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Working capital dynamics

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Abstract
We assess short-run variations in firms' working capital allocations in light of finding persistence in these allocations in the recent literature. Specifically, we study the extent and speed of mean reversion in firms' working capital allocations to evaluate if firms tend to follow firm-specific value-maximizing optimal allocations. Furthermore, we assess whether and to what extent firms trade off their working capital to accommodate capital expenditure shocks. While we find frequent inter-temporal offsetting movements in working capital allocations in the short run, we do not find evidence of a systematic trade-off between working capital and fixed asset investments.

JEL Classification: **G30, G31, G32**

Keywords
Asset allocation, investment trade-off, mean reversion, short-run variations, working capital

1. Introduction

Firms' working capital acts as their lifeblood in day-to-day operations and, hence, is an important source of value for these business entities.[1] Past literature and practitioners (see, for example, Aktas et al., 2015; Brennan et al., 1988; Chi and Tang, 2006; Corsten and Gruen, 2004; Ek and Guerin, 2011; Guay and Sidhu, 2001; Hill et al., 2010, 2012; Love and Zaidi, 2010) argue that while higher working capital allocations compared to the industry norms imply locking-in vital cash, lesser allocations may negatively affect firms' sales. Similarly, while adequate working capital may improve customer relations (e.g. by extending credit and allowing customers to assess product quality before paying) and enable firms to deal with contingencies (such as stock-outs in inventories), additional resources into working capital may require costly financing. Such a trade-off in the past literature suggests that firms could enhance their values while conforming to their respective industry standards of working capital allocations.

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Similarly, given that components of working capital—namely, accounts receivable, inventories, and accounts payable—are turned over several times in a year, working capital allocations are deemed a flexible source of financing in the past literature. Accordingly, firms may swiftly modulate their allocations to cater to firms' specific objectives. For example, working capital allocations can be modulated to absorb exogenous shocks to firms' capital expenditure schedule (see, for example, Ben-Nasr, 2016; Ding et al., 2013; Fazzari and Petersen, 1993). It is argued that when firms are not likely to generate enough operating cash, they may squeeze their working capital allocations, at least temporarily, to generate the incremental cash flows needed for capital expenditures.

Past literature, therefore, suggests that working capital acts as a tactical tool for firms' value creation. Recent research, however, disagrees with this view and rather suggests a much broader strategic role for firms' working capital. Contrary to the past literature, Chauhan (2019) finds that firms' relative working capital allocations within the industry remain persistent for several years suggesting that these allocations are driven primarily by firm-specific strategic motives rather than normative concerns over improving inter-temporal cash flows and sales.

Persistent working capital allocations imply that firms may not be actively conforming to industry mean or median working capital allocations, at least systematically over the long run. Nevertheless, nothing stops the firms from pursuing a firm-specific optimal allocation driven by their strategic concerns. Furthermore, at least in the long run, firms may not be systematically using working capital to absorb exogenous shocks to their capital expenditure schedule.

Although persistent working capital allocations imply that the magnitude of deviations from the long-run mean working capital allocations is relatively insignificant to cause any systematic chase toward industry median allocations, we still do not know the nature of these deviations. For example, although it appears that variations in working capital allocations from their long-run means, if any, would eventually die out, it is still not evident whether they die out sooner or later. We may envisage a long-run mean working capital allocation even if deviations revert to their means relatively infrequently. Furthermore, if such reversion is asymmetric toward and away from the industry mean allocations (e.g. if firms stay deviated from their means longer while being closer to industry mean and vice versa), we may still infer conformance to industry mean allocations, at least in the shorter run. Furthermore, if the deviations from the long-run means die out relatively later, firms could still make an active trade-off between working capital and capital expenditure, at least in the short run.

To illustrate the short-run variation in working capital allocations, Figure 1 plots working capital allocations (the ratio of net operating working capital to average total assets) for two firms (WSI Industries Inc. and Arts-Way Manufacturing Inc.) in the machinery industry along with the industry median between the years 1984 and 2014. It appears that working capital allocations for the two firms remain range bound and never cross the industry median on the other side in a long span of more than 30 years. However, even though the allocations for the two firms remain range bound in the long run (and hence persist relatively within their industry), they vary quite frequently around their long-run means in the short run.

Motivated by such matters of empirical inquiry, in this article, we investigate the short-run variations in working capital allocations. Specifically, first, we evaluate the extent and speed of mean reversion in firms' working capital allocations. Second, we assess whether and to what extent firms trade off working capital to accommodate capital expenditure shocks.

Our findings suggest frequent inter-temporal offsetting movements in working capital allocations in the short run. Resorting to a partial-adjustment dynamic framework, consistent with Baños-Caballero et al. (2010, 2013), we also find rapid mean reversion such that firms typically retrace more than two-thirds of their deviations from the mean in just about a year. Thus, while there may

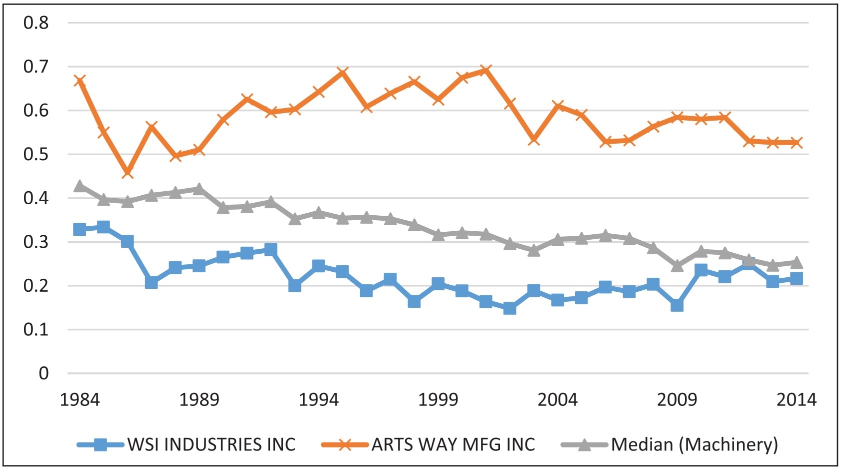

Figure 1. Illustrating variations in working capital allocations in the long as well as the short run.
Figure 1 plots the ratio of net operating working capital to average total assets for two firms (WSI Industries Inc. and Arts-Way Manufacturing Inc.) in the machinery industry in the United States along with the industry median between the years 1984 and 2014.

not be any systematic chase for an industry-wide optimal allocation, consistent with other firm-level corporate policies, firms actively tend to pursue their firm-specific optimal allocation.

Although an active trade-off between working capital and capital expenditures is not ex ante supported by rapid mean reversion in working capital allocations, we formally evaluate the degree of such trade-off. We find that at least a part of the findings in the past literature regarding such trade-off could be due to the inordinate heterogeneity introduced by the sample firms when their investments are not comparable to each other. We overcome these measurement issues and identify a general relationship between working capital and fixed asset investments.

We do not find evidence of a systematic trade-off between working capital and fixed asset investments. On the contrary, we find that these two investments relate positively, suggesting that such investments do not generally compete with each other. Firms making more of fixed asset investments are also making more working capital investments as a proportion of their initial endowments of long-term assets and working capital, respectively. Interestingly, when these two investments are positively correlated, the relative allocations of working capital and fixed asset investments with respect to the firms' total assets would remain largely stagnant. Complementarity in the two investments, therefore, is consistent with the systematic persistence in working capital allocations found in Chauhan (2019).

The remainder of this article is organized as follows. Section 2 presents the background literature. Section 3 describes the data and provides summary statistics. Section 4 assesses the extent of short-run variations in working capital allocations and identifies the speed of mean reversion. Section 5 explores the trade-off between working capital and fixed investments. Section 6 concludes the article.

2. Background literature

Several past studies suggest tactical value creation through active management of firms' working capital (see, for example, Aktas et al., 2015; Baños-Caballero et al., 2014; Ben-Nasr, 2016; Cunat, 2007; Ek and Guerin, 2011; Frankel et al., 2017). According to these studies, working capital is a relatively flexible asset that can be easily liquidated to provide much needed inter-temporal cash flows to the firms. Similarly, the allocations can be readily stretched to incentivize additional sales through new customers. In other words, working capital allocations can be swiftly modulated to achieve the desired operational efficiency. However, Chauhan (2019) shows that such modulations are absent in the cross-section of the data available for the firms in the United States.

Chauhan (2019) finds that firms' relative working capital allocations, while being quite different within and across industries, persist for long periods, often exceeding several years. Even when firms deviate from their long-run mean allocations, these deviations are not quite enough to make serious transitions within the industry. Thus, firms with low and high working capital allocations tend to co-exist without much change in their relative rankings for years. These findings are consistent with the idea of firms' "permanent working capital" put forth by Nunn (1981).

Past literature also suggests working capital acting as an inter-temporal buffer to accommodate unexpected shocks in capital expenditures and hence smoothen its course. Ben-Nasr (2016), Ding et al. (2013), and Fazzari and Petersen (1993) suggest that firms tend to absorb exogenous shocks in their capital expenditure schedules by varying their working capital investments. The authors show that working capital investments are negatively related to capital expenditures. Furthermore, such a trade-off is more prominent for firms facing financial constraints. Importantly, however, persistence in working capital allocations is contrary to the idea of such an active trade-off between working capital and fixed asset investments.

3. Data and summary statistics

The data consist of annual financial records of all available nonfinancial US firms (excluding utilities and real estate sector firms) in Compustat during the period from 1984 through 2014 (both inclusive).[2] Excluded are firm-year observations with any missing values of any relevant variable in univariate and multivariate analyses. Further exclusion involves observations with annual sales less than US$10 million, net fixed assets and total debt exceeding total assets, negative debt-to-total asset ratio, negative operating income before depreciation, and negative investments in fixed assets in a year. We winsorize these variables at their one percentile tails at both ends.

The final dataset consisted of (1) a full sample of 9582 firms, (2) a constant sample of 228 firms surviving throughout the period of analysis, (3) sample of firms having data on working capital for at least 5 (6304 firms) and 15 years (1957 firms). Appendix 1 provides the measurements and definitions of relevant variables of interest. Appendix 2 shows the summary statistics for these variables for the full and constant samples of firms. Appendix 3 reports pairwise correlations for all the variables of interest.

4. Short-run variations in working capital allocations

While exploring determinants of firms' relative working capital allocations, Chauhan (2019) finds a dominant firm fixed effect suggesting persistence in these allocations in the long run.[3] Although such persistence rules out any industry-wide optimal allocation, firms may be actively pursuing their firm-specific allocations. The relative contribution of the firm fixed effect would remain dominant in the long run even if working capital allocations (1) remain passive throughout, (2) persist for some time around both sides of their time-invariant means, or (3) frequently oscillate around these mean allocations. Thus, it is not evident whether working capital allocations are truly time invariant or frequently vary around their means in the short run. Nevertheless, persistent working capital allocations imply that deviations, if any, from their long-run means would eventually die out. Depending on the speed and frequency of mean reversion, we can infer if firms would be actively pursuing their firm-specific allocations and whether working capital investments can be set to trade off capital expenditures. In this section, we investigate the dynamic nature of persistence in working capital allocations by studying these variations in the short run.

4.1. Dynamic nature of persistence

We take a closer look at the inter-temporal movements in the relative working capital allocations to identify whether these allocations are also time invariant in the short run. If the observed persistence in working capital allocations is due to their truly passive nature or their persistence for some time around their means, we expect a strong serial correlation among consequent allocations.[4] However, if these allocations are frequently oscillating around a mean, the serial correlation would be modest at best.

We test for these two competing possibilities by estimating the effect of serial correlation in the error term, possibly induced due to the strong persistence of the working capital allocations in the long run. Specifically, we focus on the following system of equations using the fixed-effects model that allows for autoregressive disturbances

$$NWCR_{i,t} = \alpha + \beta_j \cdot X(fs)_{i,t-1} + \eta_i + \lambda_t + u_{i,t} \quad (1)$$

$$u_{i,t} = \rho \cdot u_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

where, as in Chauhan (2019), $NWCR_{i,t}$ represents the firms' relative working capital allocations measured as the ratio of net operating working capital to total net assets scaled by the median of this ratio for respective industries in a given year.[5] Net operating working capital is calculated as accounts receivable plus inventories minus accounts payable, and total net assets as the difference between total assets and accounts payable.[6] Scaling or adjusting working capital allocations by their industry median rather than using an industry fixed effect enables simultaneous control for unobserved heterogeneity at the firm and industry levels in equation (1). Such adjustment is also important given that industry median working capital allocations differ significantly across industries (see, for example, Filbeck and Krueger, 2005; Hawawini et al., 1986; Weinraub and Visscher, 1998) and such differences persist for long (Chauhan, 2019).

$X(fs)_{i,t-1}$ are the lagged values of the set of firm-specific control variables described in Appendix 1. We have used lagged values of all the control variables to alleviate any endogeneity concerns in the estimation. η_i represents time-invariant firm fixed effects and $u_{i,t}$ represents serially correlated error terms, which are assumed to be stationary and autoregressive of order one; ρ is the autoregressive or serial correlation coefficient of interest; $\varepsilon_{i,t}$ represents the stochastic error term, which is uncorrelated but possibly heteroscedastic. We use cluster-robust standard errors, clustered at the firm level, to adjust for the possible heteroscedasticity. Importantly, we observe the serial correlation of order one to focus on the consequent movement in the firms' working capital allocations.

The results shown in Table 1 suggest that while the serial correlation coefficient is 0.20 for the full sample, it is 0.32 for the constant sample of firms. The higher coefficient for the latter sample is probably due to the greater number of observations per firm, leading to a more homogeneous sample. However, since these coefficients are bounded well below unity, the autoregressive effect, per se, is quite small in magnitude. Low serial correlation implies that consequent working capital

Table 1. Effect of serial correlation in the error term.

	Full sample			Constant sample		
	1			2		
	Coeff.	*t* stat.	Eco. significance	Coeff.	*t* stat.	Eco. significance
SIZE	0.028	1.170	0.063	0.001	0.020	0.002
TAN	−1.272***	−9.500	−0.289	−0.690**	−1.800	−0.137
LEV	−0.106	−1.170	−0.019	0.646***	2.340	0.084
AGE	0.251***	2.700	0.167	−0.974	−0.260	−0.611
RND	0.104	0.350	0.008	1.837	1.170	0.065
RSK	0.005	0.160	0.002	−0.094	−0.710	−0.018
CASH	−1.126***	−10.210	−0.191	−0.195	−0.530	−0.018
SV	0.033***	1.990	0.040	0.122***	4.530	0.227
SG	0.038*	1.640	0.017	−0.233***	−2.230	−0.050
ALTZ	0.016*	1.390	0.042	0.109	1.200	0.108
STA	0.245***	7.570	0.200	0.291***	2.190	0.206
MSHR	−4.547***	−4.250	−0.115	1.332	0.470	0.049
PRF	0.445***	4.750	0.089	0.710	1.120	0.050
CPX	−0.118	−0.710	−0.010	0.499	0.960	0.031
ACQ	0.053	0.570	0.005	0.241	1.070	0.021
Constant	−0.281*	−1.550		−0.327	−0.810	
Year FE	Yes			Yes		
ρ	0.201			0.320		
N	65,185			5608		
Adj. R^2	0.023			0.049		

FE: fixed effect.
This table shows the results of estimating the effect of serial correlation in the error term using system of equations (1) and (2) that use the fixed-effects model that allows for autoregressive disturbances. Economic (Eco.) significance is estimated as the change in the dependent variable due to one standard deviation change in the explanatory variable.
***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

allocations co-move quite differently, or they are not quite persistent in the short run. However, a strong firm fixed effect, identified in Chauhan (2019), suggests that these allocations could be mean-reverting around a time-invariant mean, giving an overall impression of persistence in working capital allocations in the long run.[7]

4.2. Extent of mean reversion in working capital allocations

Although the low serial correlation among consequent working capital allocations suggests frequently changing allocations, which in turn may reflect rapid mean reversion, we formally estimate the strength of the mean reversion. It can be assessed by knowing the frequency at which working capital allocations rebalance themselves. If working capital allocations frequently rebalance in the short run, the mean reversion can be said to be fairly rapid, and vice versa. For each firm in our dataset, we observe the change in working capital allocation as compared to its allocation in the previous year and denote the change as an "advance" or a "decline" if the firm's allocation subsequently increases or decreases, respectively. We then subtract total advances from total declines to estimate the net advances or declines for each firm. The absolute value of net advances or declines

Table 2. Assessing the frequency of rebalancing.

Minimum sum of total advances and declines (years)	Average fractional duration for not rebalancing		Average regimes (years)	Average maximum regimes (years)
	NWC/NTA	Median-adjusted *NWC/NTA*	Median-adjusted *NWC/NTA*	Median-adjusted *NWC/NTA*
1	0.346	0.398	1.446	2.554
5	0.213	0.229	1.631	3.360
10	0.170	0.182	1.696	3.839
15	0.150	0.157	1.717	4.140
20	0.138	0.143	1.763	4.446
25	0.130	0.131	1.784	4.548
30	0.126	0.121	1.762	4.600

This table assesses the frequency at which working capital allocations rebalance themselves. For each firm in our dataset, we observe the change in working capital allocation as compared to its allocation in the previous year and denote the change as an "advance" or a "decline" if the firm's allocation subsequently increases or decreases, respectively. We then subtract total advances from total declines to estimate the net advances or declines for each firm. The absolute value of net advances or declines as a proportion of the sum of advances and declines then provides a measure of the time for which the firm has allowed its working capital allocations to drift, or simply suggests short-term persistence. This fraction, when subtracted from unity, would give the frequency of rebalancing.

as a proportion of the sum of advances and declines then provides a measure of the time for which the firm has allowed its working capital allocations to drift, or suggests the extent of short-term persistence. This fraction, when subtracted from unity, would reflect the frequency of rebalancing.

The results shown in Table 2 suggest fairly rapid mean reversion for working capital allocations, both unadjusted and adjusted for industry medians. For the full sample (i.e. for the sum of total advances and declines greater than or equal to 1), the unadjusted working capital allocation of a typical firm persists or does not get rebalance for about one-third of the time for which the firm exists in the sample. This persistence is slightly higher (39%) for working capital allocations normalized by their industry medians. However, as the panel length or the duration for which the firms remain in the sample increases, the rebalancing frequency increases rapidly. For the firms surviving for more than 10 years, advances and declines are squared off by each other in at least 80% of the cases. Specifically, firms surviving throughout the sample period persist for only about 12%, on average, of the total time they exist in the sample. In other words, firms' working capital allocations oscillate quite rapidly around their mean allocations.

Since squaring-off of advances and declines can be seen even if such advances and declines persist for quite a longer duration at a stretch, we estimate the average and longest regime of advances or declines for each firm. We find that, for a firm surviving throughout the 30 years of the sample, while the average regime is a mere 1.76 years, the longest regime is 4.60 years. Thus, while a typical surviving firm rebalances in less than 2 years on average, any such firm necessarily rebalances its working capital allocations in less than 5 years.

4.3. Speed of mean reversion

Although the rebalancing frequency suggests the average proportion of time working capital allocations swing in the opposite directions, we also complement the analysis by estimating their speed of adjustment (SOA) toward the mean using a partial-adjustment dynamic framework, which is conceptualized as follows. Let $NWCR_{i,t}$ represent the current relative working capital allocation for firm i at time t. Also, let $NWCR^{*}_{i,t}$ represent the dynamic equilibrium working capital allocation of the firm. Then, while following the equilibrium allocation, the firm retraces a fraction, δ, of the initial deviation moving from time $t-1$ to time t, such that partial adjustment can be described by the following structural equations

$$(NWCR_{i,t} - NWCR_{i,t-1}) = \delta(NWCR^{*}_{i,t} - NWCR_{i,t-1}) \tag{3}$$

where δ, assumed to lie in the range $0 < \delta < 1$, represents the fraction of deviation retraced in the following period or the speed of reversion or adjustment (SOA). The dynamic equilibrium working capital allocation $(NWCR^{*}_{i,t})$ is a function of time-varying and time-invariant factors and is estimated as follows[8]

$$NWCR^{*}_{i,t} = \alpha + \beta_j \cdot X(fs)_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{i,t} \tag{4}$$

where terms have their usual meanings as defined previously. Rearranging equation (3) and using equation (4) leads to

$$NWCR_{i,t} = (1-\delta)NWCR_{i,t-1} + \delta(\alpha + \beta_j \cdot X(fs)_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{i,t}) \tag{5}$$

or

$$NWCR_{i,t} = \alpha' + \theta \cdot NWCR_{i,t-1} + \beta'_j \cdot X(fs)_{i,t-1} + \eta'_i + \lambda'_t + \varepsilon'_{i,t} \tag{6}$$

where $\theta = 1 - \delta$ and terms in their primes are the counterparts of the terms in equation (4). Lower values of θ, or equivalently higher values of δ, signify rapid reversion.

We begin by identifying the nature of deviations using the fixed-effects estimator that controls for the firm fixed effect to estimate equation (6). The results shown in Panel A of Table 3 suggest that the SOA is around 72% for the full sample and close to 65% for the surviving firms. Although these estimates of SOAs suggest rapid reversion, they are not free from econometric biases. Since current working capital allocations are a function of fixed effects, the lagged dependent variable is inherently correlated with the disturbance term (Baltagi, 2008). Furthermore, Nickell (1981) suggests that within-firm transformation by mean differencing to control for firm fixed effects introduces a correlation between the transformed dependent variable and the error term. However, the correlation and the subsequent bias in the coefficient of the dependent variable seem to decrease with panel length (Flannery and Hankins, 2013).

Instrumental variables (IV) techniques are often suggested to overcome the potential biases in fixed-effects estimators, provided that reliable instruments are available. Arellano and Bond (1991) and Blundell and Bond (1998) suggest the generalized method of moments (GMM) and the system (two-step) GMM approach, respectively, and use lagged dependent variables and lagged first differences as instruments. We attempt to correct for potential biases, if any, in using the standard fixed-effects estimator using the system GMM approach of Blundell and Bond (1998). Specifically, the system GMM estimator takes the first difference in equation (6), such that

$$\begin{aligned} NWCR_{i,t} - NWCR_{i,t-1} &= \theta(NWCR_{i,t-1} - NWCR_{i,t-2}) \\ &+ \beta'_j(X(fs)_{i,t-1} - X(fs)_{i,t-2}) + (\lambda'_t - \lambda'_{t-1}) + (\varepsilon'_{i,t} - \varepsilon'_{i,t-1}) \end{aligned} \tag{7}$$

Table 3. Estimating the speed of adjustment (SOA).

Panel A: fixed-effects estimates

	Full sample						Constant sample					
	1		2		3		1		2		3	
	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat
$NWCR_i,t_{-1}$	0.280***	15.350	0.260***	14.210	0.264***	14.530	0.369***	5.220	0.335***	4.470	0.341***	4.680
SIZE			0.018	0.690	0.015	0.570			0.015	0.220	0.002	0.040
TAN			−0.951***	−4.820	−0.932***	−4.700			−0.468	−1.150	−0.353	−0.870
LEV			−0.143*	−1.460	−0.084	−0.860			0.553***	2.140	0.674***	2.480
AGE			0.154***	5.810	0.105**	1.720			0.166***	3.170	−0.634	−0.880
RND			−0.027	−0.070	−0.019	−0.050			1.101	0.860	1.182	0.910
RSK			−0.040*	−1.350	−0.009	−0.270			−0.215***	−2.660	−0.142**	−1.800
CASH			−0.873***	−6.690	−0.890***	−6.890			0.038	0.130	−0.168	−0.560
SV			0.022	0.980	0.024	1.100			0.082*	1.440	0.084*	1.500
SG			0.076***	2.710	0.063***	2.230			0.051	0.410	−0.029	−0.230
ALTZ			0.004	0.260	0.011	0.660			0.108*	1.450	0.126*	1.600
STA			0.220***	5.280	0.220***	5.240			0.213**	1.860	0.178*	1.530
MSHR			−3.437***	−2.220	−3.458***	−2.220			0.399	0.140	0.420	0.150
PRF			0.316***	2.780	0.289***	2.590			0.397	0.600	0.459	0.680
CPX			−0.476***	−2.380	−0.372**	−1.850			−0.200	−0.430	−0.117	−0.260
ACQ			0.005	0.050	0.010	0.110			−0.021	−0.110	0.018	0.100
Constant	1.224***	38.920	1.026***	5.870	0.710***	5.580	1.026***	8.840	−0.058	−0.100	0.847	0.890
Year FE	No		No		Yes		No		No		Yes	
N	74,767		74,767		74,767		5836		5836		5836	
Adj. R^2	0.4825		0.4144		0.4176		0.6051		0.5235		0.5376	

(Continued)

Table 3. (Continued)

Panel B: GMM estimates

	Full sample						Constant sample					
	1		2		3		1		2		3	
	Coeff.	z stat	Coeff.	z stat	Coeff.	z stat	Coeff.	z stat	Coeff.	z stat	Coeff.	z stat
$NWCR_i,t_{-1}$	0.292***	11.460	0.290***	11.330	0.301***	11.240	0.288***	7812.330	0.140***	773.000	0.157***	233.650
SIZE			−0.029	−0.480	−0.046	−0.780			1.241***	246.890	1.214***	109.600
TAN			0.706***	2.810	0.527***	2.100			3.741***	153.370	3.721***	71.130
LEV			0.103	0.600	0.112	0.640			−2.132***	−114.380	−1.654***	−47.640
AGE			0.029	0.670	0.113	0.410			−0.453***	−67.690	−0.933***	−62.350
RND			1.093**	1.670	1.069*	1.540			−4.599***	−48.520	−2.678***	−13.520
RSK			0.010	0.350	0.060*	1.630			−0.407***	−108.820	−0.254***	−15.060
CASH			0.975***	5.020	1.044***	5.400			1.379***	66.220	1.380***	29.920
SV			0.017	0.500	0.022	0.670			0.050***	29.930	0.069***	18.800
SG			0.028	0.620	−0.014	−0.290			0.032***	12.600	−0.07***	−10.000
ALTZ			−0.062**	−1.890	−0.035	−1.020			−1.199***	−215.290	−1.141***	−62.990
STA			−0.087*	−1.380	−0.100*	−1.580			1.578***	236.810	1.450***	63.520
MSHR			−0.391	−0.080	−0.416	−0.090			−37.014***	−146.890	−37.312***	−60.150
PRF			0.421**	1.920	0.274	1.200			7.010***	181.960	6.694***	77.080
CPX			0.300*	1.460	0.196	0.930			1.055***	65.460	0.888***	21.150
ACQ			0.195***	2.210	0.231***	2.630			0.174***	15.300	0.138***	7.370
Constant	0.914***	26.000	0.759***	2.010	0.696***	2.810	1.168***	1491.510	−6.484***	−154.410	−5.858***	−55.660
Year FE	No		No		Yes		No		No		Yes	
N	60,989		60,989		60,989		5474		5474		5474	
Arellano–Bond test for zero autocorrelation in first-differenced errors—*p* value	0.000		0.000		0.000		0.0385		0.0927		0.0761	
Sargan test of overidentifying restrictions—are instruments are valid at 5% significance?	No		No		No		Yes		Yes		Yes	

FE: fixed effect; GMM: generalized method of moments.
This table shows the estimation of SOA for the full sample and for the constant sample using partial-adjustment dynamic frameworks. Panels A and B show the results using the fixed-effects and GMM estimators, respectively.
***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

Equations (6) and (7) are then jointly estimated as a "system." The system GMM estimator uses lagged differences as the instruments for the level equation (6) and the lagged allocations as instruments for the difference equation (7). System GMM estimators are particularly helpful in overcoming the bias introduced in the estimation due to shorter panel length (Flannery and Hankins, 2013). However, Baltagi (2008) shows that the key assumption of the error term being free from second-order correlation is often not met in GMM estimations. Furthermore, Hahn et al. (2007) show that the system GMM can also be biased when the autoregressive component is close to 1. However, it may not be particularly worrisome in our analysis as the results in Table 1 show that the $AR(1)$ coefficient for working capital allocations is well below unity. Nevertheless, the effectiveness of the GMM approach is sensitive to the instrument validity.

The results in Panel B of Table 3 suggest that SOAs estimated using the system GMM (approximately 70%) are very close to those identified with the fixed-effects estimator in Panel A for the full sample. However, to verify the concerns over serial correlation, we conduct the Arellano–Bond test for zero autocorrelation in first-differenced error terms and focus on second-order correlation.[9] We find that the null hypothesis of no second-order autocorrelation is strongly rejected for all the models using the full sample. Furthermore, we perform the Sargan–Hansen test for overidentifying restrictions to test for instrument validity.[10] We find that instruments are invalid for the models using the full sample, suggesting that they are possibly misspecified.

Flannery and Hankins (2013) suggest that the accuracy of results using dynamic panel models, in a setup where the focus is on lagged dependent variables, is a function of the number of observations per firm in the dataset. The authors suggest that the performance of the system GMM approach of Blundell and Bond (1998) is relatively accurate for large panels with a greater number of observations per firm. We find that the results are indeed quite reassuring using the constant sample of surviving firms, probably because of the longer panel length. The results in Panel B of Table 3 suggest that the SOA is much greater for the sample of surviving firms using the system GMM approach. A typical firm reverts to the extent of 84% within the year following deviation from its mean. Furthermore, we fail to reject the null hypothesis of no second-order correlation at 5% and 10% significance allocations for the two models, excluding and including time-varying controls, respectively. Also, the problem of weak instruments seems to be absent in this sample. We fail to reject the hypothesis that the instruments are valid at 5% significance levels.

Interestingly, the SOAs of 70% and 84%, identified by the system GMM estimator for the full sample and the sample of surviving firms, respectively, are very close to the rebalancing frequencies that we identified earlier for the two samples.[11] Although different estimates of the lagged dependent variable in Table 3 make it difficult to precisely infer the SOAs using partial-adjustment dynamic models, these results, along with the estimated rebalancing frequency, provide us a broad sense of rapid mean reversion, and that is the key takeaway from our analysis in this section. The findings are consistent with Baños-Caballero et al. (2010, 2013), who find rapid mean reversion while generally studying the movement in firms' cash conversion cycles.

5. Trade-off between working capital and fixed investments

Ben-Nasr (2016), Ding et al. (2013), and Fazzari and Petersen (1993) suggest that firms tend to actively modulate their working capital investments to absorb any inter-temporal exogenous shocks to their fixed investment schedules. In this way, firms' working capital acts as an agent to smooth their fixed investments, for which the modulation is costly in the short run. Furthermore, the authors contend that the extent of such inter-temporal smoothing depends on firms' financial constraints. More financially constrained firms could find it relatively difficult to change their working capital allocation too frequently to cause effective smoothing of fixed investments. In this section, we investigate if variations in working capital allocations that we identify in the previous section signify a trade-off between firms' working capital investments and capital expenditures.

Before we proceed, we note that at least a part of the findings in Ben-Nasr (2016), Ding et al. (2013), and Fazzari and Petersen (1993) could be attributed to ignoring systematic and persistent differences in working capital allocations for firms operating with inherently lower or higher working capital allocations. Using incremental working capital investments and capital expenditures as a proportion of total assets or capital, as in Fazzari and Petersen (1993), may not be useful when comparing two firms with inherently low or high relative working capital allocations. For example, Fazzari and Petersen (1993) use the ratio of changes in working capital to firms' capital stock as an independent variable to assess its impact on the ratio of capital expenditures to capital stock and find a significantly negative relation between the two investments. Note that, although the scaling by firms' capital stock would help deal with heteroscedasticity, capital expenditure as a fraction of total capital or assets would usually be higher in absolute terms for firms with higher fixed asset allocations but otherwise having the same amount of total capital or assets compared to other firms. Therefore, the regression of capital expenditures on working capital investments, as in Fazzari and Petersen (1993), could only measure the impact of higher or lower working capital allocations on firms with inherently lower and higher allocations to fixed assets, respectively. It is easy to see that, measured this way, the two investments are inherently endogenous not because they are often determined simultaneously but because their measurement represents ex ante negative reciprocity at the firm level. Furthermore, even if we try to account for the endogeneity of the two investments by taking beginning-of-the-period values of an independent variable (i.e. changes in working capital in the case of Fazzari and Petersen, 1993), systematic and persistent differences in working capital allocations across firms would render such attempts less useful. Interestingly, on the contrary, such persistent differences in working capital allocations make the matter worse by adding significance to the ex ante negative reciprocity. Such a measurement issue, therefore, has the potential to bias the findings of a trade-off between these two investments in Ben-Nasr (2016), Ding et al. (2013), and Fazzari and Petersen (1993).

We attempt to overcome these measurement issues and investigate the possible trade-off between working capital and fixed investments. Specifically, to make these investments comparable across firms, when they have systematically different allocations of working capital and other assets, we scale these investments by their start-of-the-period endowments. That is, we scale firms' net operating working capital investments in a year by the beginning total amount of net operating working capital and the fixed investments by the beginning values of long-term assets. The modified measures are represented in our analysis as ΔNWC and $CPX(LA)$, respectively. This transformation enables us to make these investments comparable to firms across and within industries. If there is truly a trade-off between these two investments, we may expect a decrease in working capital investments when fixed investments increase, and vice versa, at least in the short run. Furthermore, this should be more sensitive for financially constrained firms, as suggested by Fazzari and Petersen (1993).

5.1. Contemporary trade-off

Since working capital and fixed investments could be simultaneously determined, we control for possible endogeneity in the relationship using two-stage least-squares (2SLS) estimation. Specifically, we identify a valid instrument for the fixed investments, such that it is correlated with fixed investments but uncorrelated with working capital investments through channels other than fixed investments. Importantly, endogeneity in the relationship between two investments will surface only if there is a trade-off between the two investments. If these investments are largely independent of each other, endogeneity may not be a serious concern. Furthermore, while there is inherent endogeneity in the two investments if these are measured with respect to total assets or capital, there is no a priori endogenous relationship in the transformed measures of working capital and fixed investments that we propose to work with.

We envision 1-year lagged values of fixed investments as a proportion of their beginning-of-the-period total assets (*CPX*(*A*)) as possible instruments for our transformed measures of fixed investments. Specifically, firms making larger fixed investments as a proportion of their total assets in the previous period are also likely to make larger of these investments as a proportion of their long-term assets. However, it is less likely that 1-year lagged fixed investments as a proportion of their total assets would be correlated to firms' incremental working capital investments as a proportion of the beginning net operating working capital other than through their relationship with fixed investments as a proportion of their total long-term assets. Although we formally test the instrument validity in the first-stage regression, we primarily assess it in our empirical analysis by estimating correlations between the set of covariates. Panel A of Table 4 shows that low pairwise correlations are in line with our expectations.

We estimate the first-stage regression (reported in Column 1 of Panels B and C of Table 4), involving the fixed investments as a proportion of total long-term assets as a dependent variable and the 1-year lagged fixed investments as a proportion of total assets and other variables as controls, such that

$$CPX(LA)_{i,t} = \alpha + \beta_1 \cdot CPX(A)_{i,t-1} + \beta_j \cdot X(fs)_{i,t-1} + \beta_l \cdot X(me)_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{i,t} \quad (8)$$

where *CPX* represents fixed investments or capital expenditures as a proportion of long-term assets (*LA*) and total assets (*A*), respectively; $X(me)_{i,t-1}$ represents the lagged values of the set of macroeconomic control variables described in Appendix 1; and the other terms have their usual meanings. To assess the robustness of the estimation, we estimate equation (8) using ordinary least-squares (OLS) and fixed-effects estimators.

Subsequently, we estimate the relationship between working capital and fixed investments using the instrumented values of fixed investments in the second stage as follows

$$\Delta NWC_{i,t} = \alpha + \beta_1 \cdot CPX(LA)_{i,t} + \beta_j \cdot X(fs)_{i,t-1} + \beta_l \cdot X(me)_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{i,t} \quad (9)$$

where ΔNWC represents the change in working capital as a proportion of net operating working capital at the beginning of the year. We report the results of the second-stage regression in Column 2 of Panels B and C of Table 4.

The results in Panels B and C of Table 4 for OLS and fixed-effects estimators, respectively, suggest that the instrument seems to be sufficiently related to the endogenous covariate. Contrary to the findings in Fazzari and Petersen (1993), we find that working capital and fixed investments relate positively (Column 2), suggesting no active trade-off between the two investments. It appears that firms making working capital investments also simultaneously invest in their fixed assets.

The transformation of working capital and fixed investments used to make these investments comparable across firms comes in handy by eliminating any ex ante endogeneity between the two measures of investments. The effect can be seen when we conduct the Durbin–Wu–Hausman (DWH) test for endogeneity with a null that the variables are exogenous. The results reported in Table 4 suggest that we fail to reject the hypothesis even at 10% significance.

Table 4. Trade-off between working capital and fixed investments.

Panel A: pairwise correlations

	ΔNWC	CPX(A)	CPX(LA)
ΔNWC	1		
CPX(A)	0.03	1	
CPX(LA)	0.07	0.39	1

	Panel B: OLS estimation				Panel C: fixed-effects estimation			
	Dep. var. = *CPX(LA)*		Dep. var. = Δ*NWC*		Dep. var. = *CPX(LA)*		Dep. var. = Δ*NWC*	
	1		2		1		2	
	Coeff.	*t* stat	Coeff.	*z* stat	Coeff.	*t* stat	Coeff.	*z* stat
CPX(LA)			0.512***	3.690			1.042***	3.560
CPX(A)	0.893***	64.800			0.526***	30.850		
SIZE	−0.007***	−12.970	0.002	0.420	−0.042***	−17.690	−0.095***	−4.130
TAN	−0.021***	−4.600	0.094**	2.140	−0.211***	−14.700	0.563***	4.720
LEV	−0.069***	−15.280	0.078*	1.750	−0.088***	−11.290	0.028	0.370
AGE	−0.013***	−10.490	−0.051***	−4.870	−0.032***	−11.810	−0.050**	−2.040
RND	0.069***	4.350	−0.437***	−3.040	0.090***	2.730	0.390	1.280
RSK	0.016***	6.980	0.001	0.030	0.007**	2.580	0.005	0.170
CASH	0.278***	37.230	0.465***	6.120	0.316***	26.710	0.838***	5.670
SV	0.004***	6.930	−0.001	−0.170	0.003**	2.440	0.004	0.460
SG	0.015***	7.200	0.059***	2.700	0.009***	4.180	−0.042	−1.640
ALTZ	0.003***	4.500	−0.040***	−6.380	0.006***	4.130	−0.065***	−5.600
STA	0.030***	19.300	0.034***	2.790	0.036***	10.540	−0.037	−1.240
MSHR	−0.104***	−3.350	−0.256	−0.840	−0.310**	−2.550	1.830	1.470

(Continued)

Table 4. (Continued)

	Panel B: OLS estimation				Panel C: fixed-effects estimation			
	Dep. var. = *CPX*(*LA*)		Dep. var. = Δ*NWC*		Dep. var. = *CPX*(*LA*)		Dep. var. = Δ*NWC*	
	1		2		1		2	
	Coeff.	*t* stat	Coeff.	*z* stat	Coeff.	*t* stat	Coeff.	*z* stat
PRF	0.061***	6.210	−0.085	−1.150	0.072***	5.100	−0.095	−0.950
ACQ	−0.130***	−24.330	0.283***	4.520	−0.047***	−8.030	0.133**	1.980
LIBOR	0.006***	11.120	−0.007	−1.590	−0.003**	−2.540	−0.032***	−3.630
TSPR	0.013***	11.910	0.018*	1.950	−0.004**	−2.000	−0.031**	−2.060
CSPR	−0.022***	−8.180	−0.028	−1.210	−0.016***	−5.050	0.026	1.020
GDPG	0.003***	5.400	0.009*	1.830	0.002***	4.260	0.012**	2.310
MKT	0.063***	20.590	0.129***	3.720	0.040***	11.910	0.064*	1.710
Constant	0.056***	6.810	0.113	1.630	0.422***	20.170	0.583***	2.630
N	82,155		82,155		82,155		82,155	
Adj. R^2	0.295		0.015		0.137		0.011	
Durbin–Wu–Hausman (DWH) test of endogeneity—*p* value	0.2989							

OLS: ordinary least-squares.
where Δ*NWC* is the ratio of the net operating working capital investments in a year to the beginning total amount of net operating working capital; *CPX*(*LA*) is the ratio of the fixed investments by the beginning values of long-term assets; *CPX*(*A*) is the 1-year lagged ratio of the fixed investments by the beginning values of total assets. This table shows the results of assessing a trade-off between working capital and fixed investments using a two-stage least-squares (2SLS) regression. Panel A shows the correlation between Δ*NWC, CPX*(*A*), and *CPX*(*LA*) defined there. Panels B and C show results of the first-stage (Column 1) and second-stage (Column 2) regressions using OLS and fixed-effects estimators, respectively. We use 1-year lagged values of fixed investments as a proportion of their total assets (*CPX*(*A*)) as possible instruments for our transformed measures of fixed investments. Results of the DWH test for endogeneity with a null that the variables are exogenous are also reported.
***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

Table 5. Trade-off between working capital and fixed investments in the long run.

	1		2	
	Coeff.	*t* stat	Coeff.	*t* stat
CPX(LA)	0.346***	5.440	0.601***	4.140
SIZE	−0.124***	−6.910	−0.085***	−3.460
TAN	0.484***	4.290	0.186	1.090
LEV	−0.042	−0.590	−0.371***	−3.740
AGE	−0.082***	−3.770	−0.035	−0.710
RND	0.453*	1.500	−0.147	−0.280
RSK	0.008	0.310	0.046	1.050
CASH	1.071***	9.770	0.707***	4.820
SV	0.006	0.670	0.009	0.810
SG	−0.025	−1.030	−0.044	−0.950
ALTZ	−0.060***	−5.270	−0.096***	−3.970
STA	−0.014	−0.500	0.041	0.890
MSHR	1.629*	1.330	−0.948	−0.570
PRF	−0.038	−0.390	0.001	0.000
ACQ	0.116**	1.730	0.141**	1.790
LIBOR	−0.035***	−4.090	−0.015	−1.000
TSPR	−0.038***	−2.540	−0.003	−0.130
CSPR	0.012	0.490	0.010	0.310
GDPG	0.014***	2.630	0.018***	2.820
MKT	0.089***	2.480	0.083***	2.040
Constant	0.918***	5.400	0.680***	2.480
N	82,155		82,155	
Adj. R^2	0.017		0.013	

Columns 1 and 2 in this table show the results of assessing whether fixed investments made at time *t* may influence working capital investments at time $t+k$, where $k>1$. The results reported in Columns 1 and 2 show the contemporary coefficients of fixed investments and the sum of all the coefficients lagged up to 5 years, respectively. ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

5.2. Trade-off in the long run

Although we find no contemporary trade-off between working capital and fixed investments, such a trade-off may exist in the long run. Specifically, fixed investments made at time *t* may influence working capital investments at time $t+k$, where $k>1$. We, therefore, use lagged fixed investments for 5 years in equation (9) to test whether such is the case. Since the 2SLS estimator is generally less efficient than the usual OLS and fixed-effects estimators (Wooldridge, 2010) and we verified that the transformed measures for the two investments are ex ante exogenous, we then use the fixed-effects estimator to compare the short- and long-term impacts of fixed investments on working capital investments.

The results reported in Columns 1 and 2 of Table 5 show the contemporary coefficients of fixed investments, and the sum of all the coefficients lagged up to 5 years, respectively. We estimate the robust standard error clustered at the firm level using a linear transformation of coefficients for the sum of 5-year lagged coefficients (Column 2). The results suggest that working capital investments relate positively to fixed investments both in the short run and in the long run. Thus, the trade-off between the two investments is practically nonexistent even in the long run. In fact, the comparison of the two coefficients suggests that the marginal long-term impact is more positive than the short-term impact. Interestingly, positively correlated working capital and fixed investments signify a largely stagnant relative allocation of working capital and fixed assets as a proportion to the firms' total assets. It is consistent with the persistence that we observe in firms' working capital allocation earlier.

5.3. Effect of financial constraints

Fazzari and Petersen (1993) also suggest that the trade-off between working capital and fixed investments would be more prominent for financially unconstrained firms. It is so because these firms are at relative ease to modulate their working capital investments to absorb inter-temporal exogenous shocks to their fixed investments. We test whether the two investments are sensitive to firms' financial constraints such that the trade-off might be visible for relatively unconstrained firms. We use firms' size and age as a measure of financial constraint and identify relatively unconstrained firms with greater size or age. As an alternative measure of financial constraint, we also use Hadlock and Pierce's (2010) SA index, Kaplan and Zingales' (1997) KZ index, and Whited and Wu's (2006) WW index.[12] Their construction is described in Appendix 1. Higher values of all the three indices represent relatively more financial constraints. We estimate the effect of fixed investments in equation (9) for financially constrained and unconstrained firms separately using a dummy for them to interact with the fixed investments as follows

$$\Delta NWC_{i,t} = \alpha + \beta_1 \cdot D \cdot CPX(LA)_{i,t} + \beta_2 (1-D) \cdot CPX(LA)_{i,t} + \beta_j \cdot X(fs)_{i,t-1} + \beta_l \cdot X(me)_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{i,t} \tag{10}$$

where D is the dummy representing relatively unconstrained firms identified using median values of size, age, and SA, KZ, and WW indices in the sample. The results in Columns 1–5 of Table 6 suggest that, irrespective of the measure and degree of financial constraint, the working capital investments relate positively to fixed investments.

In sum, the analysis in this section suggests that there may not be any tactical trade-off between working capital and fixed investments. However, since firms' mean relative working capital allocations remain largely time invariant (Chauhan, 2019), there may be a strategic trade-off between firms' allocation of working capital and other assets. Since the short-term variation in working capital allocations could not be ascribed to an active trade-off between working capital and fixed investments, along with the fact that they are largely insignificant and frequently mean-reverting to cause serious deviations from long-run means, they could be largely noise around their equilibrium allocations. However, a systematic exploration into these aspects may shed more light on the causes of such short-run variations.

6. Conclusion

Previous studies suggest that relative working capital allocations within industries persist over a long period. While such persistence rules out any industry-wide optimal allocation, firms could still be pursuing their firm-specific optimal allocations. Furthermore, although persistent allocations over time suggest that deviations from long-run means would eventually die out, we know little about their speed of reversion. Depending on the speed of such reversion, we can further infer whether firms would be actively trading off their working capital investments to absorb any exogenous shocks to capital expenditure schedules. We assess short-run variations in working capital allocations to shed light on these issues in this article.

We find that working capital allocations frequently deviate from their long-term means in the short run. However, such deviations are also rapidly mean-reverting. A typical firm retraces more than two-thirds of their deviations from long-run means in just about a year. Thus, even if there

Table 6. Trade-off between working capital and fixed investments and the effect of financial constraints.

	1		2		3 (*SAind*)		4 (*KZind*)		5 (*WWind*)	
	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat	Coeff.	*t* stat
D(SIZE) × *CPX(LA)*	0.327***	3.130								
[1−*D(SIZE)*] × *CPX(LA)*	0.351***	5.120								
D(AGE) × *CPX(LA)*			0.379***	4.390						
[1−*D(AGE)*] × *CPX(LA)*			0.326***	4.600						
D(ind) × *CPX(LA)*					0.330***	4.920	0.300***	2.121	0.371***	3.652
[1−*D(ind)*] × *CPX(LA)*					0.407***	3.880	0.437***	3.674	0.254**	1.761
SIZE	−0.123***	−6.960	−0.125***	−6.940	−0.126***	−7.210	−0.130***	−8.508	−0.130***	−6.976
TAN	0.485***	4.300	0.480***	4.230	0.478***	4.240	0.540***	5.046	0.513***	4.945
LEV	−0.043	−0.600	−0.041	−0.570	−0.039	−0.550	−0.048	−0.572	−0.056	−0.572
AGE	−0.082***	−3.750	−0.086***	−3.850	−0.085***	−3.820	−0.088***	−4.775	−0.085***	−4.059
RND	0.453*	1.500	0.449*	1.490	0.451*	1.500	0.478*	1.590	0.550*	1.511
RSK	0.008	0.310	0.008	0.310	0.008	0.320	0.010	0.352	0.008	0.419
CASH	1.071***	9.770	1.069***	9.750	1.069***	9.730	1.325***	11.676	1.272***	12.727
SV	0.006	0.640	0.006	0.690	0.008	0.810	0.009	1.004	0.007	0.894
SG	−0.025	−1.030	−0.025	−1.030	−0.025	−1.040	−0.026	−1.144	−0.029*	−1.373
ALTZ	−0.060***	−5.270	−0.060***	−5.250	−0.060***	−5.270	−0.062***	−6.219	−0.054***	−5.535
STA	−0.014	−0.490	−0.015	−0.530	−0.015	−0.550	−0.016	−0.578	−0.017	−0.647
MSHR	1.617*	1.320	1.643*	1.340	1.667*	1.360	2.034**	1.700	2.034***	2.006
PRF	−0.038	−0.390	−0.039	−0.400	−0.038	−0.390	−0.043	−0.417	−0.042	−0.342
ACQ	0.116**	1.730	0.115**	1.720	0.115**	1.730	0.128**	1.765	0.142*	1.500
LIBOR	−0.035***	−4.050	−0.035***	−4.080	−0.036***	−4.130	−0.042***	−4.832	−0.049***	−4.301
TSPR	−0.038***	−2.520	−0.039***	−2.560	−0.039***	−2.580	−0.049***	−3.044	−0.055***	−3.440
CSPR	0.012	0.480	0.014	0.560	0.013	0.510	0.013	0.576	0.012	0.628
GDPG	0.014***	2.630	0.013***	2.590	0.013***	2.590	0.014***	2.668	0.012***	3.175
MKT	0.089***	2.490	0.088***	2.480	0.087***	2.450	0.091***	2.573	0.075***	2.650
Constant	0.914***	5.380	0.932***	5.440	0.940***	5.560	1.044***	5.560	0.991***	4.448
N	82,155		82,155		82,155		79,658		76,152	
Adj. R^2	0.017		0.017		0.017		0.019		0.013	

Columns 1–5 in this table show the results of assessing whether the two investments are sensitive to firms' financial constraints. We use firms' size, age, Hadlock and Pierce's (2010) SA index (Column 3) along with Kaplan and Zingales' (1997) KZ index (Column 4) and Whited and Wu's (2006) WW index (Column 5) as a measure of financial constraint. Here *D* is the dummy representing relatively unconstrained firms identified using median values of size, age, and SA, KZ, and WW indices in the sample.

***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

may not be any industry-wide optimal working capital allocation, firms actively tend to pursue their firm-specific optimal allocations.

Even though working capital allocations frequently deviate from their long-run means in the short run, we find that such short-run variations in working capital could not be systematically ascribed to an active trade-off between working capital and fixed investments. On the contrary, we find that working capital and fixed investments positively correlate with each other. Such a positive correlation is consistent with persistence in working capital allocations. Given that short-run deviations are small and frequently mean-reverting, it is possible that these deviations are simply some noise around the long-term equilibrium allocations.

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Notes

1. See, for example, Hill et al. (2010), Corsten and Gruen (2004), and Brennan et al. (1988).
2. Since we assess plausible implications of the findings in Chauhan (2019), we use the same time frame and set of firms to highlight our findings.
3. Specifically, Chauhan (2019) finds that firms' initial working capital allocations represent the most important determinant of their current allocations. That is, working capital allocations that were decided as many as 30 years back for the sample firms could still predict the current working capital allocations of these firms reasonably well. Furthermore, using type III partial sum of squares to study the relative contribution of the firm fixed effect, the author finds that the firm fixed effect contributes to more than 90% of the explained variation, while both the year fixed effect and the cross-sectional control variables contribute very little.
4. Ali (1994) studies relative persistence in firms' earnings, working capital, and cash flows using serial correlations.
5. Following the extant literature on working capital management (e.g. Aktas et al., 2015; Hill et al., 2010), we primarily classified firms using Fama and French's (1997) 48 industry classification, excluding utility, banking, insurance, real estate, and trading industries. The industry classification is available through Kenneth French's webpage: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/. A prime advantage of using the Fama–French classification is that the industries are grouped in manageable numbers based on their most concentrated but similar industrial activity. The classification picks up functional industries using four-digit SIC (Standard Industrial Classification) codes, the details of which are available in their paper. The classification, therefore, enables researchers to work with a greater number of firms around a given functionality. Although, using the raw SIC codes may group firms into specific products, very few firms are available for many SIC codes rendering it difficult to draw any meaningful inferences from these industries.
6. Accounts payables are reported as liabilities in Compustat. However, since we intend to use them as contra assets offsetting gross current assets, they are deducted from total assets to reflect total net assets. Consistent with past literature (as in, for example, Bae and Wang, 2015; Hensher and Jones, 2007;

Jones and Walker, 2007; Kusnadi, 2011), we evaluate working capital allocations with respect to total assets rather than sales. This is partly because, among several other explanations, Ingram and Lee (1997) suggest inappropriate measurement of working capital allocations using sales due to a lag between the income reported and operating cash flows. Specifically, as sales increase (decrease), net operating working capital would likely increase (decrease) leading to the lag.

7. We also note the economic significance of the cross-sectional variables in Table 1. Economic significance is estimated as the change in working capital allocations due to one standard deviation change in the subject variable. Notably, the estimated economic significance of these variables remains much smaller when compared to the unconditional variation in working capital allocations or the impact of initial working capital allocations identified in Chauhan (2019).
8. Since initial working capital explains significant variations in the current allocations and hence is a good proxy for equilibrium working capital allocation, we also use initial working capital allocations to test for the strength of mean reversion. The results are qualitatively similar and are available on request.
9. Since the first difference of independently and identically distributed error terms will be autocorrelated, the model misspecification cannot be established by no serial correlation at order one. Thus, we test for the null hypothesis at the second order under the null that there is no autocorrelation and report the *p* values for the same.
10. See Bun and Windmeijer (2010) for the problems of weak instruments and their validity thereof, in the system GMM dynamic panel data models.
11. In fact, Hovakimian and Li (2011), in the context of mean reversion in debt ratios, suggest that SOAs estimated from partial-adjustment models indicate the frequency of full rebalancing in the sample when firms have specifically defined target debt ratios and adjust only occasionally. This is because times when firms actively rebalance are characterized by the SOA equal to one but separated by periods of inactivity where the SOA is zero.
12. We thank the associate editor, Konari Uchida, for suggesting alternate indices for financial constraints to check the robustness of our findings.

References

Aktas N, Croci E and Petmezas D (2015) Is working capital management value-enhancing? Evidence from firm performance and investments. *Journal of Corporate Finance* 30: 98–113.

Ali A (1994) The incremental information content of earnings, working capital from operations, and cash flows. *Journal of Accounting Research* 32: 61–74.

Arellano M and Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies* 58: 277–297.

Bae KH and Wang J (2015) Why do firms in customer–supplier relationships hold more cash? *International Review of Finance* 15: 489–520.

Baltagi B (2008) *Econometric Analysis of Panel Data*. Hoboken, NJ: John Wiley.

Baños-Caballero S, García-Teruel PJ and Martínez-Solano P (2010) Working capital management in SMEs. *Accounting & Finance* 50: 511–527.

Baños-Caballero S, García-Teruel PJ and Martínez-Solano P (2013) The speed of adjustment in working capital requirement. *The European Journal of Finance* 19: 978–992.

Baños-Caballero S, García-Teruel PJ and Martínez-Solano P (2014) Working capital management, corporate performance, and financial constraints. *Journal of Business Research* 67: 332–338.

Ben-Nasr H (2016) State and foreign ownership and the value of working capital management. *Journal of Corporate Finance* 41: 217–240.

Blundell R and Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87: 115–143.

Brennan MJ, Maksimovic V and Zechner J (1988) Vendor financing. *The Journal of Finance* 43: 1127–1141.

Bun MJ and Windmeijer F (2010) The weak instrument problem of the system GMM estimator in dynamic panel data models. *The Econometrics Journal* 13: 95–126.

Chauhan GS (2019) Are working capital decisions truly short-term in nature? *Journal of Business Research* 99: 238–253.

Chi LC and Tang TC (2006) Bankruptcy prediction: Application of logit analysis in export credit risks. *Australian Journal of Management* 31: 17–27.

Corsten D and Gruen TW (2004) Stock-outs cause walkouts. *Harvard Business Review* 82: 26–28.

Cunat V (2007) Trade credit: Suppliers as debt collectors and insurance providers. *The Review of Financial Studies* 20: 491–527.

Ding S, Guariglia A and Knight J (2013) Investment and financing constraints in China: Does working capital management make a difference? *Journal of Banking and Finance* 37: 1490–1507.

Ek R and Guerin S (2011) Is there a right level of working capital? *Journal of Corporate Treasury Management* 4: 137–149.

Fama EF and French KR (1997) Industry costs of equity. *Journal of Financial Economics* 43: 153–193.

Fazzari SM and Petersen BC (1993) Working capital and fixed investment: New evidence on financing constraints. *The RAND Journal of Economics* 24: 328–342.

Filbeck G and Krueger TM (2005) An analysis of working capital management results across industries. *American Journal of Business* 20: 11–20.

Flannery MJ and Hankins KW (2013) Estimating dynamic panel models in corporate finance. *Journal of Corporate Finance* 19: 1–19.

Frankel R, Levy H and Shalev R (2017) Factors associated with the year-end decline in working capital. *Management Science* 63: 438–458.

Graham JR (2000) How big are the tax benefits of debt? *The Journal of Finance* 55: 1901–1941.

Guay WR and Sidhu BK (2001) The usefulness of long-term accruals. *Abacus* 37: 110–131.

Hadlock CJ and Pierce JR (2010) New evidence on measuring financial constraints: Moving beyond the KZ index. *The Review of Financial Studies* 23: 1909–1940.

Hahn J, Hausman J and Kuersteiner G (2007) Long difference instrumental variables estimation for dynamic panel models with fixed effects. *Journal of Econometrics* 140: 574–617.

Hawawini G, Viallet C and Vora A (1986) Industry influence on corporate working capital decisions. *Sloan Management Review* 27: 15–24.

Hensher DA and Jones S (2007) Forecasting corporate bankruptcy: Optimizing the performance of the mixed logit model. *Abacus* 43: 241–264.

Hill MD, Kelly GW and Highfield MJ (2010) Net operating working capital behavior: A first look. *Financial Management* 39: 783–805.

Hill MD, Kelly GW and Lockhart GB (2012) Shareholder returns from supplying trade credit. *Financial Management* 41: 255–280.

Hovakimian A and Li G (2011) In search of conclusive evidence: How to test for adjustment to target capital structure. *Journal of Corporate Finance* 17: 33–44.

Ingram RW and Lee TA (1997) Information provided by accrual and cash-flow measures of operating activities. *Abacus* 33: 168–185.

Jones S and Walker RG (2007) Explanators of local government distress. *Abacus* 43: 396–418.

Kaplan SN and Zingales L (1997) Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly Journal of Economics* 112: 169–215.

Kusnadi Y (2011) Do corporate governance mechanisms matter for cash holdings and firm value? *Pacific-Basin Finance Journal* 19: 554–570.

Lamont O, Polk C and Saaá-Requejo J (2001) Financial constraints and stock returns. *The Review of Financial Studies* 14: 529–554.

Love I and Zaidi R (2010) Trade credit, bank credit and financial crisis. *International Review of Finance* 10: 125–147.

MacKie-Mason JK (1990) Do taxes affect corporate financing decisions? *The Journal of Finance* 45: 1471–1493.

Nickell S (1981) Biases in dynamic models with fixed effects. *Econometrica: Journal of the Econometric Society* 49: 1417–1426.

Nunn KP (1981) The strategic determinants of working capital: A product-line perspective. *Journal of Financial Research* 4: 207–219.

Weinraub HJ and Visscher S (1998) Industry practice relating to aggressive conservative working capital policies. *Journal of Financial and Strategic Decision* 11: 11–18.

Whited TM and Wu G (2006) Financial constraints risk. *The Review of Financial Studies* 19: 531–559.

Wooldridge JM (2010) *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

Appendix 1. Measurement and definition of variables.

Variable	Symbol	Description
Working capital allocations	*NWCR*	Firms' relative working capital allocations measured as the ratio of net operating working capital to net total asset scaled by the median of this ratio for respective industries in a given year; estimated through equation (2)
Change in working capital	ΔNWC	Change in working capital as a proportion of net operating working capital at the beginning of the year
Median working capital allocation	*MED*	Industry median ratio of net operating working capital to total net assets for a given period
Size	*SIZE*	Firms' size measured as the log of inflation-adjusted (to 2004 US$) total book value of assets in millions of dollars
Asset tangibility	*TAN*	Asset tangibility measured as the ratio of net fixed assets to net total assets (total assets minus accounts payables)
Leverage	*LEV*	Leverage measured as the ratio of debt to net total assets
Age	*AGE*	Age measured as the log of number of years since the stock price is available for the firm in Compustat
Investments into intangible assets	*RND*	Investments into intangible assets measured as the ratio of research and development expenditure to net total assets
Perceived risk	*RSK*	Perceived risk is measured as annualized standard deviation of monthly stock returns
Cash balances	*CASH*	Cash balances measured as the ratio of cash and cash equivalent to net total assets
Sales volatility	*SV*	Sales volatility measured as the standard deviation of a firm's annual sales over the previous 5-year period. Annual sales used in this calculation is in billions of dollars. Firm-year observations are included in the sample for a given year if the firm has at least three observations during the previous 5-year period
Sales growth	*SG*	Sales growth measured as growth in total sales over the previous year
Financial soundness	*ALTZ*	Financial soundness is captured through the modified Altman *Z* score proposed by MacKie-Mason (1990) and is measured as 3.3 times EBIT (operating income) plus sales plus 1.4 times retained earnings plus 1.2 times (current assets minus current liabilities) divided by net total assets. The Altman *Z* score measures the ex ante probability of distress (Graham, 2000)
Asset turnover	*STA*	Asset turnover measured as the ratio of total sales to net total assets
Market share	*MSHR*	Market share measured as the ratio of total sales of the firms to total industry sales. Industries are classified according to Fama–French 49 industry classification
Profitability	*PRF*	Profitability measured as the ratio of operating income before depreciation to net total assets
Capital expenditures	*CPX*	Capital expenditures measured as the difference in gross fixed assets over the previous year to net total assets

(*Continued*)

Appendix 1. (Continued)

Variable	Symbol	Description
Acquisitions	*ACQ*	Acquisitions measured as acquisitions (obtained from cash flow statement item no. A129) to net total assets
SA index	*SAind*	SA index is proposed by Hadlock and Pierce (2010) as a measure of financial constraints, which is computed as $(-0.737 \times SIZE) + (0.043 \times SIZE^2) - (0.040 \times AGE)$, where *SIZE* is the log of inflation-adjusted total assets (in million dollars) and *AGE* is the number of years since the stock price is available for the firm in Compustat
KZ index	*KZind*	The KZ index, as reported by Lamont et al. (2001), is calculated as $-1.002(CF/K) + 0.283(Q) + 3.139(Debt/Capital) - 39.368(Div/K) - 1.315(CASH/K)$, where K represents lagged Property, Plant, and Equipment, *CF* is measured as Income before extraordinary items + Depreciation, *Q* as [Total assets + (Market value as of December year $t-1$) − Common equity − Deferred taxes]/Total assets, *Debt* as the summation of long-term and short-term debt, *Capital* as the summation of debt and shareholder's equity, and *Div* as the summation of common and preferred dividends
WW index	*WWind*	The Whited–Wu index is defined as $(-0.091 \times CF) - (0.062 \times DD) + (0.021 \times LTD/A) - (0.044 \times LNTA) + (0.102 \times ISG) - (0.035 \times SG)$, where *DD* is the dummy variable for dividend-paying firms set to be 1 if the firm pays dividend or else 0, *LTD/A* is the long-term debt to total assets, *LNTA* is the log of total assets, *ISG* is the three-digit SIC industry sales growth
Libor rate	*LIBOR*	Libor rate measured as the annual average of 3-month LIBOR rate; obtained from the FRED database
Term spread	*TSPR*	Term spread measured as the average of the monthly term spread. The term spread is defined as the difference between the 10-year and 1-year constant maturity treasury rates; obtained from the FRED database
Credit spread	*CSPR*	Credit spread measured as the spread between Moody's Aaa and Baa Corporate Bond yields as a proxy for general credit risk; obtained from the FRED database
Real GDP growth	*GDPG*	Real GDP growth measured as the annual percentage change in real GDP; obtained from the FRED database
Stock market returns	*MKT*	Stock market returns measured as the annualized returns on S&P 500 index using data on monthly returns

GDP: gross domestic product.

Appendix 2. Descriptive statistics for variables of interest.

Variable	Full sample ($N = 85,881$)					Constant sample ($N = 6048$)				
	Mean	SD	Q1	Median	Q3	Mean	SD	Q1	Median	Q3
NWCR	1.707	3.173	0.663	1.128	1.779	1.633	2.364	0.734	1.155	1.651
SIZE	5.625	2.243	3.969	5.541	7.173	7.259	2.035	5.890	7.234	8.754
TAN	0.300	0.227	0.120	0.241	0.431	0.313	0.198	0.167	0.265	0.413
LEV	0.237	0.181	0.084	0.219	0.355	0.222	0.130	0.129	0.216	0.306
AGE	2.198	0.666	1.609	2.197	2.708	2.636	0.628	2.197	2.773	3.178
RND	0.038	0.079	0.000	0.000	0.040	0.023	0.035	0.000	0.008	0.032
RSK	0.531	0.391	0.295	0.430	0.634	0.341	0.188	0.219	0.298	0.412
CASH	0.139	0.169	0.022	0.073	0.189	0.086	0.091	0.020	0.053	0.119
SV	0.372	1.204	0.009	0.040	0.192	0.888	1.863	0.047	0.186	0.737
SG	0.153	0.454	−0.024	0.081	0.219	0.090	0.213	−0.002	0.072	0.150
ALTZ	1.331	2.585	0.863	1.814	2.643	2.421	0.991	1.770	2.379	3.011
STA	1.224	0.817	0.665	1.072	1.573	1.291	0.709	0.829	1.156	1.596
MSHR	0.009	0.025	0.000	0.001	0.005	0.020	0.037	0.001	0.006	0.020
PRF	0.084	0.199	0.055	0.115	0.169	0.145	0.070	0.101	0.141	0.184
CPX	0.071	0.084	0.022	0.046	0.087	0.065	0.062	0.028	0.047	0.079
ACQ	0.033	0.101	0.000	0.000	0.011	0.033	0.088	0.000	0.000	0.023
ΔNWC	0.192	1.507	−0.111	0.058	0.256	0.086	0.815	−0.050	0.053	0.172
LIBOR	4.336	2.527	1.795	5.197	5.984	4.277	2.615	1.624	4.751	6.039
TSPR	1.430	1.005	0.630	1.540	2.380	1.467	1.003	0.670	1.620	2.440
CSPR	0.975	0.322	0.750	0.890	1.100	0.994	0.325	0.760	0.920	1.120
GDPG	2.687	1.642	1.800	2.800	3.800	2.607	1.663	1.800	2.700	3.800
MKT	0.097	0.175	−0.020	0.098	0.236	0.094	0.172	0.020	0.098	0.198

SD: standard deviation.

Appendix 3. Correlation matrix.

	NWCR	*ΔNWC*	*MED*	*SIZE*	*TAN*	*LEV*	*AGE*	*RND*	*RSK*	*CAS*	*SV*	*SG*	*ALTZ*	*STA*	*MSHR*	*PRF*	*CPX*	*ACQ*	*LIB*	*TSP*	*CSP*	*GDP*	*MKT*
NWCR	1.00																						
ΔNWC	0.08	1.00																					
MED	−0.05	−0.02	1.00																				
SIZE	−0.01	−0.04	0.27	1.00																			
TAN	−0.05	0.01	0.39	0.20	1.00																		
LEV	−0.04	−0.01	0.07	0.16	0.27	1.00																	
AGE	0.06	−0.04	−0.14	0.23	−0.04	−0.05	1.00																
RND	−0.02	0.04	−0.07	−0.23	−0.26	−0.22	−0.07	1.00															
RSK	−0.01	0.03	0.00	−0.41	−0.10	0.02	−0.12	0.18	1.00														
CASH	−0.05	0.07	0.04	−0.17	−0.33	−0.37	−0.07	0.49	0.14	1.00													
SV	0.03	−0.02	0.08	0.52	0.06	0.03	0.16	−0.07	−0.14	−0.07	1.00												
SG	0.00	0.04	0.34	−0.04	−0.02	0.01	−0.12	0.05	0.05	0.07	−0.02	1.00											
ALTZ	0.06	−0.07	0.15	0.28	0.03	−0.01	0.05	−0.50	−0.34	−0.37	0.08	−0.05	1.00										
STA	0.05	−0.02	−0.10	−0.18	−0.20	−0.10	0.01	−0.15	0.01	−0.21	0.00	−0.07	0.43	1.00									
MSHR	−0.02	−0.02	0.08	0.48	0.04	0.06	0.11	−0.06	−0.16	−0.08	0.50	−0.06	0.06	−0.01	1.00								
PRF	0.06	−0.05	−0.05	0.32	0.15	0.03	0.08	−0.46	−0.29	−0.28	0.09	0.02	0.69	0.15	0.06	1.00							
CPX	−0.03	0.03	−0.05	0.06	0.52	0.08	−0.13	−0.11	−0.04	−0.10	0.01	0.22	0.03	−0.12	−0.03	0.14	1.00						
ACQ	−0.01	0.01	−0.06	0.08	−0.07	0.13	−0.03	−0.06	−0.04	−0.10	−0.01	0.23	0.02	−0.09	0.01	0.04	0.04	1.00					
LIBOR	−0.06	0.00	0.27	−0.18	0.07	0.08	−0.46	−0.03	0.01	−0.11	−0.11	0.06	0.13	0.10	−0.03	0.03	0.12	0.02	1.00				
TSPR	0.02	0.01	0.07	0.06	0.00	−0.04	0.14	0.00	0.00	0.04	0.03	−0.06	−0.04	−0.03	0.02	0.00	−0.09	−0.07	−0.72	1.00			
CSPR	0.01	−0.01	0.22	0.08	−0.01	−0.01	0.05	0.00	0.06	0.05	0.06	−0.09	−0.04	−0.04	0.03	−0.01	−0.07	−0.04	−0.31	0.39	1.00		
GDPG	−0.01	0.02	0.16	−0.11	0.02	0.03	−0.23	−0.01	−0.05	−0.06	−0.08	0.10	0.06	0.05	−0.03	0.02	0.09	0.05	0.43	−0.42	−0.71	1.00	
MKT	−0.01	0.02	−0.12	−0.04	0.02	0.01	−0.09	−0.02	−0.06	−0.02	−0.03	0.01	0.03	0.01	−0.01	0.02	0.03	0.01	0.08	−0.10	−0.26	0.22	1.00