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ARTICLE INFO	Joonghyuk Kim and James L. Park (2015). How do financial constraint and distress measures compare?. *Investment Management and Financial Innovations*, *12*(2), 41-50
RELEASED ON	Monday, 22 June 2015
JOURNAL	"Investment Management and Financial Innovations"
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
0	0	0

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How do financial constraint and distress measures compare?

Abstract

This paper compares three popular financial constraint measures (the Kaplan and Zingales, 1997 (KZ); Whited and Wu, 2006 (WW); and Hadlock and Pierce, 2010 (SA) indices) with three of the most widely used distress measures. Although prior studies highlight the necessity for distinguishing between financial constraint and financial distress, researchers have used these measures without examining how they correlate with each other. This paper finds a strong positive correlation between KZ and the distress measures. "Constrained firms", as measured by KZ, also exhibit characteristics very similar to those of distressed firms. On the other hand, the WW and SA correlations with the KZ and distress measures are substantially weaker. In order to distinguish financial constraint from distress, it is hypothesized that distressed firms reduce debt rather than invest when additional cash becomes available, a pattern typically expected from distressed firms but not constrained ones. Consistent with this hypothesis, it is found that both KZ "constrained firms" and financially distressed firms exhibit higher debt reduction-cash flow sensitivities but lower investment-cash flow sensitivities. These patterns are not found when analyzing data using the WW and SA measures. Based on these findings, it is concluded that the KZ index is more related to financial distress than financial constraint.

Keywords: financial constraint, financial distress, investment-cash flow sensitivities.
JEL Classification: G31, G32, D92.

Introduction

One of the key questions in finance literature is how firms behave when facing financial constraint[1]. Since financial constraint is not directly observable, researchers have heavily relied on proxies to measure degree of constraint. Three most popular constraint proxies used in recent literature are the Kaplan and Zingales (1997) index (KZ index), the Whited and Wu (2006) index (WW index), and the Hadlock and Pierce (2010) index (SA index).

A major concern for researchers using any of these three proxies is that robust results are difficult to obtain when using all three measures together. More specifically, the historically most used KZ index does not correlate with the WW and SA indices (see Hadlock and Pierce, 2010). Although this low correlation has been documented in the literature, all three measures are still frequently used as it is not clear what each measure represents. This imposes a burden on researchers, since the low correlation between the measures implies that it is difficult to obtain consistent results, which forces researchers to elect a single index for their studies and opens the door for data mining[2].

In this paper, we hypothesize that the reason behind the low correlation between the KZ index and the other two indices is that the former index captures the financial distress aspect of constraint more than the other two. If a constraint index is influenced too strongly by financial distress, researchers may not want to use the index, because literature on constraint proxies generally aims at studying firms incapable of financing profitable investment opportunities (i.e., constrained firms), rather than firms that are in need of securing funds to prevent default (i.e., distressed firms)[3]. To achieve this goal, past studies have excluded firms with negative cash flow and/or negative past real sales growth to control for distress. These studies, however, have failed to clarify whether these controls were sufficient to eliminate significant correlations between the constraint measures and financial distress. Past literature also failed to identify which constraint measure suffers the most from high correlation with financial distress.

This paper attempts to address these aforementioned concerns by analyzing how the three popular constraint measures compare to financial distress measures. After applying the common controls for financial distress, as discussed above, we directly compare firms sorted by the three financial constraint proxies to firms sorted by three popular distress measures. Distress measures are from Campbell, Hilscher and Szilagyi (2008), Ohlson (1980), and Vassalou and Xing (2004).

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The authors gratefully acknowledge funding from the Asian Institute of Corporate Governance and Korea University.

[1] Prior studies generally view that financial constraint occurs when there is a substantial disparity between the cost of external financing and the opportunity cost of internal capital. Relevant studies include Fazzari, Hubbard, and Peterson (1988), Whited (1992), Kaplan and Zingales (1997), Almeida, Campello, and Weisbach (2004), Whited and Wu (2006), Almeida and Campello (2007), Hennessy and Whited (2007), and Hadlock and Pierce (2010), among many others.

[2] For example, Hann, Ogneva and Ozbas (2013) use all three measures but find weaker results when using the KZ index. Atkas, Bodt, and Roll (2013) and Amore, Schneider, and Zaldokas (2013) only use the KZ index, Yung and Nafar (2014) only use the WW index, and Cornaggia, Mao, Tian, and Wolfe (2013) only use the SA index.

[3] The literature recognizes that financial constraint and distress are not mutually exclusive (see discussions in Kaplan and Zingales, 2000; Lamont, Polk, and Saa-Requejo, 2001; and Whited and Wu, 2006).

This paper finds that even after applying common controls, there still remains a positive correlation between each of three constraint measures and the three distress measures. The KZ index, in particular, consistently shows the highest Spearman rank correlation coefficients with the three distress measures, ranging from 49% to 61%. In addition, characteristics of firms sorted by the KZ index positively correlate with those of firms sorted by the distress measures, while negatively correlating with those of firms sorted by the WW and SA indices.

To formally test whether the KZ index displays distress characteristics, we first study whether firms ranking higher on constraint and distress indices invest less when additional cash flow becomes available (i.e., lower investment-cashflow sensitivities). This pattern is not expected from constrained firms but expected from distressed firms[1]. We find that firms sorted on all three distress measures exhibit this pattern, similar to the pattern documented for the KZ index in the literature. Firms sorted by the WW and SA indices do not exhibit this pattern.

To more specifically show the distress nature of firms sorted by the KZ index, we additionally investigate debt reduction-cash flow sensitivities as a novel specification. Generally, lowering debt levels with earnings is a common behavior displayed by distressed firms but not financially constrained firms that have an abundance of investment opportunities (as mentioned by Kaplan and Zingales, 1997). We find that financially constrained firms as sorted by the KZ index and distressed firms show higher debt reduction-cash flow sensitivities, meaning that they reduce debt when additional cash becomes available. This higher debt reduction-cash flow sensitivity inevitably lowers investment-cash flow sensitivity when cash flow is limited. As such, when we control for firms that reduce debt, we no longer find lower investment-cash flow sensitivities for KZ "constrained" firms and distressed firms as measured by the three distress measures. To the best of our knowledge, this is the first paper to empirically show such relationships.

The remainder of the paper is organized as follows. Section 1 discusses relevant literature and Section 2 develops testable hypotheses. Section 3 introduces data and variables used in our analyses. Section 4 presents the results, and the final section concludes.

1. Related literature

Researchers have closely studied how financial constraint affects firm behavior, and these efforts have generated a significant body of literature concerning the difference between financial constraint and distress. For example, although Kaplan and Zingales (1997) stress that their results are not driven by financially distressed firms, Fazzari et al. (2000) challenge this argument and suggest the contrary. In response, Kaplan and Zingales (2000) state that financial distress and constraint are difficult to distinguish because "financial distress is a form of financial constraint". Allayannis and Mozumdar (2004) later show that Kaplan and Zingales' (1997) results could be influenced by the small sample problem as well as observations that have negative cash flows.

Lamont, Polk, and Saa-Requejo (2001), also concerned with this issue, state that they do not intend to use financial constraint to mean distress, although distress is undoubtedly correlated with financial constraint. Whited and Wu (2006) also state that it is difficult to distinguish financial distress from constraint. They view distressed firms are firms close to default, whereas constrained firms are young firms that are restrained from growing due to the difficulty in financing. These papers eventually control for distress by dropping observations that have negative sales growth.

In the aftermath of these debates and as the use of the estimation coefficients of Kaplan and Zingales (1997) became widespread, researchers who wish to control for financial distress employed common controls such as exclusion of observations with negative cash flows or those with negative past real sales growth. No prior studies, however, investigated if these common controls were sufficient to alleviate these concerns.

2. Hypotheses development

An argument that has been made, but not specifically tested, by prior studies is that financially distressed firms differ from financially constrained firms because distressed firms may voluntarily or involuntarily use additional cash flows to repay debt rather than invest[2]. Lowering leverage would benefit shareholders if the marginal benefit from lowering debt is greater than investing in positive net present value (NPV) projects. These benefits would be higher when distress probabilities are higher, cost of debt is high (high leverage), and positive NPV investment opportunities are scarce (lower Tobin's Q). If debt repayment is a higher priority than investments, the residual cash flow left for investment would be reduced and the distressed firms will necessarily exhibit lower investment-cash flow sensitivities as observed for the KZ index in the literature.

[1] See, for example, Fazzari, Hubbard and Peterson (2000).

[2] See, for example, Kaplan and Zingales (1997).

We test this debt reduction hypothesis in three stages. First, we look at investment-cash flow sensitivities of distressed firms. Although this paper is by no means an attempt to argue the validity of the usefulness of these sensitivities, we examine it to compare how each financial constraint and distress measure compare and contrast. As firms with high KZ index have been shown to have lower investment-cash flow sensitivities and distressed firms would generally not invest more when additional cash flow is available, we test whether firms that rank high on distress indices also have lower investment-cash flow sensitivities. We do not expect this behavior from the WW and SA indices.

Hypothesis 1. Firms with high KZ index and distress rankings have lower investment-cash flow sensitivities.

Second, we look at debt reduction-cash flow sensitivities. If firms rank higher on the KZ index and the three distress measures are indeed more distressed, these firms should have particularly higher debt reduction-cash flow sensitivities, while the most constrained firms, according to the SA and WW indices, would not.

Hypothesis 2. Firms with high KZ index and distress rankings have higher debt reduction-cash flow sensitivities.

Third, we revisit investment-cash flow sensitivities and control for firms that reduce debt. If distressed firms repay debt with the limited cash flows, they would inevitably invest less. Thus, we verify whether firms that reduce debt have lower investment-cash flow sensitivities and whether lower investment-cash flow sensitivities are observed after debt reducing firms are controlled for.

Hypothesis 3. Firms with high KZ index and distress rankings no longer have lower investment cash-flow sensitivities after controlling for debt-reducing firms.

3. Data

The paper uses three popular constraint measures used in the literature: the KZ index, WW index, and SA index. The KZ index originates from Kaplan and Zingales (1997) and was first used out of sample by Lamont et al. (2001). The coefficients for the WW index are originally estimated on the structural model of Whited and Wu (2004). The SA index is constructed by Hadlock and Pierce (2010) using size and age of firms to estimate financial constraints.

This paper additionally uses three popular distress measures as proxies for financial distress. The first is the Campbell, Hilscher and Szilagyi (2008) (CHS) measure. The coefficients for the CHS measure are estimated from a twelve-month-ahead probability of failure using a logit regression with variables that include both market and accounting data. The CHS coefficients are estimated over the longest period using the most recent data and the measure is known to have the highest explanatory power in predicting financial failure among reduced form models. The second distress measure is the Ohlson's (1980) O-score. The O-score employs accounting variables and is used extensively in both accounting and finance literature. It is known to outperform other accounting distress measures[1]. Finally, we include the Vassalou and Xing (2004) (VX) measure that is based on the Merton (1974) model.

We follow standard procedure to estimate the KZ, WW, and SA indices, and the CHS and O-score measures. Detailed definitions and derivations of each measure can be found in the Appendix. We directly use the estimates from Maria Vassalou's website for the VX measure[2]. The VX measure, however, is only available up to year 1999 and sample size also decreases by about fifty percent due to stringent data requirements. To be included in the sample, all observations must have preceding year KZ, WW, SA, CHS and O-score data, but the VX measure is not necessary for inclusion.

The dataset is constructed using all Compustat firms from 1972 to 2012. We require firm observations to have constraint and distress measures in year $t-1$, and have cash flow, investment and debt reduction variables for the current year t in order to conduct cash flow sensitivities analysis. Current variables are defined as follows:

CF/K = {income before extraordinary items (*ib*) + depreciation (*dp*)}/lagged *ppent*,

I/K = capital investment (*capex*) / lagged (*ppent*),

Debt Reduction/K = [{lagged long-term debt (*dltt*) + lagged debt in current liabilities (*dlc*) – long-term debt (*dltt*) – debt in current liabilities (*dlc*)}/lagged *ppent*],

with a zero value assigned if negative.

As final screens, we exclude financial industry firms (SIC Codes 6000-6999) and regulated utility firms (SIC Codes 4900-4949)[3]. Consistent with the literature, we exclude firms with negative contemporaneous CF/K and negative real sales growth in either the previous year or the year before. After these screens, we are left with 26,064 firm-year observations while only 12,203 firm-year observations are available when we also screen for the VX measure from the previous year.

[1] An alternative measure is the Altman (1968) Z-score, which has been estimated from a period that does not overlap with our sample (1946 to 1965), using only 33 observations. In unreported results, the Z-score measure results in low correlation not only with the three constraint measures, but also with the three distress measures.

[2] Find data at: http://maria-vassalou.com/research/data/.

[3] Notice that Kaplan and Zingales (1997) and Whited and Wu (2004) only use manufacturing firms' data. The literature has commonly used these measures for broader cross-section of industries.

4. Results

4.1. Correlations. We first examine how three financial constraint measures (KZ index, WW index, and SA index) correlate with the three financial distress measures (CHS measure, O-score, and VX measure) and how they correlate with each other. Table 1 presents the simple pair-wise correlation (Panel A) and the Spearman rank correlation (Panel B) in the pooled sample.

Panel A shows that the KZ index is not significantly correlated with other constraint measures, confirming the concerns regarding the KZ index raised by previous studies (for example, see Hadlock and Pierce, 2010). Interestingly, the only measure that shows significantly positive correlation with the KZ index is the VX distress measure. The WW index is positively correlated not only with the SA index but also with all three distress measures. The SA index is also positively correlated with all three distress measures and has particularly high correlations with the CHS measure (28%). All three distress measures are positively correlated with each other.

Table 1. Correlations

The table presents correlations between three financial constraint measures (KZ index, WW index, and SA index) and three financial distress measures (CHS measure, O-score, and VX measure). The indices/measures use preceding year data. Panel A is the simple correlation between the measures in the full sample from 1971 to 2012. Panel B presents the Spearman rank correlations between the measures in the pooled sample. Statistical significance at the 1% levels is denoted by "*".

Panel A. Correlations						
	KZ	WW	SA	CHS	O-score	VX
KZ	1					
WW	-0.005	1				
SA	-0.006	0.206*	1			
CHS	0.016	0.075*	0.286*	1		
O-score	-0.012	0.076*	0.176*	0.625*	1	
VX	0.072*	0.035*	0.097*	0.509*	0.301*	1
Panel B. Spearman rank correlations						
	KZ	WW	SA	CHS	O-score	VX
KZ	1					
WW	0.063*	1				
SA	0.034*	0.754*	1			
CHS	0.487*	0.235*	0.264*	1		
O-score	0.608*	0.137*	0.141*	0.629*	1	
VX	0.508*	0.265*	0.304*	0.703*	0.520*	1

The results in Panel B confirm the findings from Panel A, but higher rank correlations are achieved across the board. The KZ index is more closely related to the distress measures, compared to the other two constraint measures. The rank correlations between the KZ index and the distress measures range from 49% (CHS measure) to 61% (O-score), whereas, the rank correlations between the KZ index and the WW index (SA index) is only 6.3% (3.4%). Surprisingly, the rank correlations between the KZ index and the other distress measures are almost as high as the correlations between the distress measures themselves.

On the other hand, the WW index and SA index are highly correlated with each other, with a rank correlation of 75%. They are also positively correlated with the distress measures, ranging from 14% to 30%, but at a much lower degree than the rank correlations between the KZ index and the distress measures. The results in Panel B provide important additional information to Panel A results since the literature generally divides firms into "less constraint/distress firm" bins and "high constraint /distress firm" bins for analyses, a practice dating back to Fazzari et al. (1988) and Kaplan and Zingales (1997)[1].

Overall, the results in Table 1 show that all three constraint measures are positively correlated with the distress measures. In particular, the KZ index is more closely related to the distress measures than the other constraint measures in Spearman rank correlations, whereas the WW index and SA index are highly correlated with each other but have low correlation levels with the KZ index. The screens to control for distress are insufficient to lower the correlations, particularly for the KZ index.

4.2. Firm characteristics. Next, we study firm characteristics by sorting firms into quintiles using the previous year's financial constraint and distress measures[2]. Then we compute mean firm characteristics across these quintiles based on the five elements that comprise the KZ index as a summary of the financial state of the firms: Tobin's Q, CF/K, Debt/Capital, Cash/K, and Div/Kusing the most recent fiscal year accounting variables at the end of the previous year[3]. All variables are winsorized at the top 99% and the bottom 1% level, to be consistent with existing literature.

Figure 1 (see Appendix) presents the results. The first row in Panel A shows that the KZ index generally displays firm characteristics in the opposite direction to those of the WW and SA indices, with the exception of dividends. More constrained firms sorted by the WW and SA indices are those with better investment opportunities, higher cash flows, lower leverage,

[1] Calculating simple correlations of annual quintile (or tercile) rankings formed by each measure, yields similar results to the Spearman rank correlations.

[2] Although pattern shapes are similar, we use quintile sorting bins instead of tercile sorting bins to show clearer pattern variations.

[3] See Appendix for definitions and detailed derivation of each variable. Notice that previous year's CF/K can still be negative as we drop observations with current negative CF/K to screen for distressed firms consistent with literature. We find similar results by dropping observations with negative CF/K in the previous year, instead of the current year CF/K.

higher cash holdings, and lower dividends. These characteristics are consistent with the "non-distressed aspect of financial constraint" in that constrained firms prepare precautionary cash holdings because it is difficult to finance profitable investment opportunities with limited debt financing.

On the other hand, more financially constrained firms identified by the KZ index have lower investment opportunity (Tobin's Q), lower cash flows, higher debt ratio, lower cash holdings, and lower dividends[1]. These characteristics are more consistent with what one would expect from distressed firms.

To compare characteristics of firms sorted by the KZ index with those of firms sorted by the distress measures, the characteristics of the three financial distress measures are presented in Panel B. For all characteristics, the firm characteristic patterns of the KZ index are in the same direction as all three distress measures. In sum, the combined results in Table 1 and Figure 1 suggest that the KZ index systematically captures the distress aspect of financial constraint more than the WW and SA indices do.

4.3. Investment-cash flow sensitivities. So far we find that the KZ index has particularly strong commonalities with the distress measures. In this section, we explicitly investigate this relationship beyond simple correlations by studying investment behavior when firms face additional cash flows by testing hypothesis 1.

Panel A of Table 2 presents the results. The model specifications follow the literature on investment-cash flow analysis. Firms are annually sorted in financial constraint and financial distress terciles, to be consistent with the literature. The indicator functions "I_more" denotes the firms sorted into the second tercile bin and "I_most" denotes firms sorted into the last tercile bin which includes the most financially constrained firms. I/K is regressed on Tobin's Q, CF/K, and the interaction terms of CF/K with the indicator functions of "more and most constrained/distressed" firms.

We first confirm Kaplan and Zingales' (1997) results: the most financially constrained firms show relatively lower investment sensitivities to cash flow[2]. The coefficient of the interaction term between the firms' cash flow and the dummy for the most financially constrained firms (CF/K × I_most) is -0.052 (*t*-stat = -7.226), significant at the 1% level. The most financially constrained firms sorted by the WW index and SA index, on the other hand, show non-decreasing investment to cash flow sensitivities (0.006 with *t*-stat of 1.282 for the WW index and 0.039 with *t*-stat of 8.066 for the SA index).

Table 2. Investment-cash flow sensitivities

The table presents investment cash-flow sensitivities of firms by degree of financial constraint/distress. Firms are sorted into tercile bins each year using previous year financial constraint/distress measures. The three constraint measures are the KZ index, WW index, and SA index, and the three distress measures are the CHS, O-score, and VX measures in regressions (1) through (6). "I_more" and "I_most" are indicator functions that are '1' if firms are assigned in the second tercile (medium level constraint/distress) and third tercile (high level constraint/distress), respectively, and '0' otherwise. The left-hand side variable is I/K, and the explanatory variables are Tobin's Q, CF/K, and the interaction terms of CF/K and the indicator functions of more and most financially constrained/distressed firms. Variables are winsorized below and above at the 1% level and all regressions include firm and year fixed effects. The *t*-statistics are presented in parentheses, and the statistical significance at the 10%, 5%, and 1% levels is denoted by "*", "**", and "***", respectively.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	KZ	WW	SA	CHS	O-score	VX
Q	0.051***	0.051***	0.051***	0.050***	0.050***	0.054***
	(24.641)	(24.325)	(24.730)	(23.942)	(23.972)	(14.836)
CF/K	0.107***	0.097***	0.073***	0.107***	0.109***	0.199***
	(43.936)	(20.364)	(15.497)	(40.272)	(40.920)	(28.252)
CF/K×I_more	-0.003	0.013***	0.030***	0.001	-0.003	-0.018***
	(-0.565)	(2.908)	(6.529)	(0.409)	(-1.012)	(-2.742)
CF/K × I_most	-0.052***	0.006	0.039***	-0.011***	-0.018***	-0.047***
	(-7.226)	(1.282)	(8.066)	(-3.131)	(-4.512)	(-5.790)
Observations	26,064	26,064	26,064	26,064	26,064	12,203
R-squared	0.465	0.464	0.465	0.464	0.464	0.461

[1] Notice the Tobin's Q decreases although the Tobin's Q variable enters the KZ index with a positive sign. All other characteristics are in the same direction as they enter the KZ index.

[2] Please note that the coefficients for the sample-wide investment-cash flow sensitivities are significantly positive because we drop firms with current negative cash flow at the sample stage to control for financial distress. See Allayannis and Mozumdar (2004) for the effect of negative cash flow observations on investment-cash flow sensitivities.

The most financially distressed firms sorted by all three distress measures, however, show significantly lower investment to cash flow sensitivities similar to the KZ index: -0.11 (*t*-stat = -3.131) for the CHS measure, -0.018 (*t*-stat = -4.512) for the O-score, and -0.047(*t*-stat = -5.790) for the VX measure. Thus, the results are consistent with hypothesis 1 supporting the notion that the firms with high distress rankings display investment behavior similar to more financially constrained firms by the KZ index.

4.4. Debt reduction-cash flow sensitivities. To test hypothesis 2, we examine debt reduction to cash flow sensitivities in Table 3. The empirical setting is similar to Table 2, except that the left-hand variable is now replaced by debt reduction.

From the first row, we initially observe negative coefficients for Tobin's Q, which as expected, suggests firms with higher investment opportunities reduce debt at a lower rate. For debt reduction-cash flow sensitivities, we focus on the KZ index in model (1). We find that the debt reduction-cash flow sensitivities increase as firms are more constrained (0.005 with *t*-stat of 1.881 for all firms, 0.048 with *t*-stat of 9.158 for more constrained firms, and 0.115 with *t*-stat of 14.591 for the most constrained firms, as identified by the KZ index). This increasing pattern of debt reduction-cash flow sensitivities is also observed in all three distress measures in models (4) through (6), while it does not appear in the WW and SA indices in models (2) and (3). Financially constrained firms sorted by the WW index show insignificant results, while firms sorted by the SA index show significantly negative sensitivities of debt reduction to cash flow.

Table 3. Debt reduction-cash flow sensitivities

The table presents debt reduction-cash flow sensitivities. The setting for the regressions is similar to that of Table 2. The sole difference is that the left-hand side variable is debt reduction divided by lagged K. The variables are winsorized at the top 99% and the bottom 1%, and all regressions include firm and year fixed effects. The *t*-statistics are presented in parentheses, and statistical significance at the 10%, 5%, and 1% levels are denoted by "*", "**", and "***", respectively.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	KZ	WW	SA	CHS	O-score	VX
Q	-0.023***	-0.022***	-0.022***	-0.019***	-0.015***	-0.019***
	(-10.077)	(-9.700)	(-9.788)	(-8.370)	(-6.772)	(-5.727)
CF/K	0.005*	0.009*	0.026***	-0.001	-0.025***	0.013**
	(1.881)	(1.674)	(5.079)	(-0.214)	(-8.620)	(2.001)
CF/K×I_more	0.048***	0.004	-0.015***	0.013***	0.056***	0.018***
	(9.158)	(0.855)	(-2.987)	(4.221)	(16.355)	(3.033)
CF/K×I_most	0.115***	0.001	-0.018***	0.043***	0.124***	0.026***
	(14.591)	(0.185)	(-3.427)	(11.087)	(29.805)	(3.530)
Observations	26,064	26,064	26,064	26,064	26,064	12,203
R-squared	0.238	0.229	0.23	0.234	0.262	0.304

In sum, we find that as firms become more financially "constrained", as identified by the KZ index, they exhibit higher debt reduction sensitivities to cash flow consistent with hypothesis 2. This means that the more "constrained" firms are, the tendency to reduce debt increases when additional cash flow is made. This is a pattern generally expected for financially distressed firms, not financially constrained firms. Thus, firms that rank highest on the KZ index exhibit a behavior closer to that expected of financially distressed firms.

4.5. Investment-cash flow sensitivities revisited. Finally, to test hypothesis 3, we investigate how debt reduction-cash flow sensitivities observed in Table 3 affect the earlier results in Table 2: the lower investment sensitivities to cash flow of most constrained/distressed tercile when firms are sorted by the KZ index and the three distress measures. The left-hand side variable is now replaced back to I/K, and the table includes three additional regressors to control for firms that reduce debt. To create these additional variables, the indicator function of the firms that reduce debt (I_debt reduction) are interacted with CF/K, CF/K × I_more, and CF/K × I_most in rows 5, 6 and 7, respectively. For each constrained/distressed tercile group, these variables can be interpreted as the difference in CF/K sensitivities when they are the firms that reduce debt.

The results are presented in Table 4. We first focus on these additional regressors in rows 5 to 7. In models (1), (4), (5), and (6), we can see that most coefficients are negative, suggesting that debt reducing firms have lower investment-cash flow sensitivities as conjectured. In particular, the reduction of cash flow sensitiveness is the largest for the most financially constrained firms: -0.128 (*t*-stat = -10.378) for the KZ index, -0.027 (*t*-stat = -4.188) for the CHS measure, -0.040 (*t*-stat = -6.318) for the O-score, and -0.092 (*t*-stat = -6.882) for the VX measure. The WW and SA indices in models (2) and (3) do not exhibit these patterns and have insignificant

coefficients for firms that rank highest on these indices (row 7). These results confirm the conjecture that distressed firms that repay debt with the limited cash flow have less to invest, and therefore have lower investment-cash flow sensitivities when firms are sorted by the KZ index and the distress measures.

Table 4. Investment-cash flow sensitivities controlling for debt reducing firms

The table presents investment-cash flow sensitivities after controlling for firms that reduce debt. The settings for the regressions are similar to that of Table 2. The only difference is that this table includes three variables controlling for debt reducing firms in addition. The three variables are the CF/K variables each interacted with an indicator function (I_Debt Reduction) that is '1' if a firm reduces debt, and '0' otherwise. The variables are winsorized at the top 99% and the bottom 1%, and all regressions include firm and year fixed effects. The *t*-statistics are presented in parentheses, and statistical significance at the 10%, 5%, and 1% levels are denoted by "*", "**", and "***", respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	KZ	WW	SA	CHS	O-score	VX
Q	0.049***	0.050***	0.050***	0.049***	0.049***	0.051***
	(23.655)	(23.968)	(24.317)	(23.544)	(23.601)	(14.177)
CF/K	0.114***	0.109***	0.079***	0.115***	0.113***	0.233***
	(44.642)	(20.681)	(14.837)	(40.479)	(40.263)	(29.242)
CF/K×I_more	0.026***	0.009	0.038***	0.003	0.011***	-0.030***
	(4.406)	(1.616)	(7.018)	(0.774)	(2.819)	(-3.612)
CF/K×I_most	0.016*	0.008	0.042***	0.004	0.011**	-0.004
	(1.649)	(1.560)	(7.626)	(0.906)	(2.171)	(-0.389)
CF/K × I_Debt Reduction	-0.023***	-0.039***	-0.022***	-0.028***	-0.018***	-0.069***
	(-8.337)	(-5.628)	(-3.387)	(-7.901)	(-5.197)	(-8.771)
CF/K×I_more × I_Debt Reduction	-0.056***	0.016**	-0.026***	-0.004	-0.028***	0.014
	(-7.200)	(1.995)	(-3.254)	(-0.752)	(-4.653)	(1.186)
CF/K×I_most × I_Debt Reduction	-0.128***	-0.004	-0.011	-0.027***	-0.040***	-0.092***
	(-10.378)	(-0.543)	(-1.455)	(-4.188)	(-6.318)	(-6.882)
Observations	26,064	26,064	26,064	26,064	26,064	12,203
R-squared	0.473	0.469	0.47	0.469	0.47	0.481

Finally, once we control for debt reducing firms, the coefficients of cash flows for "more and most constrained" firms in rows 3 and 4 do not present significantly negative coefficients for all constraint and distress measures[1]. These results imply that the lower investment-cash flow sensitivities of the "most financially distressed" firms as identified by the KZ index and the distress measures in Table 2 are indeed driven by the firms that repay debt with cash flows, lowering the investment-cash flow sensitivities. These results support hypothesis 3.

Overall, these results are consistent with the debt reduction hypotheses 1, 2 and 3 which predict that constrained/distressed firms, as determined by the KZ index and the distress measures, use additional cash flows to repay debt rather than invest. Constrained firms, as measured by the KZ index, exhibit similar financing behaviors as distressed firms, while these similarities are not found with constrained firms, as measured by the WW and SA indices.

Conclusion

In financial constraint literature, one of the common concerns has been to distinguish financial constraint from financial distress. Researchers, however, have used the popular financial constraint measures without properly checking whether they proxy for what they are supposed to capture. In this study, by comparing three popular constraint measures to three popular distress measures, we attempt to shed a light on this issue.

We find a positive correlation between each of three constraint measures and the three distress measures, even after applying common controls. Especially, the KZ index shows the highest correlation with the three distress measures. Unlike the KZ index, firm characteristics sorted by the WW and SA indices are negatively correlated with those sorted by the distress measures.

Our results also indicate that financially constrained firms by the KZ index and distressed firms reduce debt when additional cash becomes available. When we control for firms that reduce debt, we no longer find lower investment-cash flow sensitivities for KZ "constrained" firms and distressed firms as measured by the three distress measures.

In conclusion, this paper suggests that the KZ index shares more common characteristics with the three distress measures. To the extent that financial distress can be considered a variation of financial constraint (Kaplan and Zingales, 2000), the KZ index better captures the distress aspect of

[1] To clarify, these results were not obtained merely due to the higher proportion of debt reducing firms comprising highly constrained (KZ)/ distressed firms. Rather, it resulted from the fact that constrained (KZ)/distressed firms initially hold less cash (see Figure 1 in the Appendix) and use a large portion of current limited cash flow to reduce debt (see Table 3), rather than invest.

financial constraint than the WW and SA indices. On the other hand, if the focus of one's study is on financial constraint and not distress, the WW and SA indices seem to be better options. Our results suggest that researchers need to carefully evaluate the differences among the financial constraint measures, especially their relation to financial distress, when choosing constraint indices for their studies and interpreting the results of past and present data.

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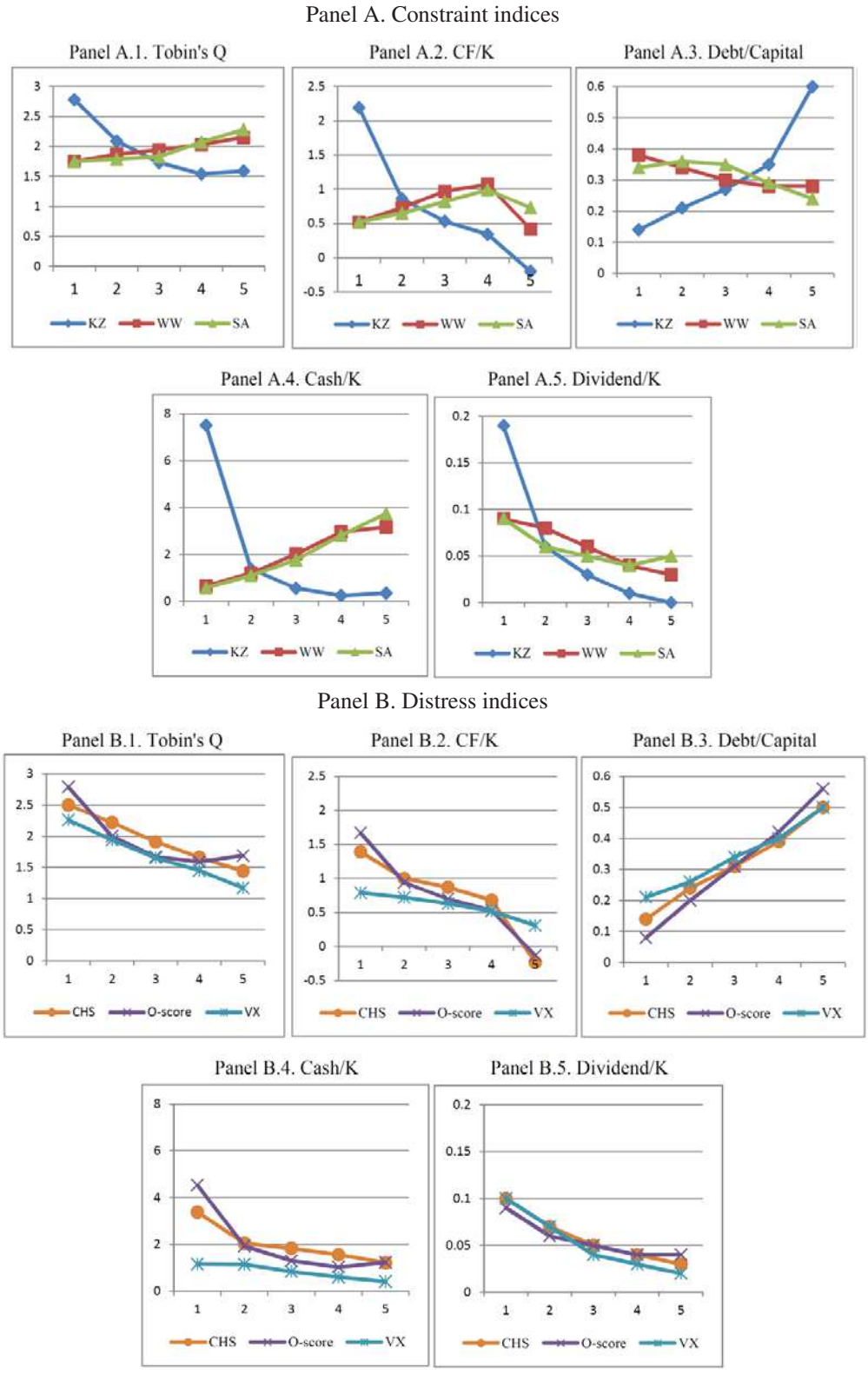
Appendix

Table 1A. Index definition

Variable names from the Compustat Annual or Quarterly and CRSP databases are italicized	
KZ	The KZ index is constructed following Lamont, Polk, and Saa-Requejo (2001) as KZ = 0.283Q − 1.002CF/K + 3.139Debt/Capital − 39.368Div/K − 1.315Cash/K, Q = [total assets (*at*) + fiscal year end price (*prcc_f*) × common shares outstanding (*csho*) − common equity (*ceq*) − deferred tax (*txdb)*]/property plant and equipment (*ppent*), CF/K = [income before extraordinary items (*ib*) + depreciation(*dp*) /lagged *ppent*, Debt/Capital = [long-term debt (*dltt*) + debt in current liabilities(*dlc*)]/[*dltt* + *dlc* + stockholder's equity(*seq*)], Div/K = [dividends common (*dvc*) + dividends preferred (*dvp*)]/lagged *ppent,* Cash/K = cash holdings and short − term investments (*che*)/lagged *ppent.*
WW	The WW index is constructed following Whited and Wu (2006) as WW = -0.091CF − 0.062DIVPOS + 0.021TLTD − 0.044LNTA + 0.102ISG − 0.035SG, CF = [income before extraordinary items (*ib*) + depreciation*(dp)*/total assets (*at*), DIVPOS = indicator set to one if dividends (*dvc + dvp*) is positive, and zero otherwise, TLTD = long-term debt (*dltt*)/total asset *(at*), LNTA = ln(total assets (*at*)), SG = sale (*sale)*/lagged *sale* where sale is inflation adjusted to 2004 dollars, ISG = average industry SG for each three-digit SIC industry each year.
SA	The SA index is constructed following Hadlock and Pierce (2010) as SA = -0.737Size + 0.043Size^2 − 0.040Age, Size = log(total assets (*at*)adjusted in 2004 dollars winsorized above at $4.5 billion, Age = number of years the firms is listed with a non-missing fiscal year end stock price on Compustat, winsorized above at 37 years.
CHS	The CHS is constructed following Campbell, Hilscher and Szilagyi (2008) as CHS = -20.26NIMTAAVG + 1.42TLMTA − 7.13EXRETAVG + 1.41SIGMA − 0.045RSIZE-2.13CASHMTA + 0.075MB-0.058PRICE-9.16, ME=price (*prc*) × shares outstanding (*shrout*), NIMTAAVG = $(1-2^{-1})/(1-2^{-4})(\text{NIMTA}_{t-1,\ t-3} + \ldots + 2^{-3}\text{NIMTA}_{t-10,t-12})$ where NIMTA = net income (*niq*)/[ME + total liabilities (*ltq*)], TLMA = total liabilities (*ltq*)/[ME + total liabilities (*ltq*)]. $\text{EXRETAVG} = \left(1-2^{\frac{1}{3}}\right)/\left(1-2^{\frac{4}{3}}\right)\left(\text{EXRET}_{t-1} + \ldots + 2^{-\frac{11}{3}}\text{EXRET}_{t-2}\right)$, where EXRET = $\log(1 + r_i) - \log(1 + r_{S\&P500,t})$ and r is monthly stock returns, SIGMA = $252 / (N-1)(\Sigma_{t-1,t-2,t-3} r_{j,k}^2)^{1/2}$ where r is daily stock returns. RSIZE = log(ME/total S&P 500 ME), CASHMTA = cash and short-term investments (*cheq*)/[ME + total liabilities (*ltq*)], MB = ME/BE, where book equity (BE) is constructed as in Cohen, Polk and Vuolteenaho (2003), PRICE = price (*prc*) of stock winsorized above $15. All variables are winsorized below and above at 5% level, Compustat quarterly and CRSP monthly data are used.
O-score	The O-score index is constructed following Ohlson(1980) as O-score = -1.32 − 0.407SIZE + 6.03TLTA − 1.43WCTA + 0.757CLCA − 2.37NITA − 1.83FUTL + 0.285INTWO − 1.72OENEG − 0.521CHIN, SIZE = log(*at*/GNP price − level index), where index assumes base value of 100 for 1968, TLTA = total liabilities (*lt*)/total assets (*at*), WCTA = working capital (*wcap*)/total assets (*at*), CLCA = current liabilities (*lct*)/current assets (*act*), NITA = net income (*ni*)/total assets (*at*), FUTL = funds provided by operations (*fopt*)/total liabilities (*lt*), INTWO = indicator function set to one if *ni* < 0 for the past two year, and zero otherwise, OENEG = indicator function set to one if *lt* > *at,* CHIN = (net income (*ni*) − lagged net income (*ni*))/|*ni*| − |lagged *ni*|.
VX	The measure is constructed as in Vassalou and Xing (2004). Find data at http://maria-vassalou.com/research/data/.



Notes: The figure presents firm characteristics of firms sorted on financial constraint indices and financial distress indices. For each year, firms are sorted into quintile bins based on financial constraints in Panel A and financial distress indices in Panel B. Financial constraint indices are the KZ, WW, and SA indices, and the three financial distress indices are the CHS, O-score, and VX measure. Mean firm characteristics are calculated for Tobin's Q, CF/K, Debt/Capital, Cash/K and Dividend/K in each of the five columns. The definitions and derivations of each variable constructing the KZ index can be found in the Appendix. All variables are winsorized at the top 99% and bottom 1% level.

Fig. 1. Firm characteristics sorted on financial constraint and financial distress indices