number of annual observations available (i.e., $N = 34$).

Panel A of Table 7 reports correlations between the annual variables. The annual R^2 estimates are strongly positively correlated with the annual estimates of seasonal cash flow variation ($SVCF^R$). Both the R^2 values and $SVCF^R$ are strongly positively correlated with average sales seasonality (ψ), operating cash cycle (δ), and days inventory outstanding (γ_1), and strongly negatively correlated with days payable outstanding (β). The correlation with days receivable outstanding (α) is weaker. Also note that the annual estimates of $SVCF^R$ and $SVCF^{EXP}$ have a strong positive correlation (0.84), which suggests that our conceptual framework generates time-series variation that is descriptive of the actual time-series variation in seasonal cash flow variation.

Panels B and C of Table 7 report the results from estimating the trend in the working capital accrual-cash flow relation. The coefficient on the time trend variable is negative and highly significant. More importantly, the coefficient on the time trend variable weakens and becomes statistically insignificant once we control for the annual estimates of actual ($SVCF^R$) and expected ($SVCF^{EXP}$) seasonal variation in cash flows. The coefficients on $SVCF^R$ and $SVCF^{EXP}$ are positive and statistically significant in three out of four specifications, which is consistent with accruals playing a more important role in offsetting seasonal variation in cash flows in times when this seasonal variation is stronger.

These results suggest that the decline in the seasonal variation of cash flows over time provides a plausible explanation for the weakening of the quarterly accrual-cash flow relation. We also explore which of the determinants are most important in explaining this result. We again regress the annual R^2s on the time trend, but now separately include the annual values of ψ, δ, α, γ_1, and β as control variables. The time trends become insignificant after we control for annual average γ_1 and β, which suggests that the time trend in the quarterly accrual-cash flow relation is most likely explained by the reductions in inventory holdings and increases in days payable, respectively, through their effect on seasonal cash flow variation.

4.6. Cohort effects

Are the time trends in seasonal cash flow variation and its determinants related to systematic macroeconomic trends or driven by changes in sample composition? By examining successive cohorts of newly listed firms, Srivastava (2014) finds that accounting properties change over time because more recent cohorts of listed firms have greater intangible intensity and more volatile performance. In this section, we adopt a similar method to examine whether the trends in seasonal cash flow variation and its determinants are driven by cohort effects or general trends.

Panel A of Figure 8 presents time trends in seasonal cash flow variation ($SVCF^R$) for successive cohorts of listed firms. Seasonal variation declines for all cohorts, but we also observe that average seasonal variation is lower for the more recent 2000s and 2010s cohorts. These results are consistent with both a general trend and a cohort effect. Importantly, these results for seasonal cash flow variation differ markedly from those based on within-firm volatility of annual cash flows documented by Srivastava (2014) and Christensen et al. (2023), who find that this volatility increases sharply for more recent cohorts.

Panels B–F of Figure 8 focus on the components of seasonal variation in cash flows. We find that the patterns in sales seasonality (Panel B) and days receivable outstanding (Panel D) do not relate to specific cohorts of listed firms. By contrast, the patterns for the operating cash cycle (Panel C) and days inventory outstanding (Panel E) display clear cohort effects. Firms in the later listing cohorts have shorter average operating cash cycles and lower inventory holdings, which is in line with the trends found by Na (2019) for the levels of non-cash working capital and firms becoming more intangible-intensive over time (Srivastava 2014).

The trends in the operating cash cycle in Panel C of Figure 8 warrant a separate discussion. For all cohorts with a listing starting as of the 1970s, there is a clear trend with the more recent cohorts displaying shorter average operating cash cycles. The patterns are consistent with those observed for inventory holdings in Panel E. But the trend for the most seasoned firms is different. Firms in the seasoned cohort, with listings before 1970, display a steady decline in average operating cash cycle from 86 days in 1989 to 57 days by 2022. Panel F provides an explanation for this result. While all post-1970 cohorts display a relatively steady increase in days payable outstanding, the increase is much sharper for seasoned firms from 34 days in 1989 to 54 days in 2022.[23]

[23]The unique patterns for seasoned firms are not driven by sample size. For the seasoned cohort, there are still 232 firms active in our sample in 2022, more than the 200 firms in 2022 for the 1970s cohort.

Overall, we conclude that the decline in the seasonal variation in cash flows over time captures both a cohort effect and more systematic macroeconomics trends. Seasonal variation in cash flows is lower for recent cohorts of listed firms, which coincides with shorter operating cash cycles for these firms. The cohort effect in the operating cash cycle coincides with a systematic decline in inventory holdings for recent cohorts. Increases in the length of outstanding trade credit are strongest for the most seasoned firms, which is consistent with these firms having increased market power to impose extended payment terms on their suppliers. This increase in market power changes the dynamics of operating cash flows within the year for these firms (e.g., Frankel et al. 2017). The result is also consistent with the increasing popularity of supply chain finance. For example, Chuk et al. (2024) find that firms offering supply chain finance are substantially older and have significantly longer days payable outstanding than other firms.

4.7. Predictive ability tests

While our analyses thus far infer the timing role of accruals based on the contemporaneous correlation between accruals and cash flows, a key implication of this timing role is that accruals should make earnings a more informative measure of periodic firm performance than the firm's operating cash flows. In this section, we follow prior research (Barth et al. 2001; Nallareddy et al. 2020; Ball and Nikolaev 2022; Casey and Ruch 2024) and examine the predictive ability of operating cash flows and accruals for future firm performance.

Table 8 presents the coefficients and R^2s obtained from regressing future operating performance on current-period operating cash flows and accruals. We measure future operating performance with operating cash flows (Panel A) and operating earnings (Panel B) aggregated over the next four quarters. Consistent with Ball and Nikolaev (2022), we define operating earnings as the sum of operating cash flows and working capital accruals (Dechow and Dichev 2002). Similar to our earlier analyses, we separately estimate the regression for annual quartiles formed based on our measure of seasonal variation in cash flows. For these tests, we focus on the $SVCF^{CHSS}$ measure that is based only on past information, to ensure that our tests do not capture contemporaneous noise in cash flows that affects their predictive ability for reasons other than seasonal variation.[24]

The results presented in the first rows of Panels A and B of Table 8 suggest a strong decline in the predictive ability of operating cash flows when seasonal variation increases, regardless of whether we measure future performance using operating cash flows or operating earnings. For example, the R^2 (coefficient) is 0.074 (0.521) in Panel A for firms with the most seasonal cash flows, but 0.506 (2.553) for firms with the least seasonal cash flows. This result suggests that the extent of seasonality in operating cash flows substantially reduces their informativeness for future performance expectations, even when future performance is measured to account for seasonal effects (i.e., the aggregation over the subsequent four quarters should cancel out seasonal effects).

To provide an understanding of how accruals improve the measurement of performance when seasonal variation distorts the informativeness of cash flows, we examine the effect of including working capital accruals alongside operating cash flows in the regressions. Recall that operating cash flows and working capital accruals sum to operating earnings. As a result, this modification allows us to compare the predictive ability of operating earnings and operating cash flows for future performance. The results in the bottom rows of Panels A and B of Table 8 reveal that, when we account for the information in working capital accruals, the predictive ability of operating cash flows improves substantially. This improvement in predictive ability is strongest for firms with the most seasonal cash flows. For example, in Panel A we find that the coefficient on cash flows increases from 0.521 to 1.853 for the most seasonal firms when we control for working capital accruals. Moreover, the R^2 increases by a factor 3.5.

These results corroborate our conclusion that quarterly accruals play a nontrivial role in

[24]Because of concerns associated with the use of fixed effects in regressions where the regressors are lags of the dependent variable, we present these tests without accounting for cross-sectional differences. Inferences are similar, however, when we follow Ball and Nikolaev (2022) and demean the variables by firm.

offsetting noise in operating cash flows that is induced by seasonal variation. As a result of this timing role of quarterly accruals, current-period operating earnings are more informative of future firm performance than current-period operating cash flows. This noise-reducing role of accruals is strongest for firms with the strongest seasonality in their operating cash flows.

5. Conclusions

In contrast to recent conclusions in the literature based on annual performance measurements, we find that quarterly working capital accruals play a pronounced timing role in offsetting cash flows shocks. We predict and find that this result is explained by the seasonal component in cash flows.

We first extend the framework of DKW to show how seasonal variation in operating cash flows and accruals is determined by the seasonality in sales and firms' working capital policies. Next, we show that the timing role of quarterly accruals strongly increases with seasonal cash flow variation and find this effect is stronger than that of non-seasonal cash flow shocks. We further find that the timing role of quarterly working capital accruals becomes somewhat less pronounced over time, which can be explained by a systematic decline in seasonal cash flow variation and changes in the determinants of seasonal variation (primarily reductions in inventory holdings and lengthier payment delays to suppliers).

Our research contributes to the literature on the properties of accruals by providing evidence on the importance of seasonal cash flow variation as a determinant of variation in accruals that arises with firms' economics and in the absence of manipulation. Our study also adds to the recent literature that debates the significance of the noise-reducing role of accruals. The annual performance measurements in prior research obscure the nontrivial role of working capital accruals in offsetting seasonal cash flow shocks. Finally, our results contribute to the literature examining time trends in the properties of earnings, cash flows, and accruals, and suggest that changes in firms' working capital policies have important implications for the time-series properties of operating cash flows.

Appendix A. Examples of cash flow seasonality and effects of annual aggregation

Below, we present two examples that illustrate the seasonal variation in cash flows and the effects of aggregating this seasonal variation in annual performance measurements.

Example 1: Amazon Inc.

Amazon has significant seasonal variation in operating cash flows. Based on 10-K and 10-Q data, we infer that out of the 40 fiscal quarters that Amazon reported during the ten-year period 2013–2022, the ten lowest values of operating cash flows (as percentage of average total assets) all belong to the first fiscal quarter. By contrast, the eight highest values of operating cash flows are fourth-quarter observations. The values of operating accruals display the opposite pattern. The ten highest values of operating accruals (working capital accruals) belong to the first fiscal quarter, while the nine (eight) lowest values correspond to the fourth fiscal quarter.

The opposite patterns of operating cash flows and accruals in the first and fourth quarter can be traced back to predictable variation in Amazon's accounts payable balance sheet account. Accounts payable tend to increase from the second quarter of the fiscal year, with the largest increase in the fourth quarter. The first fiscal quarter is instead associated with a sharp decline in accounts payable, as Amazon pays its vendors and sellers. Accordingly, the first (fourth) fiscal quarter tends to be associated with relatively low (high) operating cash flows and relatively high (low) operating accruals.

Figure A-1

Cash flow patterns and the accrual-cash flow relation effects for Amazon

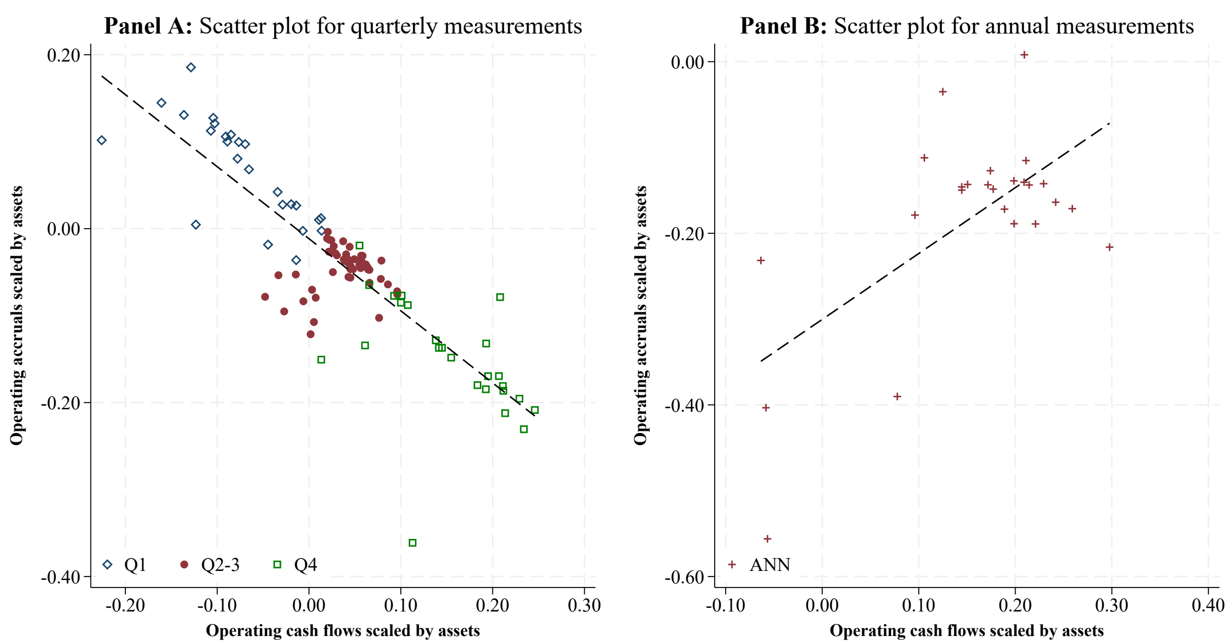


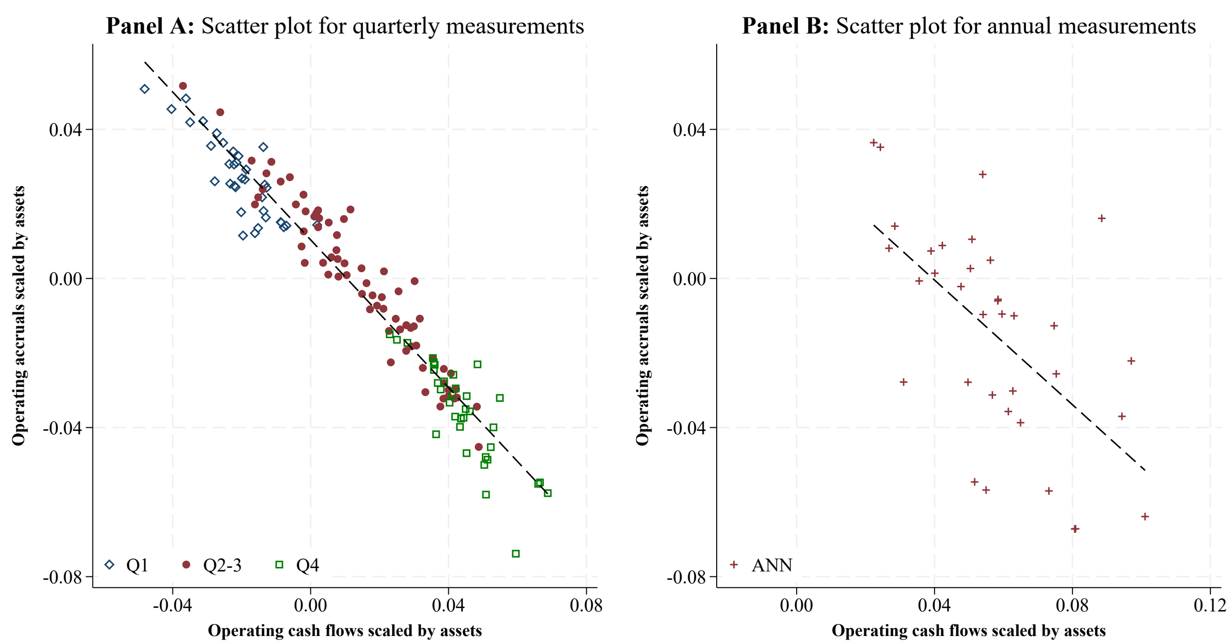
Figure A-1 provides a visual illustration of Amazon's seasonal patterns in cash flows and accruals. It also shows the effects on the observed relation between accruals and cash flows when quarterly performance measurements are aggregated at the annual level. Panel A presents a scatter plot of 100 quarterly operating accrual and cash flow observations available for the years 1998–2022. A clear pattern emerges in the quarterly data, with the first-quarter observations being concentrated in the upper-left quadrant of the graph, while the fourth-quarter observations are concentrated in the lower-right quadrant. The fitted regression line reveals a stark negative correlation between accruals and cash flows for Amazon with a high goodness of fit. Specifically, in a regression of quarterly operating accruals on operating cash flows, the coefficient on operating cash flows equals -0.83 and the R^2 equals 0.72.

Panel B presents a scatter plot of the 25 corresponding annual measurements of accruals and cash flows. The figure illustrates how the measurement of accruals and cash flows using annual data completely obscures the inter-temporal variation in operating cash flows and accruals that gives rise to a negative correlation. In other words, the aggregation at the annual level completely obscures the role of accruals in offsetting the firm's within-year variation in cash flows.

Example 2: Deere & Co.

Figure A-2

Cash flow patterns and the accrual-cash flow relation for Deere



Deere & Co. is a manufacturer and distributor of agricultural and construction equipment. The firm has a long operating cash cycle (more than 370 days in 2022), which makes accruals particularly important in offsetting cash flows shocks and making earnings a more informative measure of performance than cash flows (Dechow 1994). Deere's business is subject to strong seasonal patterns in demand, with revenues historically peaking in the second and third fiscal quarters (ending in April and July, respectively) and being weakest in the first fiscal quarter (ending in January).

Deere historically reports the lowest (highest) operating cash flows in the first (fourth) fiscal quarter, while operating accruals are highest (lowest) in the first (fourth) fiscal quarter. The firm's low first-quarter cash flows tend to be associated with the building up of inventory in preparation for the subsequent peak in consumer demand and significant reductions in accounts payable that build up over the fiscal year. Both the increases in inventory and reductions in accounts payable are positive working capital accruals. In the fourth quarter, Deere experiences substantial reductions in accounts receivable due to the collection of payments from credit sales made in earlier quarters, and increases in accounts payable, both of which are negative working capital accruals. During the second fiscal quarter, the firm's operating cash flows (accruals) are also relatively low (high) due to increases in accounts receivable (due to the second-quarter credit sales) and inventory (to meet additional demand in the third quarter). Because of additional increases in accounts payable during the second fiscal quarter, however, the operating cash flows (accruals) are not as low (high) as in the first fiscal quarter.

For the 136 quarterly observations available for the period 1989–2022, Panel A of Figure A-2 illustrates the concentration of first and fourth quarter combinations of accruals and cash flows in the upper-left and lower-right quadrants of the figure, respectively. The scatter plot reveals a tight relation between accruals and cash flows with high goodness of fit. The coefficient on cash flows equals -0.99 and the R^2 equals 0.94. The Pearson correlation equals -0.97. By contrast, Panel B reveals a much weaker fit when the accrual and cash flow information is aggregated at the annual level. While the coefficient relating cash flows to accruals equals -0.84 in the annual data, the R^2 drops to 0.36 (which corresponds to a Pearson correlation of -0.60). Similar to the Amazon example, this example illustrates how the aggregation of accrual and cash flow data into annual measurements causes important information about seasonal variation in cash flows and the timing role of accruals to be lost.

Appendix B. Derivations of quarterly accrual and cash flow expressions

B.1. Expressions for quarterly accruals

This Appendix presents the derivations of the expressions of quarterly accruals presented in Section 2.2.2. These expressions are derived by setting accruals equal to the change in accounts receivable plus the change in inventory less the change in accounts payable. Equation (6) implies the following expressions for sales in the four fiscal quarters, where ψ is the seasonality factor and $\psi' = \frac{1}{(1+\psi)} - 1$:

$$S_{it}^{Q1} = (1 + \psi')S_{it-1} + \varepsilon_{it} \tag{B-1}$$
$$S_{it}^{Q2} = S_{it-1} + \varepsilon_{it} \tag{B-2}$$
$$S_{it}^{Q3} = S_{it-1} + \varepsilon_{it} \tag{B-3}$$
$$S_{it}^{Q4} = (1 + \psi)S_{it-1} + \varepsilon_{it} \tag{B-4}$$

Based on these expressions for quarterly sales, the levels of accounts receivable are obtained as a fraction α of sales and are defined as:

$$AR_{it}^{Q1} = \alpha S_{it}^{Q1} = \alpha(1 + \psi')S_{it-1} + \alpha\varepsilon_{it} \tag{B-5}$$
$$AR_{it}^{Q2} = \alpha S_{it}^{Q2} = \alpha S_{it-1} + \alpha\varepsilon_{it} \tag{B-6}$$
$$AR_{it}^{Q3} = \alpha S_{it}^{Q3} = \alpha S_{it-1} + \alpha\varepsilon_{it} \tag{B-7}$$
$$AR_{it}^{Q4} = \alpha S_{it}^{Q4} = \alpha(1 + \psi)S_{it-1} + \alpha\varepsilon_{it} \tag{B-8}$$

The changes in accounts receivable are then derived as the difference between current-period accounts receivable (as defined above) and prior-period accounts receivable (αS_{it-1}):

$$\Delta AR_{it}^{Q1} = \alpha(1 + \psi')S_{it-1} + \alpha\varepsilon_{it} - \alpha S_{it-1} = \alpha\varepsilon_{it} + \alpha\psi' S_{it-1} \tag{B-9}$$
$$\Delta AR_{it}^{Q2} = \alpha S_{it-1} + \alpha\varepsilon_{it} - \alpha S_{it-1} = \alpha\varepsilon_{it} \tag{B-10}$$
$$\Delta AR_{it}^{Q3} = \alpha S_{it-1} + \alpha\varepsilon_{it} - \alpha S_{it-1} = \alpha\varepsilon_{it} \tag{B-11}$$
$$\Delta AR_{it}^{Q4} = \alpha(1 + \psi)S_{it-1} + \alpha\varepsilon_{it} - \alpha S_{it-1} = \alpha\varepsilon_{it} + \alpha\psi S_{it-1} \tag{B-12}$$

Following DKW, we model a firm's target inventory as a constant fraction (γ_1) of next period's expected cost of sales, i.e., $INV_t = \gamma_1(1 - \pi)\mathbb{E}_t[S_{t+1}]$. For tractability purposes, we assume firms do not deviate from the target inventory levels (i.e., following DKW we set parameter γ_2 in their framework equal to zero). With $\mathbb{E}_t[\varepsilon_{it+1}] = 0$, we obtain the following expressions for the quarterly levels of inventory:

$$INV_{it}^{Q1} = \gamma_1(1 - \pi)S_{it} = \gamma_1(1 - \pi)((1 + \psi')S_{it-1} + \varepsilon_{it}) \tag{B-13}$$
$$INV_{it}^{Q2} = \gamma_1(1 - \pi)S_{it} \tag{B-14}$$
$$INV_{it}^{Q3} = \gamma_1(1 - \pi)(1 + \psi)S_{it} \tag{B-15}$$
$$INV_{it}^{Q4} = \gamma_1(1 - \pi)(1 + \psi')S_{it} \tag{B-16}$$

The last equality follows because $(1+\psi')(1+\psi) = 1$. The quarterly changes in inventory are then equal to:

$$\Delta INV_{it}^{Q1} = \gamma_1(1-\pi)((1+\psi')S_{it-1} + \varepsilon_{it} - (1+\psi')S_{it-1}) = \gamma_1(1-\pi)\varepsilon_{it} \tag{B-17}$$

$$\Delta INV_{it}^{Q2} = \gamma_1(1-\pi)(S_{it} - S_{it-1}) = \gamma_1(1-\pi)\varepsilon_{it} \tag{B-18}$$

$$\Delta INV_{it}^{Q3} = \gamma_1(1-\pi)((1+\psi)S_{it} - S_{it-1}) = \gamma_1(1-\pi)(\varepsilon_{it} + \psi S_{it}) \tag{B-19}$$

$$\Delta INV_{it}^{Q4} = \gamma_1(1-\pi)((1+\psi')S_{it} - (1+\psi)S_{it-1}) = \gamma_1(1-\pi)(\varepsilon_{it} + \psi' S_{it}) \tag{B-20}$$

Accounts payable depend on the credit terms with suppliers (as captured by β) and the current-quarter purchases needed to cover sales and to maintain the target inventory level at the end of the period. Current-period purchases are then defined as the current-period costs of sales (i.e., $(1-\pi)S_{it}$) plus the change in inventory:

$$P_{it}^{Q1} = (1-\pi)S_{it} + \gamma_1(1-\pi)\varepsilon_{it} \tag{B-21}$$

$$P_{it}^{Q2} = (1-\pi)S_{it} + \gamma_1(1-\pi)\varepsilon_{it} \tag{B-22}$$

$$P_{it}^{Q3} = (1-\pi)S_{it} + \gamma_1(1-\pi)(\varepsilon_{it} + \psi S_{it}) \tag{B-23}$$

$$P_{it}^{Q4} = (1-\pi)S_{it} + \gamma_1(1-\pi)(\varepsilon_{it} + \psi' S_{it}) \tag{B-24}$$

Given these expressions for quarterly purchases, the levels and changes in accounts payable can be depicted as:

$$AP_{it}^{Q1} = \beta P_{it}^{Q1} = \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it}) \tag{B-25}$$

$$AP_{it}^{Q2} = \beta P_{it}^{Q2} = \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it}) \tag{B-26}$$

$$AP_{it}^{Q3} = \beta P_{it}^{Q3} = \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it} + \gamma_1\psi S_{it}) \tag{B-27}$$

$$AP_{it}^{Q4} = \beta P_{it}^{Q4} = \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it} + \gamma_1\psi' S_{it}) \tag{B-28}$$

The changes in accounts payable are then defined as:

$$\begin{aligned} \Delta AP_{it}^{Q1} &= \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it} - S_{it-1} - \gamma_1\varepsilon_{it-1} - \gamma_1\psi' S_{it-1}) \\ &= \beta(1-\pi)(\Delta S_{it} + \gamma_1\Delta\varepsilon_{it} - \gamma_1\psi' S_{it-1}) \\ &= \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \psi' S_{it-1} - \gamma_1\psi' S_{it-1}) \end{aligned} \tag{B-29}$$

$$\begin{aligned} \Delta AP_{it}^{Q2} &= \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it} - S_{it-1} - \gamma_1\varepsilon_{it-1}) \\ &= \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it}) \end{aligned} \tag{B-30}$$

$$\begin{aligned} \Delta AP_{it}^{Q3} &= \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it} + \gamma_1\psi S_{it} - S_{it-1} - \gamma_1\varepsilon_{it-1}) \\ &= \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \gamma_1\psi S_{it}) \end{aligned} \tag{B-31}$$

$$\begin{aligned}
\Delta AP_{it}^{Q4} &= \beta(1-\pi)(S_{it} + \gamma_1\varepsilon_{it} + \gamma_1\psi' S_{it} - S_{it-1} - \gamma_1\varepsilon_{it-1} - \gamma_1\psi S_{it-1}) \\
&= \beta(1-\pi)(\Delta S_{it} + \gamma_1\Delta\varepsilon_{it} + \gamma_1\psi' S_{it} - \gamma_1\psi S_{it-1}) \\
&= \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \psi S_{it-1} + \gamma_1\psi' S_{it} - \gamma_1\psi S_{it-1}) \\
&= \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \psi S_{it-1} + \gamma_1\psi'\varepsilon_{it} - 2\gamma_1\psi S_{it-1})
\end{aligned} \tag{B-32}$$

The last equality follows from the fact that $\psi' S_{it}$ is equal to $\psi'\varepsilon_{it} - \psi S_{it-1}$ in Q4. Given the expressions derived above and an expression for the operating cash cycle ($\delta = \alpha + \gamma_1(1-\pi) - \beta(1-\pi)$), we obtain the following expressions for quarterly accruals:

$$\begin{aligned}
A_{it}^{Q1} &= \alpha\varepsilon_{it} + \alpha\psi' S_{it-1} + \gamma_1(1-\pi)\varepsilon_{it} - \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \psi' S_{it-1} - \gamma_1\psi' S_{it-1}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \alpha\psi' S_{it-1} - \beta(1-\pi)(\psi' S_{it-1} - \gamma_1\psi' S_{it-1}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \delta\psi' S_{it-1} - \gamma_1(1-\pi)\psi' S_{it-1} + \beta(1-\pi)\gamma_1\psi' S_{it-1} \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \delta\psi' S_{it-1} - \gamma_1(1-\pi)(1-\beta)\psi' S_{it-1}
\end{aligned} \tag{B-33}$$

$$\begin{aligned}
A_{it}^{Q2} &= \alpha\varepsilon_{it} + \gamma_1(1-\pi)\varepsilon_{it} - \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it}
\end{aligned} \tag{B-34}$$

$$\begin{aligned}
A_{it}^{Q3} &= \alpha\varepsilon_{it} + \gamma_1(1-\pi)(\varepsilon_{it} + \psi S_{it}) - \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \gamma_1\psi S_{it}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \gamma_1(1-\pi)\psi S_{it} - \beta(1-\pi)\gamma_1\psi S_{it} \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \gamma_1(1-\pi)(1-\beta)\psi S_{it}
\end{aligned} \tag{B-35}$$

$$\begin{aligned}
A_{it}^{Q4} &= \alpha\varepsilon_{it} + \alpha\psi S_{it-1} + \gamma_1(1-\pi)(\varepsilon_{it} + \psi' S_{it}) \\
&\quad - \beta(1-\pi)(\varepsilon_{it} + \gamma_1\Delta\varepsilon_{it} + \psi S_{it-1} + \gamma_1\psi'\varepsilon_{it} - 2\gamma_1\psi S_{it-1}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \alpha\psi S_{it-1} + \gamma_1(1-\pi)(\psi'\varepsilon_{it} - \psi S_{it-1}) \\
&\quad - \beta(1-\pi)(\psi S_{it-1} + \gamma_1\psi'\varepsilon_{it} - 2\gamma_1\psi S_{it-1}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \delta\psi S_{it-1} + \gamma_1(1-\pi)(\psi'\varepsilon_{it} - 2\psi S_{it-1}) \\
&\quad - \beta(1-\pi)(\gamma_1\psi'\varepsilon_{it} - 2\gamma_1\psi S_{it-1}) \\
&= \delta\varepsilon_{it} - \beta(1-\pi)\gamma_1\Delta\varepsilon_{it} + \delta\psi S_{it-1} + \gamma_1(1-\pi)(1-\beta)(\psi'\varepsilon_{it} - 2\psi S_{it-1})
\end{aligned} \tag{B-36}$$

Finally, quarterly cash flows are defined as quarterly earnings (πS_{it}) minus the quarterly accruals as defined above.

B.2. Expressions for expected values of quarterly cash flows and accruals

This Appendix presents the derivations of the expressions for expected quarterly cash flows and accruals presented in Table 1. Given the expressions for quarterly accruals and the assumptions that $\mathbb{E}[\varepsilon_{it}] = 0$ and $\mathbb{E}[\Delta\varepsilon_{it}] = 0$, we obtain the following expressions for the quarterly expected values of accruals as a function of profit margin, working capital parameters, and expected sales:

$$\begin{aligned}\mathbb{E}[A_{it}^{Q1}] &= \delta\mathbb{E}[\varepsilon_{it}] - \beta(1-\pi)\gamma_1\mathbb{E}[\Delta\varepsilon_{it}] \\ &+ \delta\psi'\mathbb{E}[S_{it-1}] - \gamma_1(1-\pi)(1-\beta)\psi'\mathbb{E}[S_{it-1}] \\ &= (\delta - \gamma_1(1-\pi)(1-\beta))\psi'\mathbb{E}[S_{it-1}]\end{aligned} \tag{B-37}$$

$$\mathbb{E}[A_{it}^{Q2}] = \delta\mathbb{E}[\varepsilon_{it}] - \beta(1-\pi)\gamma_1\mathbb{E}[\Delta\varepsilon_{it}] = 0 \tag{B-38}$$

$$\begin{aligned}\mathbb{E}[A_{it}^{Q3}] &= \delta\mathbb{E}[\varepsilon_{it}] - \beta(1-\pi)\gamma_1\mathbb{E}[\Delta\varepsilon_{it}] + \gamma_1(1-\pi)(1-\beta)\psi\mathbb{E}[S_{it}] \\ &= \gamma_1(1-\pi)(1-\beta)\psi\mathbb{E}[S_{it}]\end{aligned} \tag{B-39}$$

$$\begin{aligned}\mathbb{E}[A_{it}^{Q4}] &= \delta\mathbb{E}[\varepsilon_{it}] - \beta(1-\pi)\gamma_1\mathbb{E}[\Delta\varepsilon_{it}] \\ &+ \delta\psi\mathbb{E}[S_{it-1}] + \gamma_1(1-\pi)(1-\beta)(\psi'\mathbb{E}[\varepsilon_{it}] - 2\psi\mathbb{E}[S_{it-1}]) \\ &= (\delta - 2\gamma_1(1-\pi)(1-\beta))\psi\mathbb{E}[S_{it-1}]\end{aligned} \tag{B-40}$$

The expected values of quarterly cash flows can be obtained as the expected values of quarterly earnings ($\pi\mathbb{E}[S_{it}]$) minus the expectations of quarterly accruals as defined above:

$$\begin{aligned}\mathbb{E}[CF_{it}^{Q1}] &= \pi\mathbb{E}[S_{it}] - \mathbb{E}[A_{it}^{Q1}] = \pi\mathbb{E}[S_{it}] - (\delta - \gamma_1(1-\pi)(1-\beta))\psi'\mathbb{E}[S_{it-1}] \\ &= \pi(1+\psi')\mathbb{E}[S_{it-1}] - (\delta - \gamma_1(1-\pi)(1-\beta))\psi'\mathbb{E}[S_{it-1}] \\ &= (\pi + (\pi - \delta + \gamma_1(1-\pi)(1-\beta))\psi')\mathbb{E}[S_{it-1}]\end{aligned} \tag{B-41}$$

$$\mathbb{E}[CF_{it}^{Q2}] = \pi\mathbb{E}[S_{it}] - \mathbb{E}[A_{it}^{Q2}] = \pi\mathbb{E}[S_{it}] \tag{B-42}$$

$$\begin{aligned}\mathbb{E}[CF_{it}^{Q3}] &= \pi\mathbb{E}[S_{it}] - \mathbb{E}[A_{it}^{Q3}] = \pi\mathbb{E}[S_{it}] - \gamma_1(1-\pi)(1-\beta)\psi\mathbb{E}[S_{it}] \\ &= (\pi - \gamma_1(1-\pi)(1-\beta)\psi)\mathbb{E}[S_{it}]\end{aligned} \tag{B-43}$$

$$\begin{aligned}\mathbb{E}[CF_{it}^{Q4}] &= \pi\mathbb{E}[S_{it}] - \mathbb{E}[A_{it}^{Q4}] = \pi\mathbb{E}[S_{it}] - (\delta - 2\gamma_1(1-\pi)(1-\beta))\psi\mathbb{E}[S_{it-1}] \\ &= \pi(1+\psi)\mathbb{E}[S_{it-1}] - (\delta - 2\gamma_1(1-\pi)(1-\beta))\psi\mathbb{E}[S_{it-1}] \\ &= (\pi + (\pi - \delta + 2\gamma_1(1-\pi)(1-\beta))\psi)\mathbb{E}[S_{it-1}]\end{aligned} \tag{B-44}$$

B.3. Expressions for correlations between cash flows and accruals in DKW model

Below, we first derive an expression for the expected correlation between the changes in accruals and cash flows in the DKW framework. With $CF_{it} = \pi S_{it} - \delta\varepsilon_{it}$ and $A_{it} = \delta\varepsilon_{it}$, the changes in cash flows and accruals are defined as $\Delta CF_{it} = \pi\varepsilon_{it} - \delta\Delta\varepsilon_{it}$ and $\Delta A_{it} = \delta\Delta\varepsilon_{it}$. Given $\mathbb{E}[\varepsilon_{it}] = 0$ and $\mathbb{E}[\Delta\varepsilon_{it}] = 0$, the expected values of changes in cash flows and accruals are zero.

The expected correlation between changes in accruals and cash flows is derived as:

$$\rho(\Delta A_{it}, \Delta CF_{it}) = \frac{\mathrm{Cov}[\Delta A_{it}, \Delta CF_{it}]}{\sqrt{\mathrm{Var}[\Delta A_{it}] \cdot \mathrm{Var}[\Delta CF_{it}]}}, \tag{B-45}$$

where:

$$\begin{aligned}\text{Cov}[\Delta A_{it}, \Delta CF_{it}] &= \mathbb{E}[(\Delta CF_{it} - \mathbb{E}[\Delta CF_{it}])(\Delta A_{it} - \mathbb{E}[\Delta A_{it}])] \\ &= \mathbb{E}[(\Delta CF_{it})(\Delta A_{it})] = \mathbb{E}[(\pi\varepsilon_{it} - \delta\Delta\varepsilon_{it})(\delta\Delta\varepsilon_{it})] \\ &= \delta\pi\mathbb{E}[\varepsilon_{it}\Delta\varepsilon_{it}] - \delta^2\mathbb{E}[(\Delta\varepsilon_{it})^2] = (\delta\pi - 2\delta^2)\sigma_\varepsilon^2\end{aligned} \tag{B-46}$$

$$\begin{aligned}\text{Var}[\Delta A_{it}] &= \text{Var}[\delta\Delta\varepsilon_{it}] = \mathbb{E}[(\delta\Delta\varepsilon_{it})^2] - \mathbb{E}[\delta\Delta\varepsilon_{it}]^2 \\ &= \delta^2\mathbb{E}[(\Delta\varepsilon_{it})^2] = 2\delta^2\sigma_\varepsilon^2\end{aligned} \tag{B-47}$$

$$\begin{aligned}\text{Var}[\Delta CF_{it}] &= \text{Var}[\pi\varepsilon_{it} - \delta\Delta\varepsilon_{it}] = \mathbb{E}[(\pi\varepsilon_{it} - \delta\Delta\varepsilon_{it})^2] - \mathbb{E}[\pi\varepsilon_{it} - \delta\Delta\varepsilon_{it}]^2 \\ &= \mathbb{E}[(\pi\varepsilon_{it} - \delta\Delta\varepsilon_{it})(\pi\varepsilon_{it} - \delta\Delta\varepsilon_{it})] \\ &= \pi^2\mathbb{E}[\varepsilon_{it}^2] - 2\delta\pi\mathbb{E}[\varepsilon_{it}^2] + \delta^2\mathbb{E}[(\Delta\varepsilon_{it})^2] = (\pi - 2\pi\delta + 2\delta^2)\sigma_\varepsilon^2\end{aligned} \tag{B-48}$$

Putting these terms together, we obtain:

$$\rho(\Delta A_{it}, \Delta CF_{it}) = \frac{(\delta\pi - 2\delta^2)\sigma_\varepsilon^2}{\sqrt{2\delta^2\sigma_\varepsilon^2(\pi - 2\pi\delta + 2\delta^2)\sigma_\varepsilon^2}} = \frac{\delta(\pi - 2\delta)}{\sqrt{2\delta^2(\pi - 2\pi\delta + 2\delta^2)}} \tag{B-49}$$

In a similar vein, the expected correlation between the *levels* of accruals and cash flows can be obtained. Because $\mathbb{E}[CF_{it}] = \pi\mathbb{E}[S_{it}] - 0$ and $\mathbb{E}[A_{it}] = 0$, we obtain the following expression for the covariance between accruals and cash flows:

$$\begin{aligned}\text{Cov}[A_{it}, CF_{it}] &= \mathbb{E}[(CF_{it})(A_{it})] - \mathbb{E}[CF_{it}]\mathbb{E}[A_{it}] \\ &= \mathbb{E}[(CF_{it})(A_{it})] = \mathbb{E}[(\pi S_{it} - \delta\varepsilon_{it})(\delta\varepsilon_{it})] \\ &= \pi\delta\mathbb{E}[S_{it}\varepsilon_{it}] - \delta^2\mathbb{E}[\varepsilon_{it}^2] = (\pi\delta - \delta^2)\sigma_\varepsilon^2\end{aligned} \tag{B-50}$$

The variances of the levels of accruals and cash flows equal, respectively:

$$\text{Var}[A_{it}] = \text{Var}[\delta\varepsilon_{it}] = \delta^2\sigma_\varepsilon^2 \tag{B-51}$$

$$\begin{aligned}\text{Var}[CF_{it}] &= \text{Var}[\pi S_{it} - \delta\varepsilon_{it}] = \pi^2\text{Var}[S_{it}] + \delta^2\text{Var}[\varepsilon_{it}] - 2\text{Cov}[\pi S_{it}, \delta\varepsilon_{it}] \\ &= \pi^2 t\sigma_\varepsilon^2 + \delta^2\sigma_\varepsilon^2 - 2\pi\delta\mathbb{E}[S_{it}\varepsilon_{it}] = \pi^2 t\sigma_\varepsilon^2 + \delta^2\sigma_\varepsilon^2 - 2\pi\delta\sigma_\varepsilon^2 \\ &= (\pi^2 t + \delta^2 - 2\pi\delta)\sigma_\varepsilon^2\end{aligned} \tag{B-52}$$

The correlation between the levels of accruals and cash flows is then defined as:

$$\rho(A_{it}, CF_{it}) = \frac{(\pi\delta - \delta^2)\sigma_\varepsilon^2}{\sqrt{\delta^2\sigma_\varepsilon^2(\pi^2 t + \delta^2 - 2\pi\delta)\sigma_\varepsilon^2}} = \frac{\delta(\pi - \delta)}{\sqrt{\delta^2(\pi^2 t - 2\pi\delta + \delta^2)}} \tag{B-53}$$

B.4. Correlation between cash flows and accruals in the presence of a fixed firm component

The derivation of the correlation between the levels of accruals and cash flows in the previous section relied on the implicit assumption that the starting value of each firm i is a cross-sectional constant in the random-walk sales generating process defined in equation (1). In other words, when the random-walk process is defined as $S_{it} = S_{i0} + \sum_{\tau=1}^{t} \varepsilon_{i\tau}$, S_{i0} is assumed to have zero variance ($\sigma_S^2 = 0$). With $\sigma_S^2 > 0$ and $\text{Var}[S_{it}] = \sigma_S^2 + t\sigma_\varepsilon^2$, the correlation between the levels of accruals and cash flows differs from that derived above because now the variance of cash flows is determined by σ_S^2:

$$\begin{aligned}\text{Var}[CF_{it}] &= \text{Var}[\pi S_{it} - \delta\varepsilon_{it}] = \pi^2\text{Var}[S_{it}] + \delta^2\text{Var}[\varepsilon_{it}] - 2\text{Cov}[\pi S_{it}, \delta\varepsilon_{it}] \\ &= \pi^2(\sigma_S^2 + t\sigma_\varepsilon^2) + \delta^2\sigma_\varepsilon^2 - 2\pi\delta\mathbb{E}[S_{it}\varepsilon_{it}] \\ &= \pi^2(\sigma_S^2 + t\sigma_\varepsilon^2) + \delta^2\sigma_\varepsilon^2 - 2\pi\delta\sigma_\varepsilon^2 \\ &= \pi^2\sigma_S^2 + (\pi^2 t + \delta^2 - 2\pi\delta)\sigma_\varepsilon^2\end{aligned} \tag{B-54}$$

While the covariance between accrual and cash flow levels and the variance of accruals remain the same as defined before, the expected correlation between the levels of accruals and cash flows with cross-sectional variation in S_{i0} becomes:

$$\rho(A_{it}, CF_{it}) = \frac{\delta(\pi - \delta)\sigma_\varepsilon^2}{\sqrt{\delta^2\sigma_\varepsilon^2(\pi^2\sigma_S^2 + (\pi^2 t - 2\pi\delta + \delta^2)\sigma_\varepsilon^2)}} \tag{B-55}$$

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Figure 1

Example: Amazon's Quarterly Operating Cash Flows and Earnings Over Time

Notes: This figure displays the quarterly values of operating cash flows and earnings for Amazon Inc. over 100 fiscal quarters in the period 1998–2022. Operating cash flows and earnings are derived from the year-to-date variables for operating cash flow (OANCFY) and income before extraordinary items (IBCY) in Compustat Fundamentals Quarterly. Both variables are scaled by average total assets over the fiscal quarter.

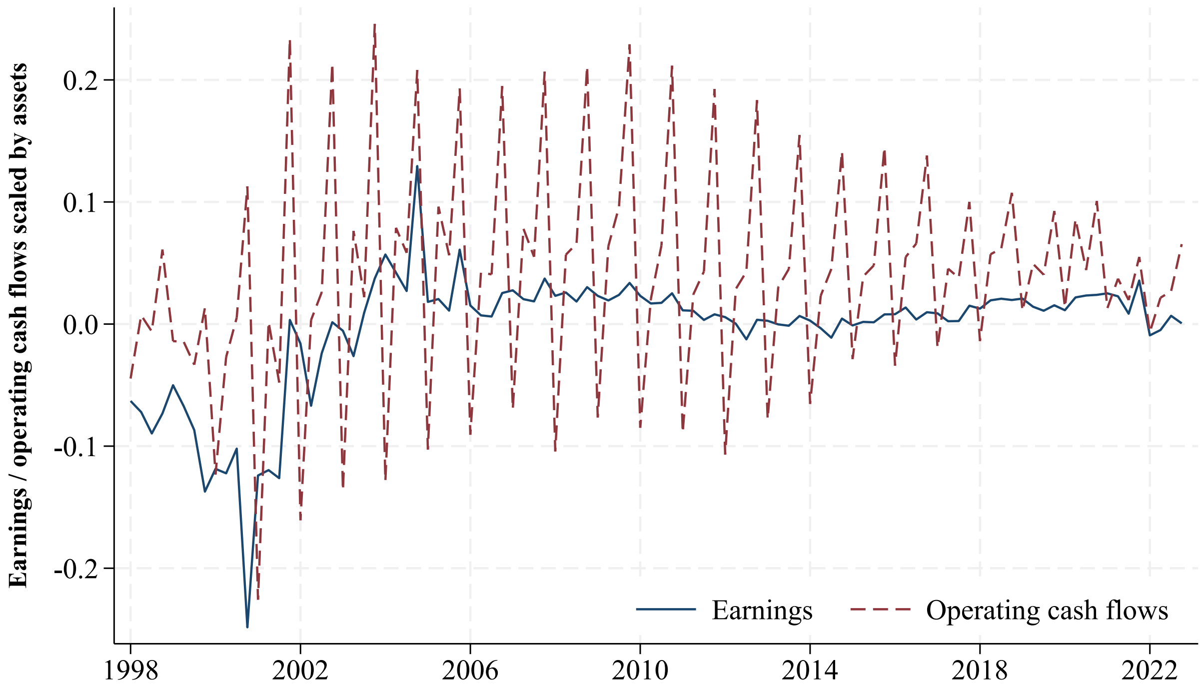


Figure 2

Predicted Effects of Sales Seasonality and Working Capital Policy Parameters on Seasonal Cash Flow Variation

Notes: This figure illustrates the effects of sales seasonality and working capital policies on seasonal cash flows variation based on our extension of the DKW model. Given the expressions for the expected values of quarterly cash flows presented in Panel A of Table 1, we construct an equally-spaced $51 \times 51 \times 51 \times 51$ grid of unique combinations of seasonality ($\psi \in [0, 0.5]$), credit terms with customers ($\alpha \in [0, 1.0]$), target inventory rate ($\gamma_1 \in [0, 1.0]$), and credit terms with suppliers ($\beta \in [0, 1.0]$). The profit margin parameter π is set to 0.05 (DKW). For each unique combination of the parameters, we compute the four expected values of quarterly cash flows as defined in Panel A of Table 1. We set the expected value of annual sales equal to a constant to ensure that seasonality only affects the distribution of sales across the quarters. With annual sales set equal equal to 4, expected sales in Q4 equal $(1 + \psi)\mathbb{E}[S_{it-1}]$, as per equation (6), and expected sales in Q1 to Q3 equal $1 - \frac{\psi}{(4+\psi)}$, respectively. We then estimate the within-year cash flow variation as the difference between the highest and the lowest four expected values for each unique combination of parameters. The figure plots this difference for alternative values of ψ and values of the quarterly operating cash cycle δ $(= \alpha + \gamma_1(1 - \pi) - \beta(1 - \pi))$ between -0.3 and 1.2.

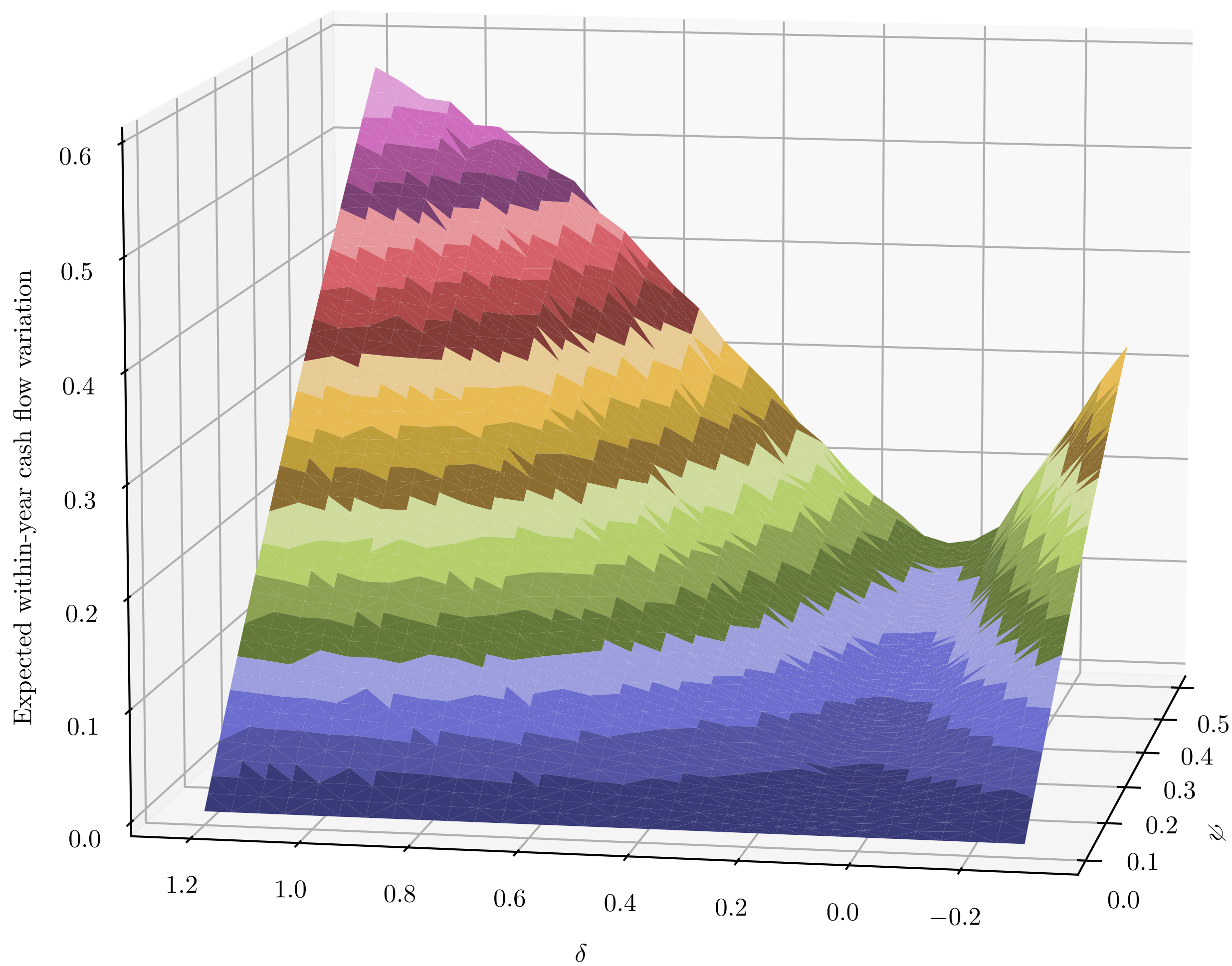
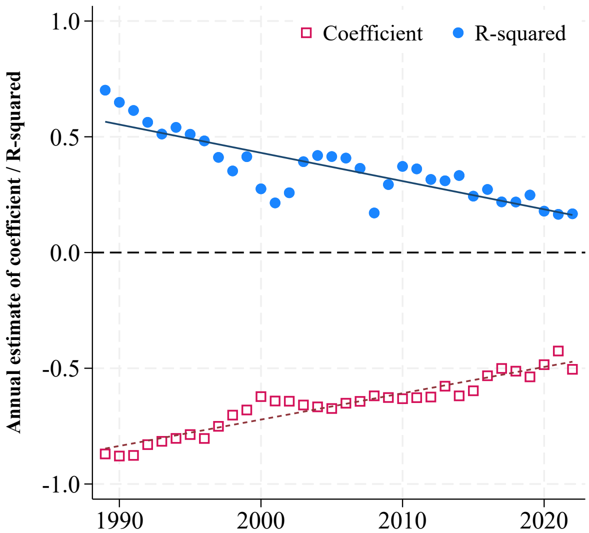


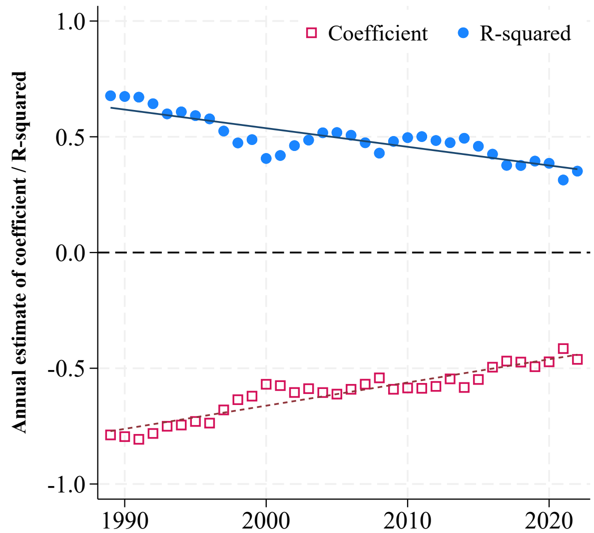
Figure 3

Estimates of Quarterly Accrual-Cash Flow Relation Over Time

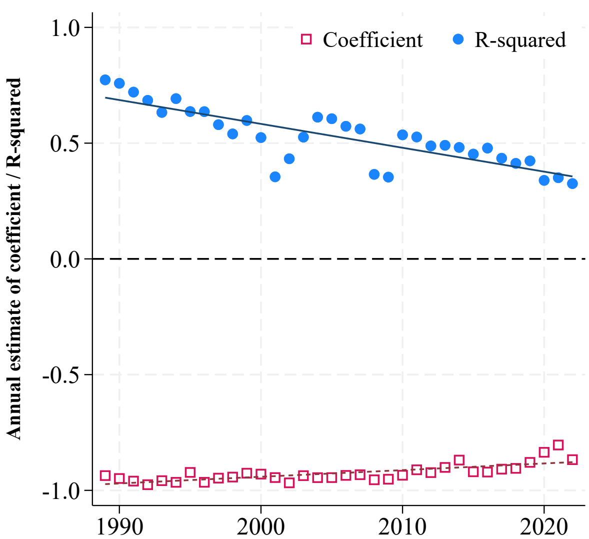
Notes: This figure presents estimates of the quarterly accrual-cash flow relation over time. The accrual-cash flow relation is estimated based on annual regressions of quarterly accruals on contemporaneous quarterly cash flows, where accruals and cash flows are either demeaned by firm or measured in changes. Subfigure (a) shows results for firm-demeaned operating accruals, subfigure (b) shows results for firm-demeaned working capital accruals, subfigure (c) shows results for changes in operating accruals, and subfigure (d) shows results for changes in working capital accruals.



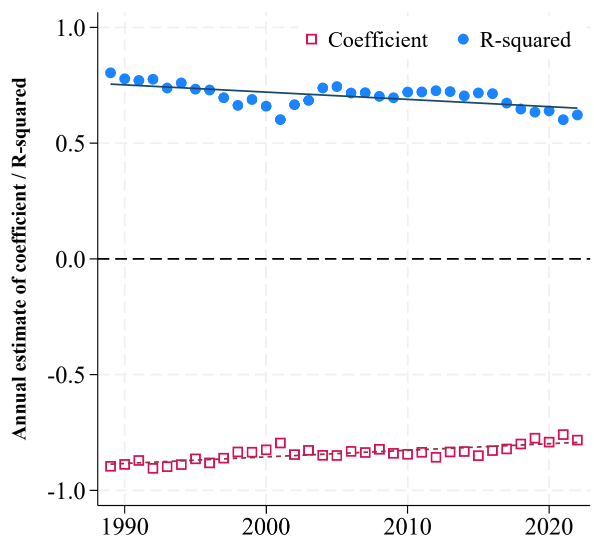
(a) Operating Accruals



(b) Working Capital Accruals



(c) ΔOperating Accruals

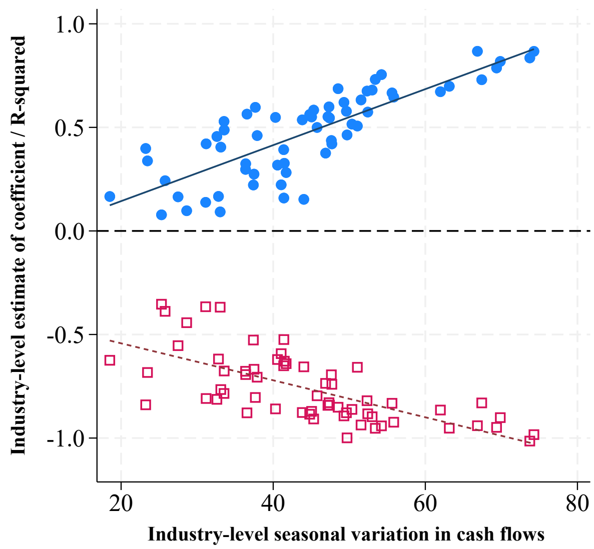


(d) ΔWorking Capital Accruals

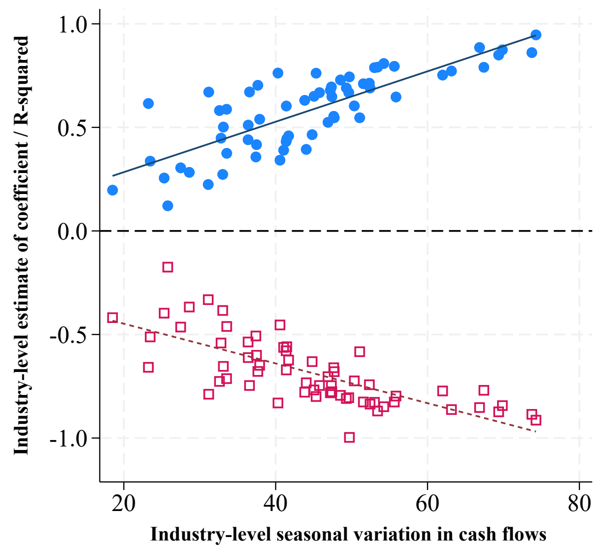
Figure 4

Industry Estimates of Accrual-Cash Flow Relation and Seasonal Variation in Cash Flows

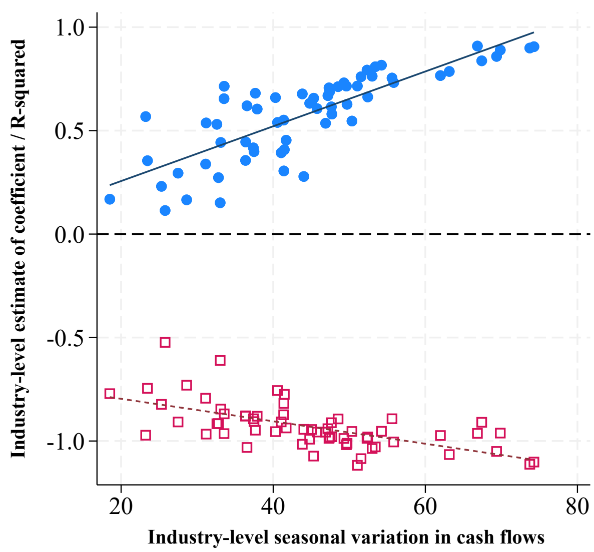
Notes: This figure presents scatter plots for industry estimates of the quarterly accrual-cash flow relation and seasonal variation in operating cash flows. The quarterly accrual-cash flow relation is estimated based on a regression of quarterly accruals on contemporaneous quarterly cash flows, where accruals and cash flows are either demeaned by firm or measured in changes. Industries are identified based on 2-digit SIC industry codes. Industry-level seasonal variation in operating cash flows is estimated as the average within-firm-year cash flow volatility, where within-firm-year cash flow volatility is measured by annually ranking quarterly operating cash flows in percentiles and then computing the difference between the highest and lowest ranks for each firm-year. Subfigure (a) shows results for firm-demeaned operating accruals, subfigure (b) shows results for firm-demeaned working capital accruals, subfigure (c) shows results for changes in operating accruals, and subfigure (d) shows results for changes in working capital accruals.



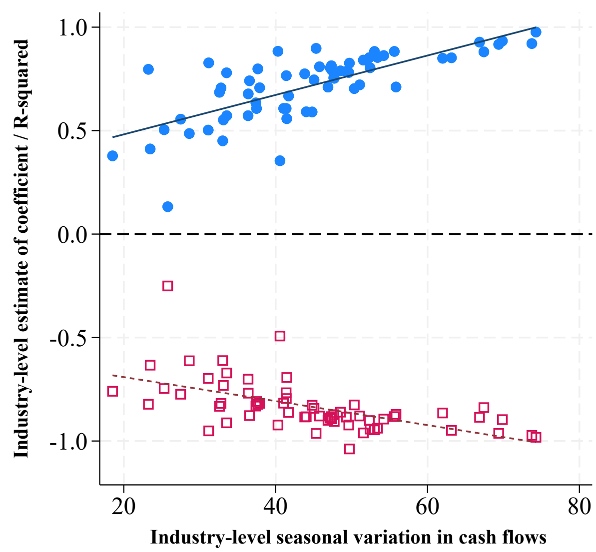
(a) Operating Accruals



(b) Working Capital Accruals



(c) ΔOperating Accruals



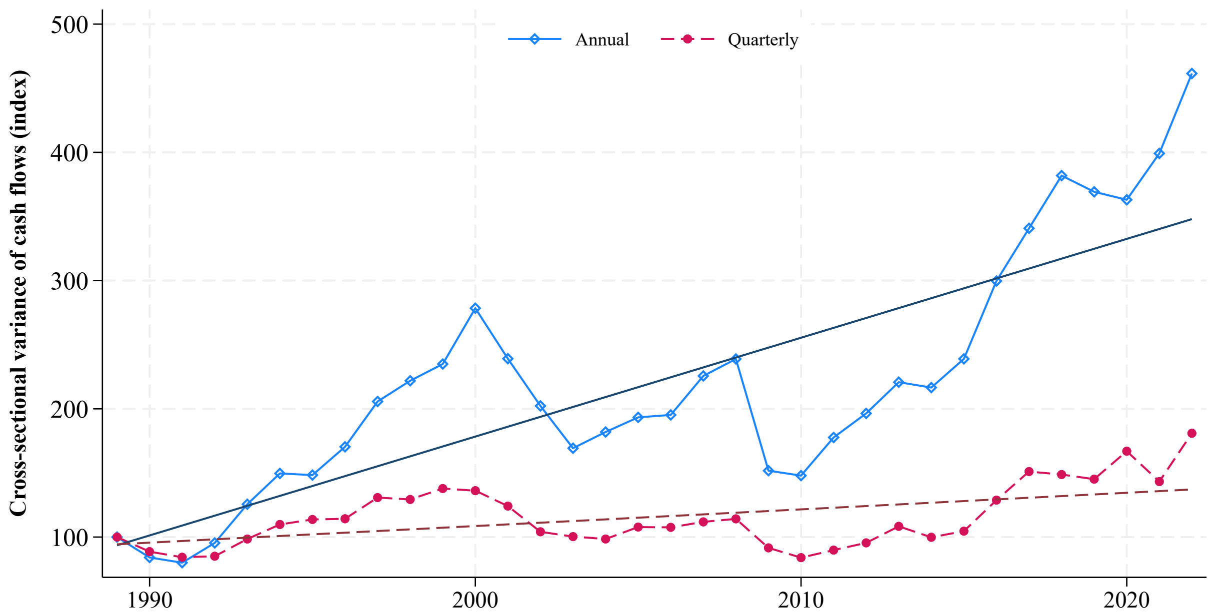
(d) ΔWorking Capital Accruals

Figure 5

Time Trends in Annual and Quarterly Variance of Operating Cash Flows

Notes: This figure plots annual estimates of the cross-sectional variance of annual and quarterly operating cash flows. The variances are indexed (standardized) at 100 in the first sample year, 1989, to facilitate a comparison between the trends in annual and quarterly cash flow variances. In Panel A, the annual variances are calculated based on the levels of operating cash flows. In Panel B, the annual variances are calculated after accounting for firm fixed effects in operating cash flows.

Panel A: Cross-sectional variance of annual and quarterly operating cash flows



Panel B: Cross-sectional variance after firm-demeaning

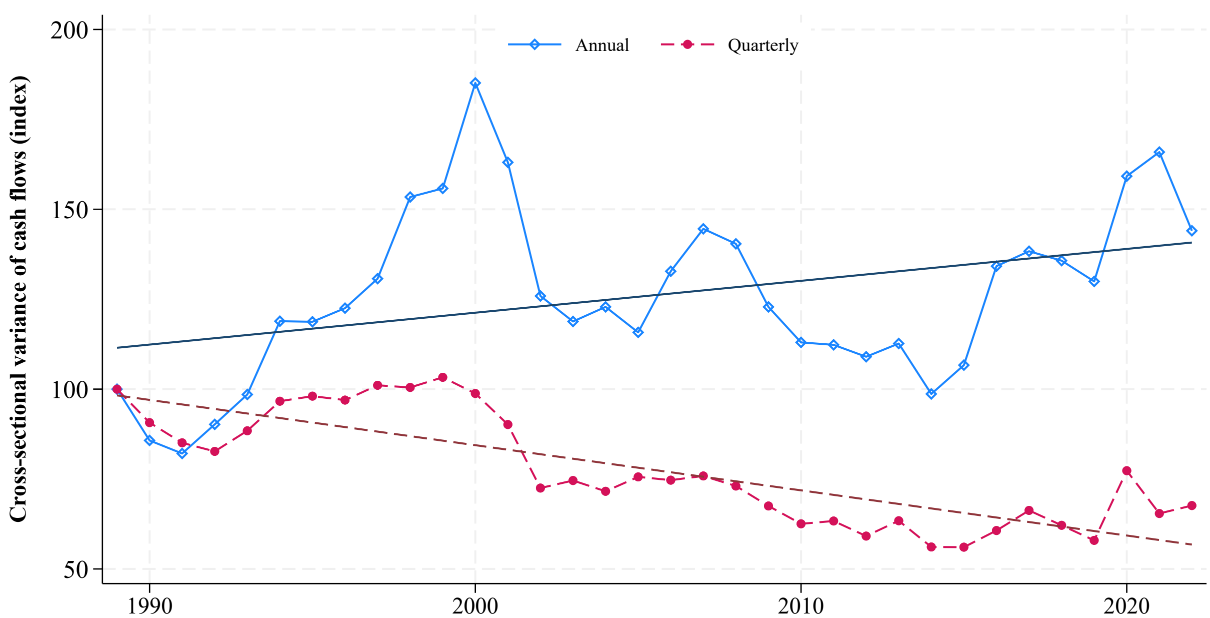


Figure 6

Time Trend in Seasonal Variation in Operating Cash Flows and Earnings

Notes: This figure presents annual estimates of seasonal variation in operating cash flows versus earnings. Seasonal variation is identified based on the difference between the maximum and minimum percentile ranks of quarterly cash flows or earnings in each firm-year. For $SVCF^R$, we annually rank $CFOQ$ in percentiles and compute the difference between the highest and lowest ranks within each firm-year. $CFOQ$ is defined in the notes to Table 2. For SVE^R, we annually rank earnings in percentiles and compute the difference between the highest and lowest ranks within each firm-year, where earnings are defined as income before extraordinary items (IBQ) scaled by average total assets (ATQ).

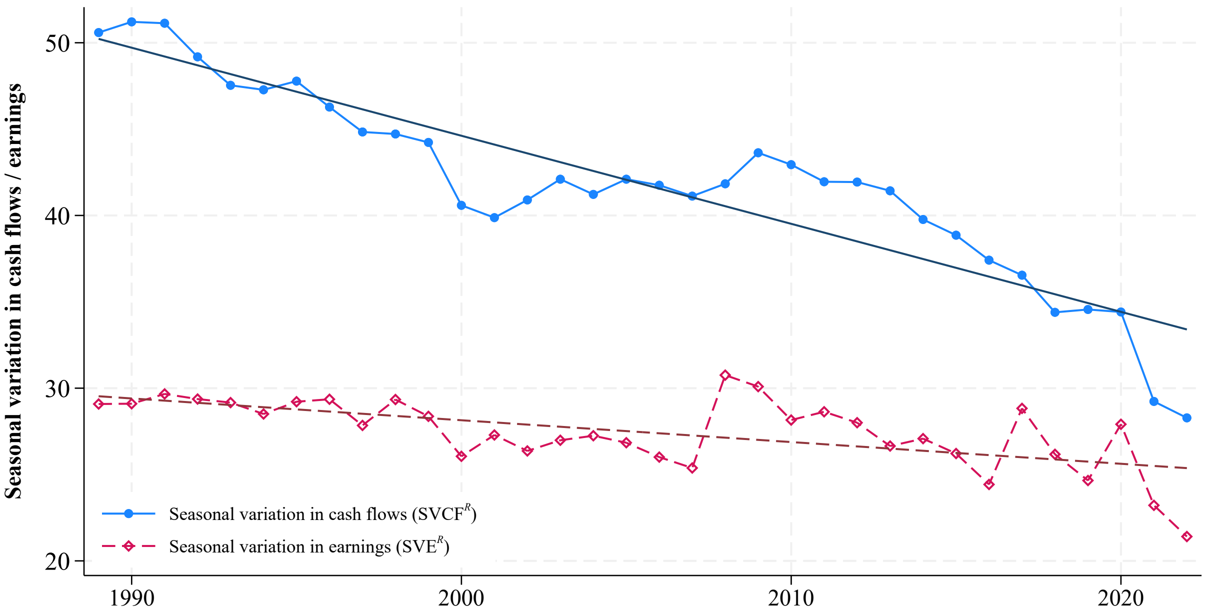
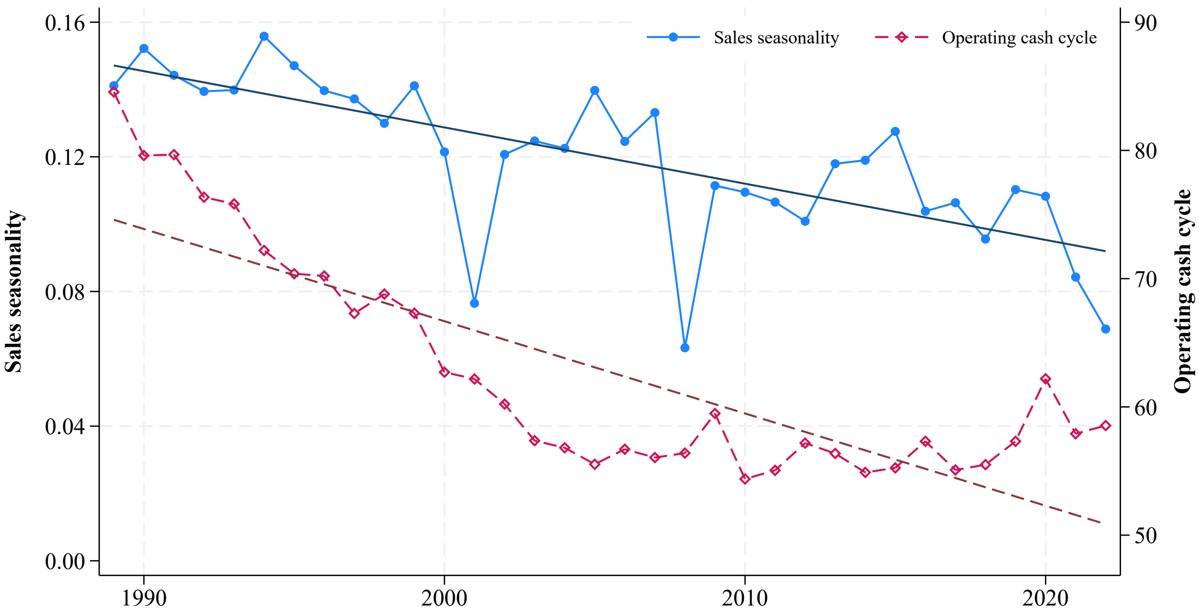


Figure 7

Time Trends in Sales Seasonality, Operating Cash Cycle, and Working Capital Policies

Notes: This figure presents annual descriptive statistics for sales seasonality (ψ), the operating cash cycle measured in days ($\delta \times 360$), days inventory outstanding ($\gamma_1 \times 360$), and the annual median difference between the days receivable ($\alpha \times 360$) and days payable ($\beta \times 360$) outstanding. All variables are defined in the notes to Table 6.

Panel A: Trends in sales seasonality and operating cash cycle



Panel B: Trends in inventory holdings and terms of trade credit

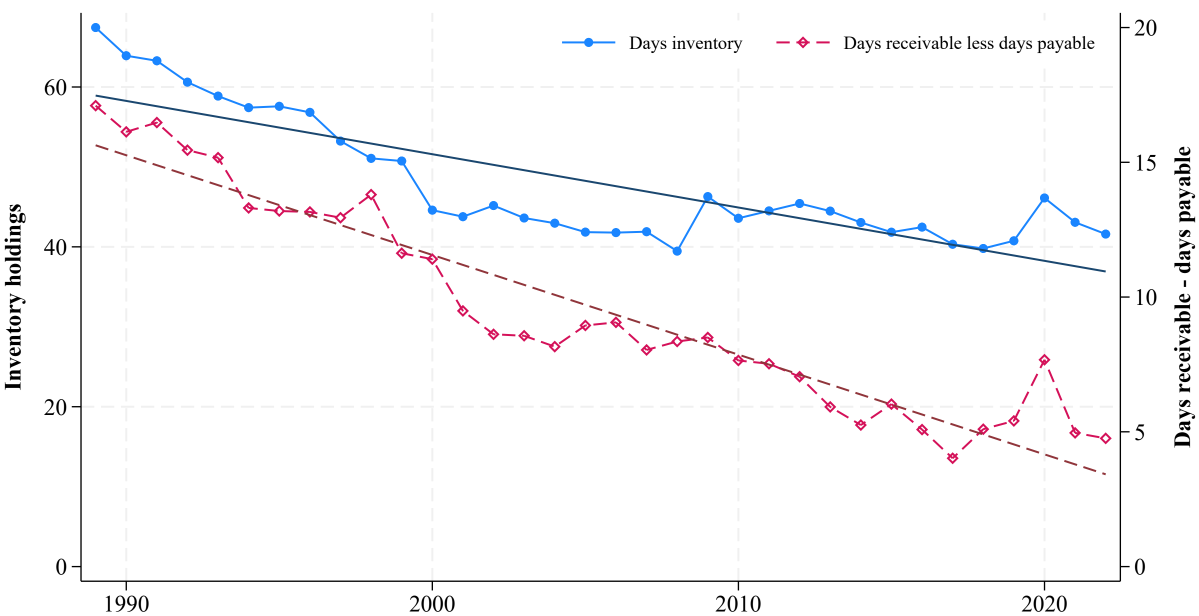
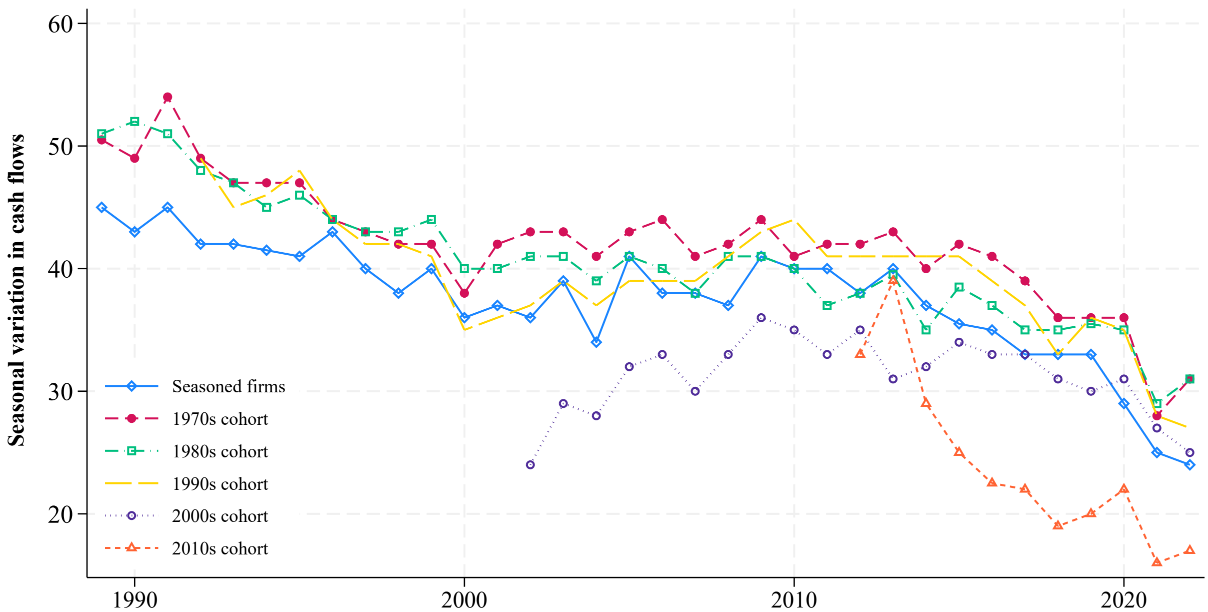


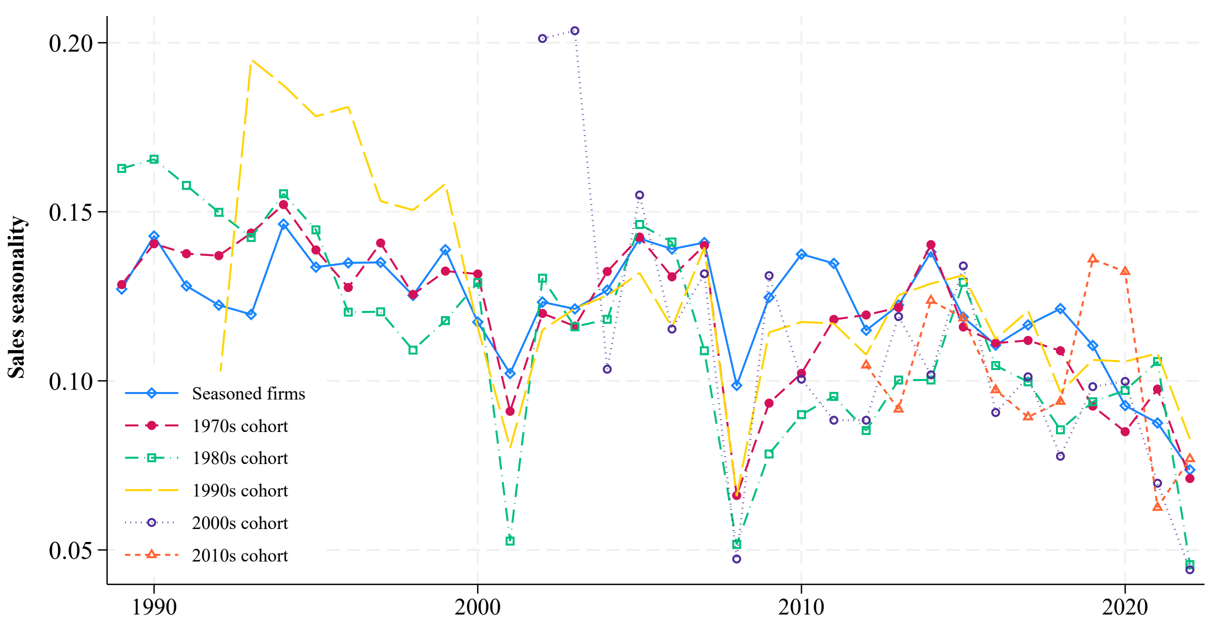
Figure 8
Tests of Cohort Effects

Notes: This figure present descriptive statistics for different cohorts of newly listed firms. We assign each firm in the sample to a cohort based on the first year it is identified as being listed on an exchange in CRSP. The seasoned firms cohort contains all firms listed before 1970, the 1970s cohort contains all firms first listed in any of the years 1970–1979, the 1980s cohort contains all firms first listed in any of the years 1980–1989, etc. Panels A–F present the cohort-specific annual median of seasonal variation in cash flows ($SVCF^R$), sales seasonality (ψ), median operating cash cycle (δ), median days receivable α, median days inventory (γ_1), and median days payables (β), respectively. The variables are defined in the notes to Table 6.

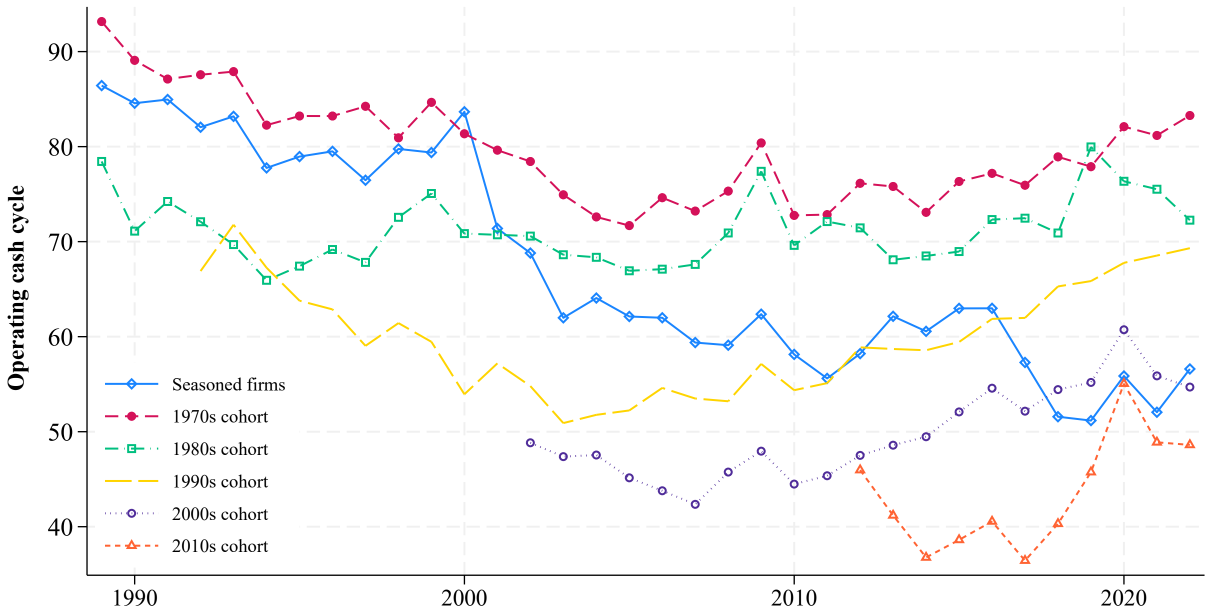
Panel A: Seasonal variation in cash flows by listing cohort



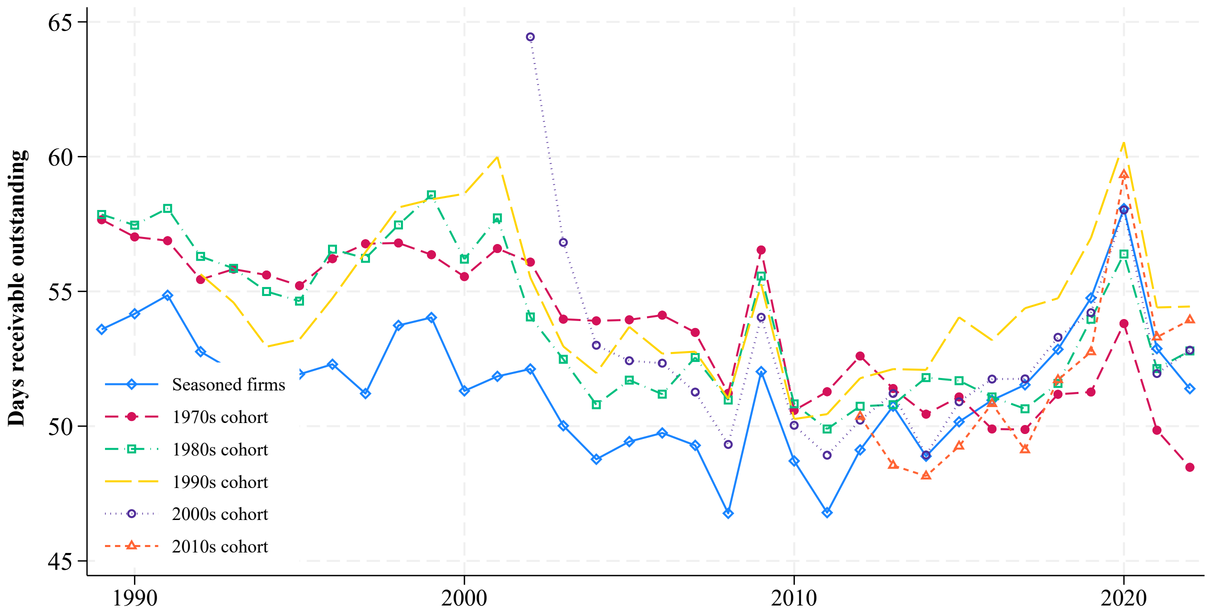
Panel B: Sales seasonality by listing cohort



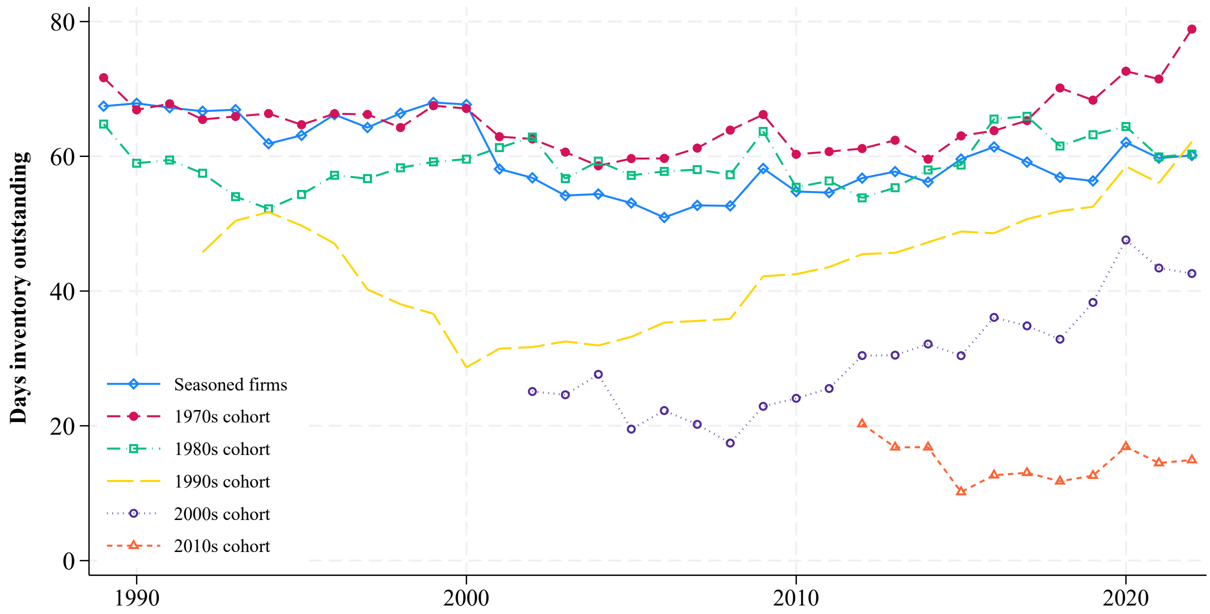
Panel C: Operating cash cycle by listing cohort



Panel D: Days receivable outstanding by listing cohort



Panel E: Days inventory outstanding by listing cohort



Panel F: Days payable outstanding by listing cohort

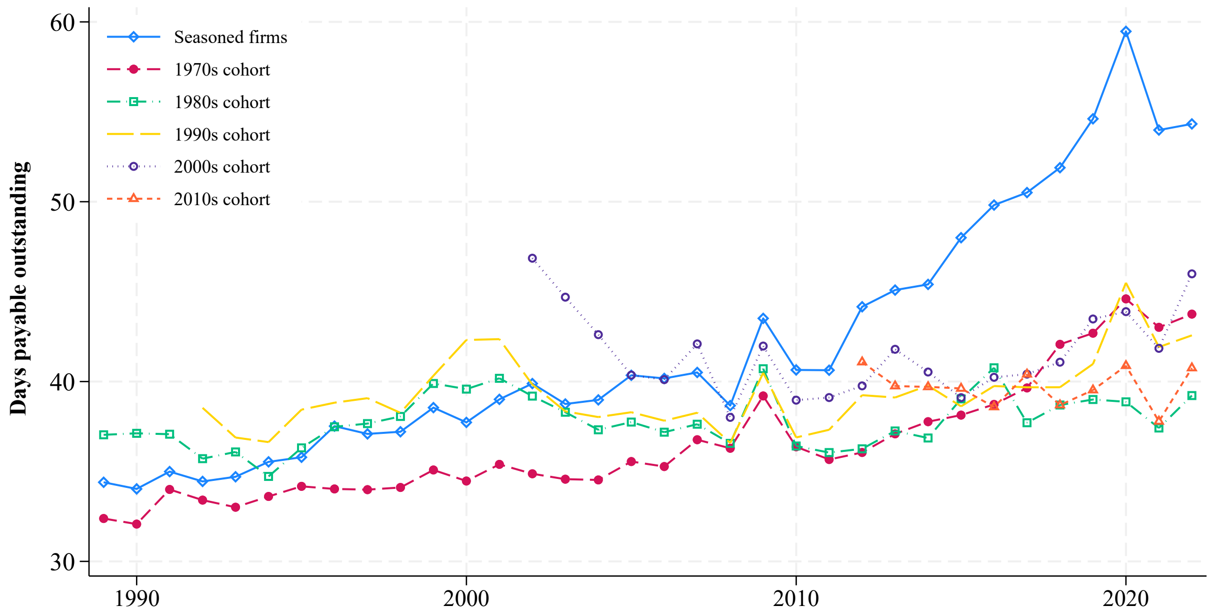


Table 1

Conceptual Predictions Derived from Quarterly Extension of DKW Framework

Panel A: General expressions for expected quarterly cash flows and accruals

	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$
Q1	$(\pi + (\pi - \delta + \gamma_1(1-\pi)(1-\beta))\psi')\mathbb{E}[S_{it-1}]$	$(\delta - \gamma_1(1-\pi)(1-\beta))\psi'\mathbb{E}[S_{it-1}]$
Q2	$\pi\mathbb{E}[S_{it}]$	0
Q3	$(\pi - \gamma_1(1-\pi)(1-\beta)\psi)\mathbb{E}[S_{it}]$	$\gamma_1(1-\pi)(1-\beta)\psi\mathbb{E}[S_{it}]$
Q4	$(\pi + (\pi - \delta + 2\gamma_1(1-\pi)(1-\beta))\psi)\mathbb{E}[S_{it-1}]$	$(\delta - 2\gamma_1(1-\pi)(1-\beta))\psi\mathbb{E}[S_{it-1}]$

Panel B: Expected quarterly cash flows, accruals, and seasonal variation in stylized cases

$\alpha > 0$, $\gamma_1 = 0$, $\beta = 0$:	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$
Q1	$(\pi + (\pi - \alpha)\psi')\mathbb{E}[S_{it-1}]$	$\alpha\psi'\mathbb{E}[S_{it-1}]$
Q2	$\pi\mathbb{E}[S_{it}]$	0
Q3	$\pi\mathbb{E}[S_{it}]$	0
Q4	$(\pi + (\pi - \alpha)\psi)\mathbb{E}[S_{it-1}]$	$\alpha\psi\mathbb{E}[S_{it-1}]$
|Q4–Q1| (seasonal var.)	$(\|\pi - 2\alpha\|)\psi S_0$	$2\alpha\psi S_0$

$\alpha = 0$, $\gamma_1 > 0$, $\beta = 0$:	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$
Q1	$\pi\mathbb{E}[S_{it}]$	0
Q2	$\pi\mathbb{E}[S_{it}]$	0
Q3	$(\pi - \gamma_1(1-\pi)\psi)\mathbb{E}[S_{it}]$	$\gamma_1(1-\pi)\psi\mathbb{E}[S_{it}]$
Q4	$(\pi + (\pi + \gamma_1(1-\pi))\psi)\mathbb{E}[S_{it-1}]$	$-\gamma_1(1-\pi)\psi\mathbb{E}[S_{it-1}]$
|Q4–Q3| (seasonal var.)	$(\pi + 2\gamma_1(1-\pi))\psi S_0$	$2\gamma_1(1-\pi)\psi S_0$

$\alpha = 0$, $\gamma_1 = 0$, $\beta > 0$:	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$
Q1	$(\pi + (\pi + \beta(1-\pi))\psi')\mathbb{E}[S_{it-1}]$	$-\beta(1-\pi)\psi'\mathbb{E}[S_{it-1}]$
Q2	$\pi\mathbb{E}[S_{it}]$	0
Q3	$\pi\mathbb{E}[S_{it}]$	0
Q4	$(\pi + (\pi + \beta(1-\pi))\psi)\mathbb{E}[S_{it-1}]$	$-\beta(1-\pi)\psi\mathbb{E}[S_{it-1}]$
|Q4–Q1| (seasonal var.)	$(\pi + 2\beta(1-\pi))\psi S_0$	$2\beta(1-\pi)\psi S_0$

Panel C: Numerical illustration with $\pi = 0.05$, $\alpha = 0.5$, $\gamma_1 = 0.4$, and $\beta = 0.3$ ($\delta = 0.595$)

	$\psi = 0.00$			$\psi = 0.25$			$\psi = 0.50$		
	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$	Diff.	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$	Diff.	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$	Diff.
Q1	0.05	0.00	0.05	0.12	-0.08	0.20	0.19	-0.15	0.34
Q2	0.05	0.00	0.05	0.05	0.00	0.05	0.04	0.00	0.04
Q3	0.05	0.00	0.05	-0.02	0.06	-0.08	-0.07	0.12	-0.19
Q4	0.05	0.00	0.05	0.04	0.01	0.03	0.04	0.03	0.01
Q3–Q1	0.00	0.00	0.00	-0.14	0.14	-0.28	-0.26	0.26	-0.53

Panel D: Numerical illustration with $\pi = 0.05$, $\alpha = 0.1$, $\gamma_1 = 0.4$, and $\beta = 0.7$ ($\delta = -0.185$)

	$\psi = 0.00$			$\psi = 0.25$			$\psi = 0.50$		
	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$	Diff.	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$	Diff.	$\mathbb{E}[CF_{it}]$	$\mathbb{E}[A_{it}]$	Diff.
Q1	0.05	0.00	0.05	-0.02	0.07	-0.09	-0.09	0.13	-0.22
Q2	0.05	0.00	0.05	0.05	0.00	0.05	0.04	0.00	0.04
Q3	0.05	0.00	0.05	0.02	0.03	-0.01	-0.01	0.05	-0.06
Q4	0.05	0.00	0.05	0.16	-0.10	0.25	0.25	-0.18	0.43
Q4–Q1	0.00	0.00	0.00	0.18	-0.17	0.35	0.34	-0.32	0.66

Notes: Panel A presents expressions for expected quarterly accruals ($\mathbb{E}[A_{it}]$) and cash flows ($\mathbb{E}[CF_{it}]$) based on our extension of the DKW model. The expectations of quarterly accruals are derived from equations (7a)–(7d) with $\mathbb{E}[\varepsilon_{it}]$ and $\mathbb{E}[\Delta\varepsilon_{it}]$ equal to zero. Parameter δ refers to the operating cash cycle defined as $\alpha + \gamma_1(1-\pi) - \beta(1-\pi)$, where α is the fraction of periodic sales that remains uncollected at period-end, γ_1 is the firms' target inventory as a fraction of next period's expected cost of sales, β is the fraction of purchases that remains unpaid at period-end, and π is the profit margin. Parameter ψ is a seasonality factor that determines the difference in sales between Q4 and the sales in Q1 to Q3 in equation (6), $\psi' = \frac{1}{(1+\psi)} - 1$, and $\mathbb{E}[S_{it}]$ ($\mathbb{E}[S_{it-1}]$) refers to the expected value of sales in the current (previous) fiscal quarter. Panel B presents expressions for the expected values of quarterly accruals and cash flows in stylized cases where we assume only one of the three working capital policy parameters (α, γ_1, or β) is nonzero. S_0 refers to the expected value of sales in non-seasonal quarters. The expressions for seasonal variation in accruals and cash flows ("seasonal var.") capture the absolute value of the difference in expected values between the two fiscal quarters in which seasonality induces offsetting variation (Q4 vs. Q1, Q4 vs. Q3, and Q4 vs. Q1, respectively, when we set α, γ_1, and β to nonzero values). Each of the expressions shows how the seasonality factor interacts with the working capital policy parameter in generating seasonal variation in cash flows. In Panels C and D, we present two numerical illustrations of the expectations presented in Panel A for different levels of seasonality (ψ): Panel C presents an example of a hypothetical firm with a positive operating cash cycle, while Panel D presents an example of a hypothetical firm with a negative operating cash cycle. We set the expected value of annual sales equal to a constant to ensure that seasonality only affects the distribution of sales across the quarters. With annual sales set equal equal to 4, expected sales in Q4 equal $(1+\psi)\mathbb{E}[S_{it-1}]$, as per equation (6), and expected sales in Q1 to Q3 equal $1 - \frac{\psi}{(4+\psi)}$.

Table 2
Descriptive Statistics

Panel A: Summary Statistics for Main Test Variables

	N	Mean	SD	Min	P25	Median	P75	Max
CFOQ	447,320	0.009	0.058	-0.291	-0.009	0.017	0.039	0.191
ACCQ	447,320	-0.016	0.052	-0.388	-0.033	-0.013	0.005	0.166
WCAQ	447,320	0.004	0.039	-0.165	-0.012	0.003	0.019	0.169
NONWCAQ	447,320	-0.020	0.030	-0.348	-0.024	-0.014	-0.008	0.091
SVCF^R	447,320	41.7	26.2	0.0	20.0	38.0	62.0	99.0
SVCF^{CHSS}	250,784	8.1	3.5	0.0	5.4	8.0	10.8	15.0
ψ (sales seas.)	302,956	0.210	0.240	0.016	0.072	0.131	0.248	1.472
$360 \times \alpha$ (days rec.)	435,180	61.1	50.5	0.0	35.5	53.7	73.7	369.7
$360 \times \gamma_1$ (days inv.)	433,408	59.0	81.2	3.0	24.1	38.6	60.1	603.7
$360 \times \beta$ (days pay.)	433,428	68.6	80.1	0.0	6.5	48.3	98.7	444.8
$360 \times \delta$ (OCC)	429,112	74.1	112.7	-361.4	23.3	62.3	114.2	578.4

Panel B: Estimates of the Quarterly Accrual-Cash Flow Relation

	ACCQ		WCAQ		NONWCAQ	
	β_1	R^2	β_1	R^2	β_1	R^2
Baseline	-0.342	0.150	-0.343	0.265	0.019	0.001
Firm-demeaned CFO	-0.671	0.314	-0.616	0.468	-0.017	0.001
Firm fixed effects	-0.671	0.347	-0.616	0.494	-0.017	0.001
Change variables	-0.932	0.517	-0.843	0.702	-0.046	0.004
Firm-year fixed effects	-0.862	0.509	-0.775	0.655	-0.038	0.004

Panel C: Sales and Cash Flow Activity by Fiscal Quarter

	Fiscal Quarter			
	Q1	Q2	Q3	Q4
Average fraction of annual sales realized	0.232	0.246	0.253	0.268
Indicator for peak sales quarter	0.133	0.178	0.197	0.495
Average CFOQ	-0.001	0.007	0.010	0.019
Indicator for peak cash flow quarter	0.169	0.200	0.251	0.380

Panel D: Relation Between Sales Seasonality and Seasonal Variation in Cash Flows

	Quartile of Sales Seasonality				
	Low	2	3	High	High-Low
Median sales seasonality (ψ)	0.047	0.099	0.176	0.397	0.350
Within-firm-year st. dev. CFOQ	0.022	0.025	0.029	0.044	0.022
SVCF^R	38.2	40.7	43.0	50.8	12.5
SVCF^R for above-median δ	39.8	42.7	45.4	55.3	15.4
SVCF^R for below-median δ	36.8	38.8	40.8	46.5	9.7

Notes: Panel A presents descriptive statistics for key variables. $CFOQ$ is quarterly operating cash flows derived from Compustat variable OANCFY, from which we extract the quarterly values as the changes in year-to-date cash flow statement variables for fiscal quarters 2–4 (Collins and Hribar 2000). The same applies to the other quarterly cash flow statement variables we use to derive quarterly accruals below. $ACCQ$ is quarterly operating accruals, defined as income before extraordinary items minus operating cash flows (IBCY-OANCFY). $WCAQ$ is quarterly working capital accruals, defined as the change in accounts receivable, plus the change in inventory, less the change in accounts payable and taxes payable, plus the net change in other assets and liabilities (-(RECCHY+INVCHY+APALCHY+TXACHY+AOLOCHY)). $NONWCAQ$ refers to non-working capital accruals, defined as the difference between operating accruals and working capital accruals. All accrual and cash flow variables are scaled by average total assets. Variables $SVCF^R$ and $SVCF^{CHSS}$ are measures of seasonal variation in cash flows, defined in the notes to Table 3. ψ is a measure of sales seasonality. We follow Grullon et al. (2020) and estimate for each firm-year the fraction of annual sales realized in each fiscal quarter during the previous three years. We then identify the fiscal quarter with the highest average fraction of annual sales realized in the previous three years. For consistency with the conceptual framework developed in Section 2.2, we compute the measure as the ratio of (a) the average fraction of sales realized in the fiscal quarters with the highest sales fraction to (b) the average fraction of sales realized in the other fiscal quarters, minus one. α refers to days receivable outstanding as a fraction of the year, calculated as the ratio of average accounts receivable (RECT) to sales (SALE), γ_1 refers to days inventory outstanding as a fraction of the year, calculated as the ratio of average inventory (INVT) to costs of goods sold (COGS), and β refers to days payable outstanding as a fraction of the year, calculated as the ratio of average accounts payable (AP) to costs of goods sold plus change in inventory. δ captures the operating cash cycle (OCC), defined as $\alpha + \gamma_1 - \beta$. Panel B presents estimates of regressions of accruals on cash flows. The label "Baseline" refers to basic regressions of accruals on cash flows, "Firm-demeaned CFO" refers to using firm-demeaned operating cash flows as the independent variable, "Firm fixed effects" refers to within-firm estimation, "Change variables" refers to the use of change variables, and "Firm-year fixed effects" refers to within-firm-year estimation. For the fixed effects estimations, R^2 refers to the within-R^2. Panel C presents statistics on firm activity across fiscal quarters. Panel D presents summary statistics for firm-years sorted on sales seasonality (ψ). For the above- and below-median splits, we compute the median of δ annually. All continuous variables are winsorized at the 1^{st} and 99^{th} percentile by fiscal year.

Table 3

Accrual-Cash Flow Relation Split by Seasonal Variation in Cash Flows

Panel A: Splits by Within-Year Differences in Cash Flow Ranks

	Quartile of Seasonal Variation in Cash Flows (SVCF^R)				
Dep. Var.: ACCQ	Low	2	3	High	High-Low
CFOQ	-0.231	-0.538	-0.701	-0.823	-0.593
	(-11.44)	(-19.34)	(-38.95)	(-62.30)	(-38.84)
Adj. R^2	0.036	0.154	0.309	0.626	0.590
N	115,824	110,476	111,332	109,688	
Dep. Var.: WCAQ	Low	2	3	High	High-Low
CFOQ	-0.268	-0.523	-0.660	-0.731	-0.463
	(-21.49)	(-24.80)	(-46.00)	(-50.79)	(-52.32)
Adj. R^2	0.122	0.322	0.470	0.686	0.564
N	115,824	110,476	111,332	109,688	

Panel B: Splits by Alternative Measure of Cash Flow Seasonality

	Quartile of Seasonal Variation in Cash Flows (SVCF^{CHSS})				
Dep. Var.: ACCQ	Low	2	3	High	High-Low
CFOQ	-0.452	-0.586	-0.727	-0.887	-0.435
	(-19.59)	(-28.04)	(-43.36)	(-62.33)	(-23.82)
Adj. R^2	0.161	0.247	0.404	0.710	0.549
N	63,756	63,020	62,552	61,456	
Dep. Var.: WCAQ	Low	2	3	High	High-Low
CFOQ	-0.425	-0.543	-0.657	-0.794	-0.369
	(-23.39)	(-29.29)	(-50.14)	(-70.62)	(-25.31)
Adj. R^2	0.300	0.398	0.537	0.777	0.477
N	63,756	63,020	62,552	61,456	

Notes: This table presents regression estimates of the quarterly accrual-cash flow relation for groups of observations split by two measures of seasonal variation in cash flows ($SVCF^R$ and $SVCF^{CHSS}$). For $SVCF^R$ in Panel A, we annually rank quarterly operating cash flows in percentiles and compute the difference between the highest and lowest ranks within each firm-year. This measure captures the within-fiscal-year variation in operating cash flows. For $SVCF^{CHSS}$ in Panel B, we follow Chang et al. (2017) by applying their measurement of earnings seasonality to identify seasonal variation in operating cash flows. For each firm-quarter, we identify the string of 20 firm-quarters from quarter $q-23$ through quarter $q-4$ and rank these from low (rank 1) to high (rank 20) in terms of operating cash flows. For each fiscal quarter, we then compute the average rank of the previous five same fiscal-quarters. We separately report regression estimates for observations that fall into each annual quartile of seasonal variation in cash flows. The accrual and cash flow variables are defined in the notes to Table 2 and demeaned by firm. t-statistics are reported in parentheses and are based on standard errors clustered by firm and by year. The variables are winsorized at the 1$^{\text{st}}$ and 99$^{\text{th}}$ percentile each fiscal year.

Table 4

Conditioning on Non-Seasonal Variation in Cash Flows

Panel A: Relation Between Operating Accruals and Operating Cash Flows

		Quartile of Seasonal Variation in Cash Flows (SVCF^R)				
CFVOL quartile		Low	2	3	High	High-Low
Low	Coeff.	-0.147	-0.384	-0.571	-0.720	-0.573
	R^2	0.017	0.079	0.176	0.443	0.426
2	Coeff.	-0.230	-0.545	-0.689	-0.841	-0.611
	R^2	0.032	0.140	0.260	0.616	0.584
3	Coeff.	-0.289	-0.613	-0.730	-0.863	-0.574
	R^2	0.050	0.190	0.352	0.683	0.633
High	Coeff.	-0.335	-0.672	-0.778	-0.827	-0.492
	R^2	0.072	0.289	0.471	0.675	0.603
High-Low	Coeff.	-0.188	-0.288	-0.207	-0.107	
	R^2	0.055	0.211	0.295	0.232	

Panel B: Relation Between Working Capital Accruals and Operating Cash Flows

		Quartile of Seasonal Variation in Cash Flows (SVCF^R)				
CFVOL quartile		Low	2	3	High	High-Low
Low	Coeff.	-0.195	-0.378	-0.541	-0.655	-0.460
	R^2	0.082	0.223	0.363	0.565	0.483
2	Coeff.	-0.281	-0.510	-0.641	-0.769	-0.488
	R^2	0.139	0.315	0.450	0.701	0.562
3	Coeff.	-0.328	-0.586	-0.688	-0.793	-0.465
	R^2	0.165	0.368	0.508	0.753	0.588
High	Coeff.	-0.354	-0.642	-0.738	-0.700	-0.346
	R^2	0.165	0.440	0.599	0.701	0.536
High-Low	Coeff.	-0.159	-0.264	-0.197	-0.045	
	R^2	0.083	0.217	0.236	0.136	

Notes: This table presents estimates of the quarterly accrual-cash flow relation based on regressions of quarterly accruals on contemporaneous quarterly cash flows, conditional on both seasonal variation in cash flows ($SVCF^R$) and a similar measure constructed based on within-firm-year variation in non-seasonal operating cash flows ($CFVOL$). For $SVCF^R$, we annually rank $CFOQ$ in percentiles and compute the difference between the highest and lowest ranks within each firm-year. For $CFVOL$, we annually rank seasonally-differenced operating cash flows in percentiles and compute the difference between the highest and lowest ranks within each firm-year. We first split the sample annually by quartiles of $CFVOL$. Next, within each quartile, we split the sample annually by quartiles of $SVCF^R$. Panel A presents regression estimates when using operating accruals as dependent variable and Panel B shows regression estimates when using working capital accruals as dependent variable. The accrual and cash flow variables are defined in the notes to Table 2 and demeaned by firm. The variables are winsorized at the 1st and 99th percentile each fiscal year.

Table 5

Conditioning on Serial Correlation in Cash Flow Changes (Frankel and Sun 2018)

Panel A: Relation Between Operating Accruals and Operating Cash Flows

		Quartile of Seasonal Variation in Cash Flows (SVCF^R)				
ΔOCFSC quartile		Low	2	3	High	High-Low
Low	Coeff.	-0.172	-0.425	-0.552	-0.712	-0.540
	R^2	0.019	0.082	0.170	0.485	0.466
2	Coeff.	-0.268	-0.578	-0.726	-0.830	-0.562
	R^2	0.045	0.180	0.334	0.631	0.587
3	Coeff.	-0.412	-0.651	-0.793	-0.894	-0.482
	R^2	0.105	0.235	0.414	0.725	0.620
High	Coeff.	-0.477	-0.680	-0.790	-0.917	-0.440
	R^2	0.168	0.298	0.456	0.755	0.587
High-Low	Coeff.	-0.305	-0.255	-0.238	-0.205	
	R^2	0.149	0.216	0.286	0.270	

Panel B: Relation Between Working Capital Accruals and Operating Cash Flows

		Quartile of Seasonal Variation in Cash Flows (SVCF^R)				
ΔOCFSC quartile		Low	2	3	High	High-Low
Low	Coeff.	-0.226	-0.419	-0.540	-0.619	-0.393
	R^2	0.089	0.232	0.357	0.563	0.474
2	Coeff.	-0.303	-0.538	-0.676	-0.736	-0.433
	R^2	0.145	0.341	0.483	0.694	0.549
3	Coeff.	-0.386	-0.615	-0.740	-0.803	-0.417
	R^2	0.204	0.383	0.548	0.769	0.565
High	Coeff.	-0.449	-0.647	-0.741	-0.838	-0.389
	R^2	0.270	0.431	0.564	0.789	0.519
High-Low	Coeff.	-0.223	-0.228	-0.201	-0.219	
	R^2	0.181	0.199	0.207	0.226	

Notes: This table presents estimates of the quarterly accrual-cash flow relation based on regressions of quarterly accruals on contemporaneous quarterly cash flows, conditional on both seasonal variation in cash flows ($SVCF^R$) and a proxy for the negative serial correlation in cash flow changes following Frankel and Sun (2018). $\Delta OCFSC$ is constructed as the average of (a) the reverse percentile rank of average profit margin over the last three years and (b) the percentile rank of average annual operating cash cycle over the last three years. For $SVCF^R$, we annually rank $CFOQ$ in percentiles and compute the difference between the highest and lowest ranks within each firm-year. We first split the sample annually by quartiles of $\Delta OCFSC$. Next, within each quartile, we split the sample annually by quartiles of $SVCF^R$. The accrual and cash flow variables are defined in the notes to Table 2 and demeaned by firm. The variables are winsorized at the 1st and 99th percentile each fiscal year.

Table 6

Time Trends in Seasonal Cash Flow Variation and its Determinants

Year	SVCF^{R}	ψ	$360 \times \delta$	$360 \times \alpha$	$360 \times \gamma_1$	$360 \times \beta$	SVCF^{EXP}
1989	49.0	0.141	84.6	56.2	67.4	35.4	0.131
1990	50.0	0.152	79.6	56.4	63.9	35.0	0.137
1991	50.0	0.144	79.7	57.5	63.3	35.8	0.129
1992	47.0	0.139	76.4	54.9	60.6	35.1	0.118
1993	45.0	0.140	75.8	54.6	58.9	35.1	0.116
1994	45.0	0.156	72.2	53.8	57.4	35.2	0.125
1995	46.0	0.147	70.4	53.9	57.6	36.5	0.117
1996	44.0	0.140	70.2	54.9	56.8	37.5	0.110
1997	42.0	0.137	67.3	55.7	53.2	37.6	0.104
1998	42.0	0.130	68.8	57.1	51.1	37.4	0.098
1999	41.0	0.141	67.3	57.7	50.7	39.2	0.104
2000	36.0	0.121	62.7	57.0	44.6	39.8	0.081
2001	36.0	0.076	62.2	59.0	43.8	41.0	0.051
2002	37.0	0.121	60.2	55.8	45.2	39.6	0.080
2003	39.0	0.125	57.4	53.1	43.6	38.5	0.078
2004	37.0	0.123	56.8	51.7	43.0	38.0	0.075
2005	39.0	0.140	55.5	52.5	41.8	38.3	0.084
2006	38.0	0.125	56.7	52.0	41.8	38.1	0.075
2007	37.0	0.133	56.1	52.2	41.9	39.2	0.078
2008	39.0	0.063	56.4	50.2	39.5	37.2	0.036
2009	41.0	0.111	59.5	54.3	46.3	41.3	0.071
2010	40.0	0.110	54.4	50.1	43.6	37.9	0.066
2011	38.0	0.107	55.1	49.6	44.5	37.9	0.064
2012	38.0	0.101	57.2	50.9	45.4	39.5	0.062
2013	39.0	0.118	56.4	51.1	44.5	39.9	0.071
2014	35.0	0.119	54.9	50.0	43.0	39.8	0.068
2015	35.0	0.128	55.2	51.2	41.8	39.9	0.073
2016	33.0	0.104	57.3	51.5	42.5	40.7	0.060
2017	32.0	0.106	55.1	51.3	40.3	40.9	0.058
2018	29.0	0.096	55.5	52.5	39.8	41.3	0.053
2019	30.0	0.110	57.3	54.1	40.8	42.6	0.062
2020	29.0	0.108	62.2	58.5	46.1	44.1	0.071
2021	22.0	0.084	57.9	52.6	43.1	41.2	0.050
2022	21.0	0.069	58.5	53.2	41.6	42.7	0.039
Time trend	-63.0	-0.167	-71.9	-13.7	-66.7	20.4	-0.242
	(-7.76)	(-7.28)	(-4.34)	(-2.38)	(-4.88)	(8.72)	(-8.02)
Adj. R^2	0.809	0.515	0.685	0.267	0.691	0.734	0.761

Notes: This table presents annual summary statistics for variables hypothesized to be associated with the quarterly accrual-cash flow relation. The first column presents the annual median of $SVCF^R$, which is obtained by annually ranking quarterly operating cash flows in percentiles and then computing the difference between the highest and lowest ranks within each firm-year. The subsequent columns present annual estimates of average sales seasonality (ψ) and median annual estimates of the operating cash cycle (δ), days receivables outstanding (α), target inventory rate (γ_1), and days payable outstanding (β). To measure average sales seasonality (ψ), we follow Grullon et al. (2020) and estimate for each firm-year the fraction of annual sales realized in each fiscal quarter during the previous three years. We subsequently rank the current-year fiscal quarters based on the estimated fractions of sales realized in prior years. The annual estimate of ψ is obtained as the ratio of (a) the average fraction of sales realized in firms' predicted peak quarter to (b) the average fraction of sales realized in firms' non-peak quarters, minus one. δ is defined as the sum of α and γ_1 less β. α is estimated for each firm-quarter as the ratio of average accounts receivable (RECTQ) to sales (SALEQ), γ_1 is estimated for each firm-quarter as the ratio of average inventory (INVTQ) to costs of goods sold (COGSQ), and β is estimated as the ratio of average accounts payable (APQ) to costs of goods sold plus change in inventory. For $SVCF^{EXP}$, we use the expressions for expected quarterly cash flows in Table 1 to obtain four quarterly expected values of cash flows for each sample year based on the annual estimates of ψ, α, γ_1, and β, and π set to 0.05 (DKW). Our annual estimate of $SVCF^{EXP}$ is then derived based on the difference between the highest and lowest of the four annual expected cash flow values. The bottom rows report coefficients and Adjusted R^2s obtained from regressing the annual summary statistics on a time trend variable that is measured as the number of years since 1989 divided by 100. t-statistics are reported in parentheses and are based on Newey-West standard errors that account for serial correlation of up to three lags.

Table 7

Factors Associated with the Time Trend in the Quarterly Accrual-Cash Flow Relation

Panel A: Correlations between annual estimates

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. WCAQ R^2s	1.000								
2. ΔWCAQ R^2s	0.888	1.000							
3. SVCF^R	0.928	0.812	1.000						
4. SVCF^{EXP}	0.888	0.698	0.839	1.000					
5. ψ	0.781	0.688	0.742	0.904	1.000				
6. δ	0.777	0.522	0.720	0.886	0.612	1.000			
7. α	0.219	-0.140	0.280	0.495	0.298	0.649	1.000		
8. γ_1	0.861	0.639	0.789	0.926	0.689	0.973	0.524	1.000	
9. β	-0.882	-0.807	-0.871	-0.772	-0.653	-0.680	-0.066	-0.742	1.000

Panel B: Explaining R^2s from Working Capital Accruals Regressions (Firm-Demeaned)

Dep. Variable:	WCAQ R^2s							
Control Var.:		SVCF^R	SVCF^{EXP}	ψ	δ	α	γ_1	β
Time	-0.805	-0.097	-0.312	-0.571	-0.632	-0.952	-0.421	-0.348
	(-6.58)	(-0.42)	(-1.52)	(-3.86)	(-3.09)	(-8.04)	(-1.58)	(-1.39)
Control Var.		0.011	2.038	1.399	0.002	-0.011	0.006	-0.022
		(3.28)	(3.23)	(3.37)	(1.09)	(-1.81)	(2.03)	(-2.14)
Adj. R^2	0.721	0.854	0.803	0.774	0.728	0.784	0.791	0.802
N	34	34	34	34	34	34	34	34

Panel C: Explaining R^2s from Working Capital Accruals Regressions (Change Variables)

Dep. Variable:	ΔWCAQ R^2s							
Control Var.:		SVCF^R	SVCF^{EXP}	ψ	δ	α	γ_1	β
Time	-0.314	0.272	-0.035	-0.137	-0.310	-0.478	-0.153	0.125
	(-3.18)	(1.80)	(-0.14)	(-0.92)	(-1.62)	(-6.53)	(-0.62)	(0.78)
Control Var.		0.009	1.155	1.063	0.000	-0.012	0.002	-0.021
		(4.57)	(1.42)	(1.83)	(0.03)	(-3.36)	(0.90)	(-3.49)
Adj. R^2	0.373	0.696	0.456	0.478	0.352	0.664	0.401	0.647
N	34	34	34	34	34	34	34	34

Notes: This table presents tests on the determinants of the trend in the quarterly accrual-cash flow relation for firm-demeaned quarterly variables (Panels A and B) and changes in quarterly variables (Panels C and D). We estimate time-series regressions for which the dependent variable is the adjusted R^2 from annual regressions of quarterly accruals on contemporaneous quarterly cash flows, where accruals are measured based on operating accruals (Panels A and C) or working capital accruals (Panels B and D). *Time* is a categorical variable equal to the number of years since 1989 divided by 100. Except for the first estimation in each panel, we include an additional explanatory variable ("Control Variable") to examine the effect of controlling for the trend in this variable on the trend in the accrual cash flow relation. The control variables are listed in the header of each regression column. All variables are defined in the notes to Table 6. t-statistics are reported in parentheses and are based on Newey-West standard errors that account for serial correlation of up to three lags. Intercepts are estimated but not tabulated.

Table 8

Seasonal Variation and the Predictive Ability of Cash Flows and Accruals

Panel A: Regressions of future operating cash flows on current cash flows and accruals

	SVCF^{CHSS} Quartile			
Dep. Var.: FUTCFO	Low	2	3	High
CFOQ	2.553	2.112	1.422	0.521
	(27.38)	(18.49)	(20.06)	(13.03)
Adj. R^2 (a)	0.506	0.386	0.234	0.074
N	55,928	55,356	54,852	54,052
Dep. Var.: FUTCFO	Low	2	3	High
CFOQ	3.094	2.951	2.533	1.853
	(40.51)	(29.31)	(37.53)	(25.44)
WCAQ	2.332	2.328	2.114	1.822
	(31.62)	(26.78)	(29.20)	(22.82)
Adj. R^2 (b)	0.623	0.552	0.417	0.257
N	55,928	55,356	54,852	54,052
Relative R^2 (b) / (a)	1.231	1.430	1.782	3.497

Panel B: Regressions of future operating earnings on current cash flows and accruals

	SVCF^{CHSS} Quartile			
Dep. Var.: FUTOE	Low	2	3	High
CFOQ	2.636	2.129	1.401	0.516
	(30.11)	(19.57)	(19.83)	(12.50)
Adj. R^2 (c)	0.533	0.396	0.237	0.081
N	55,928	55,356	54,852	54,052
Dep. Var.: FUTOE	Low	Low	Low	Low
CFOQ	3.238	3.067	2.718	2.142
	(48.76)	(35.08)	(40.57)	(28.66)
WCAQ	2.594	2.600	2.505	2.223
	(38.59)	(32.66)	(31.51)	(27.93)
Adj. R^2 (d)	0.675	0.605	0.503	0.385
N	55,928	55,356	54,852	54,052
Relative R^2 (d) / (c)	1.266	1.528	2.122	4.777

Notes: This table presents tests of the predictive ability of current-quarter operating cash flows ($CFOQ$) for future operating cash flows ($FUTCFO$) and future operating earnings ($FUTOE$), before and after controlling for working capital accruals ($WCAQ$). $FUTCFO$ ($FUTOE$) is defined as the sum of operating cash flows (operating earnings) in the next four quarters, scaled by average total assets in the current quarter. Operating cash flows ($CFOQ$) and working capital accruals ($WCAQ$) are defined as in the notes to Table 2. Operating earnings (OE) equals the sum of operating cash flows and working capital accruals following Dechow and Dichev (2002) and Ball and Nikolaev (2022), scaled by average total assets. Regressions are estimated for annual quartiles formed based on seasonal variation in cash flows, identified by variable $SVCF^{CHSS}$ as defined in the notes to Table 3. The variables are winsorized at the 1^{st} and 99^{th} percentile each fiscal year.