New Evidence on Measuring Financial Constraints: Moving Beyond the KZ Index

Charles J. Hadlock
Michigan State University

Joshua R. Pierce
University of South Carolina

We collect detailed qualitative information from financial filings to categorize financial constraints for a random sample of firms from 1995 to 2004. Using this categorization, we estimate ordered logit models predicting constraints as a function of different quantitative factors. Our findings cast serious doubt on the validity of the KZ index as a measure of financial constraints, while offering mixed evidence on the validity of other common measures of constraints. We find that firm size and age are particularly useful predictors of financial constraint levels, and we propose a measure of financial constraints that is based solely on these firm characteristics. (*JEL* G31, G32, D92)

A large literature in corporate finance examines how various frictions in the process of raising external capital can generate financial constraints for firms. Researchers have hypothesized that these constraints may have a substantial effect on a variety of decisions, including a firm's major investment and capital structure choices (e.g., Hennessy and Whited 2007). Additional research suggests that financial constraints may be related to a firm's subsequent stock returns (e.g., Lamont et al. 2001).

To study the role of financial constraints in firm behavior, researchers are often in need of a measure of the severity of these constraints. The literature has suggested many possibilities, including investment–cash flow sensitivities (Fazzari et al. 1988), the Kaplan and Zingales (KZ) index of constraints (Lamont et al. 2001), the Whited and Wu (WW) index of constraints (Whited and Wu 2006), and a variety of different sorting criteria based on firm characteristics. We describe these approaches in more detail below.

While there are many possible methods for measuring financial constraints, considerable debate exists with respect to the relative merits of each approach. This is not surprising, since each method relies on certain empirical and/or the-

---

Prior versions of this article circulated under alternative titles. We thank Julian Atanassov, Sreedhar Bharath, Murillo Campello, Jonathan Carmel, Jonathan Cohn, Ted Fee, Jun-Koo Kang, Michael Mazzeo, Uday Rajan, David Scharfstein, Michael Weisbach, two anonymous referees, and seminar participants at George Mason, Michigan, North Carolina, Oregon, Pittsburgh, South Carolina, Texas, Texas Tech, and Wayne State for helpful comments. Tehseen Baweja and Randall Yu provided superb data assistance. All errors remain our own. Send correspondence to Charles J. Hadlock, Department of Finance, Michigan State University, 315 Eppley Center, East Lansing, MI 48824-1121; telephone: (517) 353-9330. E-mail: hadlock@msu.edu.

doi:10.1093/rfs/hhq009 Advance Access publication March 1, 2010

oretical assumptions that may or may not be valid. In addition, many of these methods rely on endogenous financial choices that may not have a straightforward relation to constraints. For example, while an exogenous increase in cash on hand may help alleviate the constraints that a given firm faces, the fact that a firm chooses to hold a high level of cash may be an indication that the firm is constrained and is holding cash for precautionary reasons.

In this article, we study financial constraints by exploiting an approach first advocated by Kaplan and Zingales (1997). In particular, we use qualitative information to categorize a firm's financial constraint status by carefully reading statements made by managers in SEC filings for a sample of randomly selected firms from 1995 to 2004.[1] This direct approach to categorizing financial constraints is not practical for large samples, since it requires extensive hand data collection. However, by studying the relation between constraint categories and various firm characteristics, we can make inferences that are useful for thinking about how to measure financial constraints in larger samples.

We exploit our qualitative data on financial constraints for two purposes. First, we critically evaluate methods commonly used in the literature to measure financial constraints. We pay particular attention to the KZ index, given its relative prominence in the literature and the fact that our data are particularly useful for evaluating this measure. Second, after examining past approaches, we propose a simple new approach for measuring constraints that has substantial support in the data and considerable intuitive appeal. We then subject this new measure to a variety of robustness checks.

To evaluate the KZ index, we estimate ordered logit models in which a firm's categorized level of constraints is modeled as a function of five Compustat-based variables. This modeling approach parallels the analysis of Lamont et al. (2001), who create the original KZ index by estimating similar models using the original Kaplan and Zingales (1997) sample. The KZ index, which is based on the estimated coefficients from one of the Lamont, Polk, and Saa-Requejo models, loads positively on leverage and Q, and negatively on cash flow, cash levels, and dividends.

In the ordered logit models we estimate, only two of the five components of the KZ index, cash flow and leverage, are consistently significant with a sign that agrees with the KZ index. For two of the other five components, Q and dividends, the coefficients flip signs across estimated models and in many cases are insignificant, particularly for the dividend variable. Finally, in contrast to its negative loading in the KZ index, we find that cash holdings generally display a positive and significant coefficient in models predicting constraints. This positive relation is consistent with constrained firms holding cash for precautionary reasons.

[1] The information we use includes statements regarding the strength of a firm's liquidity position and the firm's ability to raise any needed external funds. Additional details are provided below.

Our estimates differ substantially from the KZ index coefficients even though we use a parallel modeling approach. Upon further investigation, we find that the differences most likely arise from the fact that the dependent variable in the original modeling underlying the KZ index includes quantitative information in addition to qualitative information. This treatment adds a hard-wired element to the estimates underlying the KZ index, since the same information is mechanically built into both the dependent and the independent variables. In our treatment, we are careful to avoid this problem. Once this problem is addressed, our findings indicate that many of the estimated coefficients change substantially.

Clearly our evidence raises serious questions about the use of the KZ index. To explore this issue further, we calculate the KZ index for the entire Compustat universe and compare this to an index constructed using the coefficient estimates from one of our models. We find that the correlation between the traditional index and our alternative version of this index is approximately zero. This provides compelling evidence that the KZ index is unlikely to be a useful measure of financial constraints. Thus, it would appear that researchers should apply extreme caution when using the traditional KZ index or interpreting results based on index sorts.

An alternative index of financial constraints has been proposed by Whited and Wu (2006), who exploit a Euler equation approach from a structural model of investment to create the WW index. This index loads on six different factors created from Compustat data. When we use these six factors as explanatory variables in ordered logit models predicting constraints, only three of the six variables have significant coefficients that agree in sign with the WW index. Two of these variables, cash flow and leverage, are essentially the same variables that figure prominently in the KZ index. Thus, the only truly new variable from the WW index that offers marginal explanatory power in our models is firm size. As one would expect, smaller firms are more likely to be constrained.

A more traditional approach to identifying financially constrained firms is to sort by a firm characteristic that is believed to be associated with constraints. To evaluate this approach, we study the relation between several common sorting variables and our financial constraint categories. We find that some of these sorting variables are not significantly related to constraint categories. Two variables that do appear to be closely related to financial constraints are firm size and age. An appealing feature of these variables is that they are much less endogenous than most other sorting variables. Once we control for firm size and age, some of the variables that are significantly related to constraints in a univariate sense become insignificant. Thus, it appears that some common sorting variables are largely proxies for firm size and/or age.

The only variables that consistently predict a firm's constraint status in our sample after controlling for size and age are a firm's leverage and cash flow. However, given the endogenous nature of these variables, particularly the leverage variable, we are hesitant to recommend any measure of constraints that is derived from a model that relies on these factors. In addition, as we explain below, typical disclosure practices may lead us to under-detect the presence of constraints in firms with low leverage, thus possibly leading to a spurious coefficient on leverage. Given these concerns, we recommend that researchers rely solely on firm size and age, two relatively exogenous firm characteristics, to identify constrained firms.

To provide further guidance on the role of size and age in financial constraints, we examine the relation between these factors and constraints for subsamples grouped by firm characteristics and time period. While there is minor variation across groups, the general form of the relation between size, age, and financial constraint categories appears to be robust. We find that the role of both size and age in predicting constraints is nonlinear. At certain points, roughly the sample ninety-fifth percentiles ($4.5 billion in assets, thirty-seven years in age), the relation between constraints and these firm characteristics is essentially flat. Below these cutoffs, we uncover a quadratic relation between size and constraints and a linear relation between age and constraints. We represent this relation in what we call the size–age or SA index.[2] This index indicates that financial constraints fall sharply as young and small firms start to mature and grow. Eventually, these relations appear to level off.

Since all measures of financial constraints have potential shortcomings, we attempt to provide corroboratory evidence regarding our proposed index. In particular, we exploit the cash flow sensitivity of cash approach advanced by Almeida et al. (2004). When we sort firms into constrained and unconstrained groups using the SA index, we find that the constrained firms display a significant sensitivity of cash to cash flow, whereas the unconstrained firms do not. This evidence increases our confidence in the SA index as a reasonable measure of constraints.

While we cannot prove that our index is the optimal measure of constraints, it has many advantages over other approaches, including its intuitive appeal, its independence from various theoretical assumptions, and the presence of corroborating evidence from an alternative approach. The correlation between the SA index and the KZ index is negligible, casting additional doubt on the usefulness of the KZ index. The correlation between the SA index and the WW index is much higher, but this largely reflects the fact that the WW index includes firm size as one of its six components.

For completeness, we use our data to revisit the Kaplan and Zingales (1997) assertion that investment–cash flow sensitivities are dubious measures

[2] This index is derived from coefficients in one of our ordered logit models presented below. The index is calculated as $(-0.737^*\ \text{Size}) + (0.043^*\ \text{Size}^2) - (0.040^*\ \text{Age})$, where Size equals the log of inflation-adjusted book assets, and Age is the number of years the firm is listed with a non-missing stock price on Compustat. In calculating this index, Size is winsorized (i.e., capped) at (the log of) $4.5 billion, and Age is winsorized at thirty-seven years.

of financial constraints.[3] Our findings here are consistent with what Kaplan and Zingales (1997) report. In particular, using both our direct qualitative categorization of constraints and the SA index, we find that investment–cash flow sensitivities are not monotonically increasing in a firm's level of financial constraints.

The rest of the article is organized as follows. In Section 1, we detail our sample selection procedure and our assignment of firms into financial constraint groups using qualitative information. In Section 2, we use our data to critically evaluate past approaches for measuring financial constraints. In Section 3, we further explore the relation between financial constraints and the size and age of a firm and propose a simple index based on these firm characteristics. In Section 4, we revisit the prior evidence on investment–cash flow sensitivities. Section 5 concludes.

1. Sample Construction and Categorization of Financial Constraints

1.1 Sample selection and data collection

Our goal is to study a large and representative sample of modern public firms. We begin with the set of all Compustat firms in existence at some point between 1995 and 2004. From this universe, we eliminate all financial firms (SIC Codes 6000–6999), regulated utilities (SIC Codes 4900–4949), and firms incorporated outside the United States. We then sort firms by Compustat identifier and select every twenty-fourth firm for further analysis. This procedure results in a random sample of 407 firms that should be broadly representative of the overall Compustat universe.

After selecting the initial sample, we locate each firm's annual reports and 10-K filings from Lexis-Nexis and SEC EDGAR. We restrict the sample to firm years for which we can locate at least one of these electronic filings. In addition, we impose the requirement that the firm has nonzero sales and assets in the observation year and sufficient accounting data to calculate all of the components of the KZ index. The resulting sample consists of 356 unique firms and 1,848 firm years during the 1995–2004 period.[4]

To collect qualitative information on financial constraints, we carefully read annual reports and 10-K filings following the general procedure outlined by Kaplan and Zingales (1997). In particular, for each firm year, we read the annual letter to shareholders and the management discussion and analysis section. In addition, we perform an electronic search of the entire text of the annual report and/or 10-K to identify all sections of text that include

[3] For critiques of the investment–cash flow approach, see Cleary (1999), Kaplan and Zingales (1997), Erickson and Whited (2000), Alti (2003), and Moyen (2004). For a defense, see Fazzari et al. (2000).

[4] While we borrow heavily from Kaplan and Zingales (2000), the sample we study is quite different from theirs. They study a small sample (forty-nine firms) from the 1970s and 1980s that satisfies a variety of sampling requirements pertaining to industry, size, growth, dividend policy, and survival.

the following keywords: financing, finance, investing, invest, capital, liquid, liquidity, note, covenant, amend, waive, violate, and credit.

Using these procedures, we extract every statement that pertains to a firm's ability to raise funds or finance its current or future operations.[5] In many filings, we identify multiple statements. We assign to each individual statement an integer code from 1 to 5, with higher (lower) numbers being more indicative of the presence (lack) of constraints. These codes are based on the description provided by KZ regarding their categorization scheme. Later, we aggregate these codes to derive a single overall categorization of a firm's financial constraint status in any given year. It is important to note that there are literally hundreds of different types of relevant statements made by sample firms. Grouping such a large number of statements into five categories necessarily requires some judgment. Specific examples of how we code different types of statements are reported in the Appendix.

Following the spirit of the KZ algorithm, we assign to category 1 all statements that indicate that a firm has excessive or more than sufficient liquidity to fund all of its capital needs. In category 2, we place all statements that indicate that a firm has adequate or sufficient liquidity to fund its needs. The main difference between category 1 and category 2 is the strength of the firm's language. In category 3, we place all statements that provide some qualification regarding the firm's ability to fund future needs, but that do not indicate any type of current problem. Most of these statements are soft warnings, often generic or boilerplate in character, indicating that under some possible future scenario the firm could have difficulty raising funds or financing desired investments. Category 3 also includes all statements that are opaque and thus not easy to classify into the other groups.

We place all statements that indicate some current liquidity problem into category 4, but with no direct indication that these problems have led to a substantive change in the firm's investment policy or to overt financial stress. This would include difficulties in obtaining financing or the postponing of a security issue. Finally, category 5 includes all cases of clear financial problems/constraints including a current and substantive covenant violation, a revelation that investment has been affected by liquidity problems, going concern statements, or involuntary losses of usual sources of credit.[6]

[5] We were assisted by two trained accountants in our search and categorization efforts. All filings were searched independently by at least two individuals to minimize the probability of missing any relevant disclosure.

[6] Some firms indicate that a covenant had been waived or amended. Often these firms indicate that the violation was technical in nature and not of substantive concern. For example, some firms indicate that a covenant was routinely waived, and others indicate that an accounting ratio fell below a threshold because of a one-time event such as an asset sale or special charge. Since these cases are quite different from and less serious than current violations, in our baseline coding, we ignore waived/amended covenants. Alternative treatments of these cases are discussed below.

1.2 Categorization of a firm's overall financial constraint status

We proceed to assign each firm year to a single financial constraint group. Borrowing from the KZ algorithm and terminology, we create five mutually exclusive groups: not financially constrained (NFC), likely not financially constrained (LNFC), potentially financially constrained (PFC), likely financially constrained (LFC), and financially constrained (FC). We place in the NFC group firms with at least one statement coded as a 1 and no statement coded below a 2. These are firms that indicate more than sufficient liquidity and reveal no evidence to the contrary. In the LNFC category, we place all firms with statements solely coded as 2s. These are firms that indicate adequate or sufficient liquidity with no statements of excessive liquidity and no statements indicating any weakness.[7]

We place all firms with mixed information on their constraint status into the PFC category. Specifically, we include all observations in which the firm reveals a statement coded as 2 or better (indicating financial strength), but also reveals a statement coded as 3 or worse (indicating possible financial weakness). We also include in this category cases in which all of the firm's statements are coded as 3.

The LFC category includes firms with at least one statement coded as 4, no statement coded as 5, and no statement coded better than 3. These are firms that indicate some current liquidity problems, with no offsetting positive statement and no statement that is so severe that they are brought into the lowest (FC) category. Finally, all observations with at least one statement coded as 5 and no other statement coded better than 3 are assigned to the FC category. These are firms that clearly indicate the presence of constraints with no strong offsetting positive revelation.

We refer to this initial categorization scheme as qualitative scheme 1 and report a sample breakdown in Column 1 of table 1. For comparison purposes, we report in Column 4 the corresponding figures reported by KZ. One peculiar feature of qualitative scheme 1 is that a large number of firms are placed in the PFC category (32.36% versus 7.30% in the KZ sample). This elevated rate primarily reflects the fact that many firms in our sample provide boilerplate generic warnings about future uncertainties that could affect a firm's liquidity position. These statements place many firms that otherwise report strong financial health into the PFC category. In our estimation, many of these generic warning statements are uninformative. In particular, they appear to be included as a blanket protection against future legal liability and often pertain to unforeseen or unlikely contingencies that could potentially affect almost any firm.

In light of these observations, we prefer an alternative assignment procedure that ignores all generic or soft nonspecific warnings regarding a firm's future liquidity position. This procedure, which we refer to as qualitative scheme 2,

[7] We also place in this group the few observations with no useful qualitative disclosure that could be used to ascertain a firm's financial constraint status. If we exclude these observations, the ordered logit results we report below in tables 3, 4, and 6 are substantively unchanged.

Table 1
Frequency of Financial Constraint Categories

	Constraint assignment procedure			
	Qualitative scheme 1	Qualitative scheme 2	Qual./quant. scheme	KZ sample
Not financially const: NFC	10.28%	10.98%	55.84%	54.50%
Likely not financially const.: LNFC	50.49%	71.59%	31.01%	30.90%
Potentially financially const.: PFC	32.36%	10.55%	6.44%	7.30%
Likely financially const.: LFC	0.32%	0.32%	2.49%	4.80%
Financially const.: FC	6.55%	6.55%	4.22%	2.60%
Correlation with qual. scheme 1	1.00			
Correlation with qual. scheme 2	0.89	1.00		
Correlation with qual./quant. scheme	0.75	0.87	1.00	

This table reports the fraction of all firm-year observations in which an observation is assigned to the indicated financial constraint group. The figures in Columns 1–3 pertain to our random sample of 1,848 Compustat firm years representing 356 firms operating during the 1995–2004 period for observations with non-missing data on the five components of the KZ index. Qualitative scheme 1 uses only qualitative statements made by firms in their filings subsequent to the fiscal year-end regarding the firm's liquidity position and ability to fund investments. The exact algorithm used in coding and categorizing this information is detailed in the text. Qualitative scheme 2 is constructed identically to scheme 1 except that it ignores all soft and generic nonspecific warnings made by firms regarding possible future scenarios under which the firm could experience a liquidity problem. The qualitative/quantitative scheme augments scheme 2 by moving firms upward one category if the firm materially increases dividends, repurchases shares, or has a high (top quartile) level of (cash/capital expenditures) on hand. Additional details concerning the assignment procedures are provided in the text and the Appendix. The figures in Column 4 are taken from table 2 of Kaplan and Zingales (1997) and are based on their sample and algorithm for categorizing constraints. The correlation figures represent simple correlations over the sample between the two constraint assignment procedures in the indicated cell.

is identical to qualitative scheme 1 outlined earlier except that it ignores this one class of statements. As we report in Column 2 of table 1, this modification moves many (a few) firms from the PFC grouping up into the LNFC (NFC) grouping.

It is important to emphasize that the categorization schemes outlined above deliberately differ from the KZ procedure in one key respect. In particular, in our categorization, we choose to ignore quantitative information on both the size of a firm's cash position and its recent dividend/repurchase behavior. We do so this because it seems inappropriate to incorporate this information into categories that will eventually be used for coding our dependent variables, given that this same information will later be used to construct some of the independent variables. Such treatment would lead to uninformative coefficients that are hardwired and potentially misleading in terms of their ability to describe the underlying relation between quantitative variables and qualitative disclosures of constraints.

For completeness, we experiment with modifying our qualitative scheme 2 categorization to more closely match the exact KZ treatment by incorporating quantitative information on dividends, repurchases, and cash balances. In particular, we move a firm's constraint status up one notch in a given year (e.g., from PFC to LNFC) if any of the following criteria are met: (i) the firm initiates a dividend; (ii) the firm has a material increase in dividends (change in dividends/assets greater than the fifth percentile of dividend increasers); (iii)

Table 2
Sample Characteristics

Statistic	(1) Mean	(2) Mean	(3) Mean	(4) Median	(5) Median	(6) Median
Cash flow/K	−2.379	−0.915	−9.315	0.243	0.327	−0.907
Cash/K	3.689	3.579	4.208	0.439	0.508	0.199
Dividends/K	0.077	0.064	0.139	0.000	0.000	0.000
Tobin's Q	2.672	2.036	5.686	1.535	1.489	1.809
Debt/total capital	0.338	0.277	0.629	0.275	0.224	0.728
Capital exp./K	0.411	0.415	0.392	0.214	0.229	0.133
Prop., plant, equip. (PPE)	278.370	303.457	159.480	20.664	29.594	2.951
Book assets	782.928	872.877	356.647	124.627	167.089	14.800
Age	13.923	14.716	10.165	9.000	9.000	7.000
Sales growth	0.272	0.247	0.394	0.057	0.070	−0.049
# of qualitative statements	3.37	3.32	3.62	3.00	3.00	3.00
Which observations	All	Less constrained	More constrained	All	Less constrained	More constrained

The figures in each column represent the mean or median of the indicated variable over the indicated set of observations. The figures in Columns 1 and 4 refer to our random sample of 1,848 Compustat firm years representing 356 firms operating during the 1995–2004 period. The figures in Columns 2 and 5 are calculated over the subset of observations in which the firm was classified as less constrained (NFC/LNFC) using qualitative scheme 2 to categorize constraints. The figures in Columns 3 and 6 are calculated over the subset of observations in which the firm was classified as more constrained (PFC/LFC/FC). All variables are constructed from Compustat information. The PPE and book assets statistics are in millions of inflation adjusted year 2004 dollars. All variables that are normalized by K are divided by beginning-of-period PPE. Cash flow is defined to be operating income plus depreciation (Compustat item 18 + item 14). Cash is defined to be cash plus marketable securities (item 1). Dividends are total annual dividend payments (item 21 + item 19). Tobin's Q is defined as (book assets minus book common equity minus deferred taxes plus market equity) / book assets calculated as [item 6 − item 60 − item 74 + (item 25 × item 24)] / item 6. Debt is defined as short-term plus long-term debt (item 9 + item 34). Total capital is defined as debt plus total stockholders' equity (item 9 + item 34 + item 216). If stockholders' equity is negative, we set debt/total capital equal to 1. Capital expenditures are item 128. Age is defined to be the number of years preceding the observation year that the firm has a non-missing stock price on the Compustat file. Sales growth is defined as (sales in year t minus sales in year $t-1$)/sales in year $t-1$. Sales are first inflation adjusted before making this growth calculation. The number of statements row refers to the number of qualitative statements from disclosure filings that were used in assigning the firm to a constraint grouping using qualitative scheme 2, as outlined in the text.

the firm repurchases a material number of shares (repurchases/assets greater than the fifth percentile of repurchasers); or (iv) the firm's balance of cash and marketable securities normalized by capital expenditures falls in the top sample quartile. The resulting categorization is referred to in what follows as the qualitative/quantitative categorization scheme. We report in Column 3 of table 1 the percentage of firms in each of the constraint categories using this alternative scheme. As the figures illustrate, the sample frequencies using the qualitative/quantitative scheme more closely resemble the figures reported by KZ, with the modal category being firms in the most unconstrained (NFC) category.

In table 2, we present summary statistics for the sample as a whole and for subsamples grouped by the level of constraints using our preferred constraint assignment procedure, qualitative scheme 2. Several interesting differences between the more constrained and less constrained firms emerge. In particular, comparing both the reported means and medians for the subsamples grouped by constraints (NFC/LNFC versus PFC/LFC/FC), the constrained firms appear to have lower cash flow, more debt, and higher Q values, and they tend to be smaller and younger firms. Our subsequent multivariate analysis will consider these differences in more detail.

Before proceeding, we consider the relative stability of our constraint categories. If a firm's constraint status changes frequently, this may indicate that our categories are quite noisy. Alternatively, if a firm's status almost never changes, this may indicate that managers are overly reluctant to disclose meaningful changes in their firm's financial position. To investigate this issue, for all consecutive annual observations in the sample, we calculate the frequency of changes in a firm's constraint status (using qualitative scheme 2). For 79.71% of all observations, a firm's constraint status is unchanged, while in 15.16% of all cases, the firm's status increases or decreases by one level. In the remaining 5.13% of all cases, a firm's status changes by more than one level. While it is difficult to evaluate these figures, they appear consistent with what one would expect if firms are disclosing meaningful information and if their financial constraint status is fairly persistent with an occasional material shock.

2. Evaluating Existing Approaches to Measuring Financial Constraints

Following KZ and Lamont et al. (2001), our basic empirical approach is to estimate ordered logit models in which a firm's qualitatively determined financial constraint status is modeled as a function of various quantitative explanatory variables. Our choice of explanatory variables is guided by prior approaches to measuring constraints. This analysis should provide us with useful information in evaluating these prior approaches. The dependent variable in all estimated models assumes a value from 1 for the most unconstrained (NFC) observations to 5 for the most constrained (FC) observations. Each firm year is treated as a single observation, and all explanatory variables are winsorized at the 1% tails.

2.1 Evaluating the KZ index

In this subsection, we consider ordered logit models that parallel the models underlying the KZ index.[8] All variable definitions are borrowed directly from Lamont et al. (2001). We report our initial baseline models in Columns 1 and 2 of table 3, using the two different qualitative schemes to construct the dependent variable. As the figures illustrate, the coefficients on cash flow, Q, and debt are significant (5%, 1%, and 1% levels, respectively) and of the same sign (negative, positive, and positive, respectively) as in the KZ index. Thus, while the exact magnitudes differ from the KZ index, the coefficients are generally in agreement with the index. The positive coefficients on the other two ex-

[8] The KZ index, as reported by Lamont et al. (2001), is calculated as $-1.002(\text{CashFlow}/K) + 0.283(Q) + 3.139(\text{Debt/Capital}) - 39.368(\text{Div}/K) - 1.315(\text{Cash}/K)$.

Table 3
Ordered Logit Models Predicting Financial Constraint Status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow/K	−0.008** (0.004)	−0.009** (0.004)	−0.035*** (0.008)	−0.143*** (0.017)	−0.896*** (0.117)	−0.021*** (0.008)	−0.019*** (0.004)
Q	0.037*** (0.009)	0.031*** (0.009)	0.084*** (0.023)	0.099** (0.040)	−0.004 (0.011)	0.037 (0.040)	0.025*** (0.009)
Debt/total capital	1.837*** (0.156)	2.643*** (0.184)	2.758*** (0.195)	2.597*** (0.192)	2.387*** (0.191)	2.777*** (0.228)	2.707*** (0.167)
Dividends/K	0.190 (0.164)	0.224 (0.182)	0.246 (0.334)	−1.171** (0.536)	−1.543 (1.531)	−0.074 (0.292)	−0.513*** (0.195)
Cash/K	0.025*** (0.004)	0.017*** (0.005)	0.019** (0.009)	0.035*** (0.013)	0.284* (0.167)	0.017** (0.007)	−0.022*** (0.006)
Log-likelihood	−1983.929	−1530.061	−1408.514	−1488.404	−1503.759	−1180.758	−1796.799
Pseudo-R^2	0.059	0.096	0.102	0.121	0.112	0.071	0.109
Observations	1848	1848	1752	1848	1848	1562	1848
Specification	Baseline: qualitative scheme 1	Baseline: qualitative scheme 2	Exclude 1% tails	Winsorize at 5%	Normalize by assets	Assets > \$10 million	Baseline: qual./quant scheme

All coefficient estimates are maximum likelihood estimates of an ordered logit model estimated over annual observations. Asymptotic standard errors are reported in parentheses under the coefficients. All estimates are derived from our random sample of 1,848 Compustat firm years representing 356 firms operating during the 1995–2004 period or the indicated subsample. The dependent variable in model 1 (models 2–6) is based on a firm's level of constraints using purely qualitative information following the algorithm described in the text for qualitative scheme 1 (qualitative scheme 2). The dependent variable in model 7 is based on the qualitative/quantitative scheme. In all models, the dependent variable is coded as an integer varying from 1 for the most unconstrained firms (NFC) to 5 for the most constrained (FC) firms. The cash flow, Q, debt, dividends, and cash variables are defined as in the preceding tables and are constructed to be consistent with KZ and Lamont et al. (2001). All fiscal year Compustat variables are matched to corresponding constraints information garnered from filings made immediately following the fiscal year-end. K denotes beginning-of-year property, plant, and equipment. The models in Columns 1, 2, 5, 6, and 7 have all explanatory variables winsorized at the 1% tails. The model in Column 3 excludes all observations with an explanatory variable falling in one of the 1% tails (except for variables that are naturally truncated at a minimum of 0). The model in Column 4 winsorizes all explanatory variables at the 5% tails. The model in Column 5 replaces the K = PPE normalization of the indicated explanatory variables with a K = book assets normalization. The model in Column 6 requires a firm to have book assets exceeding \$10 million (inflation adjusted to 2004).
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

planatory variables, dividends and cash, are both opposite in sign to their representation in the KZ index, and in the case of cash, significantly so ($P < .01$). This suggests that these factors, particularly cash, may be related to financial constraints in a manner that is opposite to what is suggested by the KZ index.

The estimates in these initial models raise some general questions about the validity of the KZ index as a measure of constraints. Of particular concern is the role of cash holdings as an indicator of constraint status. Before drawing conclusions, in Columns 3–6 of table 3, we consider variations in our modeling choices. The dependent variable is based on qualitative scheme 2. The corresponding results for qualitative scheme 1 are similar in character.

In Column 3 of table 3, we present estimates for a model with observations in the lower/upper 1% tails trimmed (i.e., eliminated) rather than winsorized. The coefficients here all take the same signs as in the initial models, with some minor changes in significance levels. In Column 4, we winsorize the explanatory variables at the 5% tails. With the exception of dividends, the coefficients again have the same signs and similar significance levels as the earlier models. The coefficient on dividends in this model is negative and significant ($t = 2.18$), thus now agreeing in sign with the KZ index.

While the preceding specifications use PPE to normalize some of the explanatory variables, it is also common to normalize by book assets. As we report in Column 5 of table 3, if we make this change, the coefficients on cash flow and debt continue to be significant and have signs that agree with the KZ index. However, the coefficients on Q and dividends are both insignificant, and the sign of the coefficient on Q now disagrees with the KZ index. In this model, the positive coefficient on cash remains of an opposite sign to its loading in the KZ index, and it continues to be at least marginally significant ($t= 1.71$).

Since our sample contains many small firms, in Column 6 of table 3, we impose a requirement that the firm have book assets exceeding \$10 million. The coefficients on cash flow and debt continue to be significant and agree in sign with the KZ index. The coefficients on Q and dividends remain insignificant, although they do agree in sign with the index. Similar to the other models, the coefficient on cash remains stubbornly positive and significant ($t = 2.43$).

A few general conclusions emerge from this analysis.[9] First, it appears that a firm's cash flow and debt level are consistently significantly related to qualitative indicators of a firm's constraint status in a way that is captured by the KZ index. The evidence on Q and dividends is more mixed. In some of the estimated models, the coefficients on these variables are both significant and in agreement in sign with the KZ index. However, in some models, the coefficients are insignificant, and in some cases, the sign on the coefficient disagrees with the index. Since one could argue that any or all of these models are a

[9] We have conducted numerous other robustness checks, including (i) treating covenant waivers and amendments as equivalent to non-waived covenant violations; and (ii) restricting attention to firms with positive net income. The results with these modifications are similar in character to what we report in tables 3, 4, and 6.

reasonable way to model the available data, this evidence must be characterized as inconclusive. Certainly no strong case can be made that the KZ index correctly captures the ability of these two factors to predict constraints. This is particularly true for the dividend variable, which is almost always insignificant.

The evidence we present on the cash variable is interesting and suggests that firms with more cash are actually more likely to be constrained, exactly the opposite of what is suggested by the KZ index. Our finding on cash holdings is consistent with the notion that constrained firms store cash for precautionary reasons, a hypothesis that has prior support in the literature (e.g., Calomiris et al. 1995; Opler et al. 1999; Almeida et al. 2004).

Taken together, our findings suggest that researchers using the KZ index should proceed with extreme caution. Our coefficient estimates, which are derived using a refined dependent variable and a large, modern, and representative sample, are not, as a group, strongly related to the KZ index coefficients. To make this notion more precise, we use the coefficients in our baseline model (Column 2 of table 3) to create a new and improved version of the KZ index. We then compute index values for the entire Compustat universe from 1995 to 2004 using both the new-and-improved index and the traditional KZ index. In creating index values, we winsorize all Compustat variables at the 1% tails to minimize the effect of outliers. In addition, we eliminate financial firms, utilities, and foreign firms. Across this population, the correlation between the traditional index and the new-and-improved version is -0.023. This finding raises serious questions about the usefulness of the KZ index as a measure of financial constraints.

The contrast between our estimated coefficients and the KZ index is puzzling since we use a very similar modeling approach. The difference may arise from sampling differences. To investigate this possibility, we estimate our baseline model over various subsamples that more closely resemble the KZ sample. In particular, we select subsamples that are more similar to the KZ sample based on firm size, dividend policy, survivorship, sales growth, and industry composition. The results for each of these subsamples, and also for the intersection of all subsamples, are quite similar to what we report in table 3 and thus are omitted for brevity (available upon request). In particular, we continue to find that only the coefficients on cash flow and leverage are consistently significant, with a sign that agrees with the KZ index. Thus, the differences we report do not appear to be driven solely by differences in sampling criteria.

An alternative possibility is that the estimated KZ index coefficients may be highly sensitive to the inclusion of the same quantitative information in the dependent and independent variables. To investigate this explanation, in Column 7 of table 3, we present estimates for an ordered logit model that more closely matches the exact KZ treatment by using the mixed qualitative/quantitative variable introduced earlier as the dependent variable. These findings are easy to characterize. All of the coefficients on the explanatory variables are significant and agree in sign with the KZ index. Moreover, if we create an index using these coefficients and correlate this with the traditional KZ index calculated over the Compustat universe, the correlation is a respectable 0.624. Thus, once we include quantitative information in the constraint assignment procedure, our estimates are reasonably supportive of the KZ index.

The evidence above appears to explain the difference between our estimates and those that underlie the KZ index. In most of our initial models, cash and dividends do not significantly predict constraints in the manner embodied by the traditional index. Once we modify the modeling to include cash and dividends in the financial constraint assignment procedure, as is the case in the KZ index model, we find that these characteristics are significantly related to constraints, with a sign that agrees with the index. However, for obvious reasons, it is of dubious value to rely on coefficients derived from a regression in which the same information is incorporated into the dependent and independent variables. This shortcoming appears to be the fatal flaw underlying the KZ index and the source of the differing coefficient estimates.

2.2 The WW index

An alternative index of financial constraints is advanced by Whited and Wu (2006). The WW index is a linear combination of six empirical factors: cash flow, a dividend payer dummy, leverage, firm size, industry sales growth, and firm sales growth. The WW definitions of leverage and cash flow differ slightly from the KZ definitions. As WW report, the correlation between the WW index and the KZ index is approximately 0.

To provide evidence on the WW index, we estimate an ordered logit model in which financial constraints are modeled as a function of the six WW index components. In this model, and all subsequent ordered logit models in the article, we use a financial constraints dependent variable based on our preferred constraint assignment procedure, namely, qualitative scheme 2. The estimates on these WW index components are reported in Column 1 of table 4.

As the figures in the table reveal, the coefficients on the WW-cash flow and WW-leverage variables have the same signs and significance levels as their KZ counterparts. The firm size variable is negative and highly significant, indicating that larger firms are generally less constrained. Two of the other three WW variables are insignificant (firm sales growth and industry sales growth), while the other variable (the dividend dummy) is significant but with a sign that is opposite of its representation in the WW index. This evidence suggests that firm size (log of assets) is the only component of the WW index that helps predict constraints above and beyond the factors that are included in the KZ index.

This evidence on the WW index can best be characterized as mixed, as our estimates essentially support three of the six components of the index. The overall usefulness of the WW index is likely to depend on the variances and covariances between these six factors in a given sample, and also on a researcher's comfort level in using endogenous financial choices (e.g., leverage)

Table 4
Predicting Financial Constraint Status Using Alternative Explanatory Variables

Specification	(1) WW Vars. together	(2) Individual variables	(3) Indiv. Vars + Size + Age	(4) Parsimonious model
KZ: Cash flow		−0.024*** (0.003)	−0.010*** (0.003)	
KZ: Q		0.071*** (0.008)	0.012 (0.008)	
KZ: Leverage		2.731*** (0.172)	2.858*** (0.181)	
KZ: (Dividends/K)		0.522*** (0.158)	0.156 (0.163)	
KZ: (Cash/K)		0.007 (0.004)	−0.006 (0.005)	
WW: Cash flow	−0.626*** (0.106)	−1.217*** (0.107)	−0.657*** (0.100)	−0.592*** (0.100)
WW: Dividend dummy	0.375*** (0.127)	0.013 (0.113)	0.470*** (0.122)	
WW: Leverage	1.479*** (0.277)	0.804*** (0.242)	1.914*** (0.260)	1.747*** (0.268)
WW: Size	−0.413*** (0.029)	−0.435*** (0.025)	−0.393*** (0.026)	−0.357*** (0.030)
WW: Industry sales growth	0.049 (0.317)	0.016 (0.308)	−0.197 (0.311)	
WW: Firm sales growth	0.014 (0.046)	0.122*** (0.043)	0.042 (0.043)	
ACW: Payout		0.085 (0.134)	0.252* (0.136)	
ACW: Size		−0.0001*** (0.00002)		
ACW: No bond rating		1.791*** (0.202)	0.155 (0.239)	
ACW: No comm. pap. rating		1.911*** (0.226)	−0.085 (0.272)	
Firm age		−0.044*** (0.004)	−0.022*** (0.004)	−0.025*** (0.004)

All estimates are derived from an underlying ordered logit model using firm years as the unit of observation and a dependent variable based on qualitative scheme 2 coded as an integer varying from 1 for NFC firms up to 5 for FC firms. Standard errors are reported in parentheses. All estimates are derived from the sample of 1,848 observations used in the prior tables or the subsample with available information to construct the explanatory variable(s). Each estimate in Column 2 is from a separate ordered logit model in which the indicated variable is the sole explanatory variable. The estimates in Columns 1 and 4 are from single regressions in which all of the indicated variables are included simultaneously. Each estimate in Column 3 is from a separate ordered logit model in which the WW size variable, firm age, and the indicated variable are included together as the only explanatory variables. The size and age coefficients in these Column 3 models are not reported except in the size and age rows in which case we report the coefficients on these two variables when they are included together as the sole two explanatory variables. The KZ variables are defined as in the earlier tables. WW-Cash flow is defined as (operating income plus depreciation)/beginning-of-year book assets. The WW-dividend dummy is a variable indicating positive preferred or common dividends. WW-Leverage is defined as (book value of long-term debt)/current book assets. WW-Size is defined as the log of inflation adjusted (to 2004) assets. Industry sales growth is defined as the most recent annual percentage change in inflation-adjusted three-digit industry sales. Firm sales growth is the firm's most recent annual percentage change in inflation-adjusted sales. ACW-payout is (common dividends + preferred dividends + share repurchases)/operating income. ACW size is the firm's inflation-adjusted book assets. ACW-no bond rating is set equal to 1(0) if a firm has debt in a given year but has no current investment-grade bond rating (has an investment-grade bond rating). This variable is set equal to missing if a firm does not have debt. The ACW commercial paper variable is defined in an analogous manner but indicates the lack/presence of an investment-grade commercial paper rating. Age is defined as the current year minus the first year that the firm has a non-missing stock price on Compustat. All variables are winsorized at the 1% and 99% tails, and leverage and ACW-payout ratios above 1 are set equal to 1. The ACW payout variable is set equal 1 if a firm has negative operating income and positive dividends.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

to measure financial constraints. In our view, the principal strength of the WW index is its reliance on firm size. As we discuss below, this is likely to be a particularly important component of any reasonable measure of financial constraints. We will revisit the role of firm size in the WW index after discussing size effects in more detail.

2.3 Using firm-specific characteristics to sort firms into financial constraint groups

A traditional approach for identifying financially constrained firms, dating back to Fazzari et al. (1988), is to separate firms into groups based on a sorting characteristic that a researcher is confident is related to financial constraints. A recent example of this approach is illustrated by the work of Almeida et al. (2004) (ACW hereafter). These authors use univariate sorts based on a firm's payout ratio, size, bond rating, and commercial paper rating to select relatively more and less constrained firms. In this section, we consider the informativeness of various sorting factors as measures of financial constraints.

To select sorting factors, we consider the five variables in the KZ index, the six variables in the WW index, the four sorting variables used by ACW, and also firm age, a variable that several other authors have associated with constraints (e.g., Rauh 2006; Fee et al. 2009). While there is a close relationship between some of these variables, since each study uses different definitions, we consider all sixteen variables. To assess each variable, we first estimate separate ordered logit models predicting a firm's constraint level as a function of each of these variables individually.

The coefficients associated with these sixteen regressions are reported in Column 2 of table 4. As the table illustrates, the coefficients on the five KZ variables and the six WW variables are similar in character to what we report earlier, with some changes in significance levels. Moving to the ACW variables, the estimates in Column 2 confirm again that firm size is closely related to financial constraints. Distributions (i.e., dividends plus repurchases) appear not to be significant predictors of financial constraint categories. The two variables that are unique to the ACW study are the variables indicating the lack of a bond or commercial paper rating.[10] As the table illustrates, the coefficients on both of these variables are significant and of the expected positive sign. Finally, the coefficient on the firm age variable is negative and highly significant, indicating that older firms tend to be less constrained.

The preceding results cast doubt on a subset of the sorting factors that others have identified as proxies for financial constraints. However, we are still left with a large set of factors, many of which are highly correlated with each other. To choose from this set, we focus on firm size (log of assets) and age (number of years the firm is public). These characteristics are (i) intuitively appealing; (ii) highly related to constraints within our sample; and (iii) more exogenous than the others factors we consider. Given these desirable features, we include firm size and age in our subsequent models and ask whether the other variables in table 4 have marginal explanatory power after size and age have been taken into account. We address this question by selecting each variable, one at a time, and then estimate an ordered logit model with the selected variable plus size

[10] Our bond ratings variables differ slightly from the ACW treatment in that we insist that a firm have an investment grade (BBB or better) rating to be classified as unconstrained rather than simply require any rating. The character of the results is similar if we require the presence of any rating in defining these variables.

and age as the explanatory variables. The associated coefficient estimates are reported in Column 3 of table 4. The (unreported) size and age coefficients in these regressions are always significant and of the expected negative sign.

The results in Column 3 of table 4 are interesting. Only the cash flow and leverage variables emerge as factors with the expected signs that consistently predict constraints after size and age have been controlled for. The payout variables are in some cases significant, but always with the wrong sign. Many of the other variables, including the bond rating variables, become insignificant. This suggests that these variables may be reasonable measures of constraints viewed in isolation, but a large part of what they are capturing is likely related to firm size and age. If this is the case, using size and age directly is a more appealing approach.

For completeness, in Column 4 of table 4, we report coefficients from a parsimonious model that includes size, age, cash flow, and leverage as explanatory variables. As expected, all of these coefficients are highly significant. While it may be tempting to use an index based on these coefficients, we believe some caution is in order. First, several authors have noted that the endogenous nature of leverage may result in a nonmonotonic or sample-specific relation between leverage and financial constraints (e.g., Acharya et al. 2007; Hennessy and Whited 2007; and Almeida et al. forthcoming). If this is the case, it is not clear whether the estimated role of leverage in our random sample will apply in other contexts.

Adding to this concern, we suspect that there may be biases in qualitative disclosures that are systematically related to leverage and cash flow. In particular, constraints in our sample are often detected because of debt contracting events, for example, covenant violations or tightening of credit terms. While constraints arising from these conditions may be important, it is possible that the most-constrained firms may be firms with a limited ability, or even a complete inability, to borrow. This may be the situation for firms with risky growth opportunities, high levels of asymmetric information, and/or volatile cash flows. If an important trigger that gets a firm classified as constrained is related to debt contracting, we will under-detect constraints for these firms, as they may have no covenants to violate or credit lines to lose. This could lead in turn to a misleading coefficient on leverage, and to a lesser extent on cash flow, in the ordered logit models. Given these concerns, we believe that a more prudent approach is to rely solely on firm size and age as indicators of a firm's financial constraint status.

3. The Role of Firm Size and Age in Financial Constraints

3.1 A closer look at firm size, age, and financial constraints

The preceding evidence and discussion presents a compelling case that firm size and age should figure prominently in any measure of financial constraints.

Table 5
Summary Statistics on Size, Age, and Financial Constraints

Panel A: Mean constraints by sample decile

	Size	Age
Decile 1	3.263	2.309
Decile 2	2.594	2.378
Decile 3	2.324	2.303
Decile 4	2.156	2.435
Decile 5	2.108	2.339
Decile 6	2.023	2.250
Decile 7	1.920	2.286
Decile 8	2.009	2.257
Decile 9	2.000	1.770
Decile 10	1.849	1.851

Panel B: Mean constraints, 5×5 sample sort

	Size: Q1	Size: Q2	Size: Q3	Size: Q4	Size: Q5
Age: Q1	3.045 (111)	2.214 (131)	2.068 (117)	2.073 (82)	2.261 (69)
Age: Q2	3.120 (92)	2.287 (80)	2.200 (65)	2.022 (90)	2.068 (44)
Age: Q3	2.710 (93)	2.369 (84)	2.145 (83)	2.093 (107)	2.040 (50)
Age: Q4	2.852 (122)	2.318 (88)	2.125 (72)	1.782 (87)	1.846 (52)
Age: Q5	2.857 (7)	1.810 (42)	1.841 (88)	1.763 (59)	1.775 (209)

The cells in this table report the mean level of financial constraints for the indicated subsample of observations drawn from our extended sample of 2,124 observations for 382 firms operating during the 1995–2004 period. An observation's constraint level for a given firm year is coded as an integer from 1 to 5 using the qualitative scheme 2 algorithm described in the text, with 1 representing the lowest level of constraints (NFC) and 5 representing the highest level of constraints (FC). Firm size is defined to be the log of assets (inflation adjusted to 2004). Age is defined as the current year minus the first year that the firm has a non-missing stock price on the Compustat file. In panel A, we sort all observations into deciles with decile 1 (decile 10) representing the smallest/youngest (largest/oldest) firms. In panel B, we sort all firms into one of 25 cells based on the size and age quintile that a given observation is a member of. Quintile 1 (Q1) represents the smallest/youngest firms, and quintile 5 (Q5) refers to the larges/oldest firms. In panel B, the number of observations in each quintile is reported in parentheses under the mean financial constraints figure.

Certainly a simple size-age index could be constructed using the coefficients from an ordered logit model that includes only these two explanatory variables (i.e., the size and age coefficients reported in Column 3 of table 4). However, before recommending a specific measure, we look more closely at the role of these factors in financial constraints. Since information on firm size and age is more widely available, we conduct this investigation on an extended sample consisting of all observations in our original universe that have non-missing values for size, age, and financial constraint level (382 firms, 2,124 firm years).

We begin by creating sample deciles for both size and age and then compute the mean level of constraints for each decile. We use qualitative scheme 2 to categorize constraints and assign each observation an integer score between 1 for least constrained (NFC) and 5 for most constrained (FC). As we report in panel A of table 5, as we move from the smallest firms (decile 1) to the largest firms (decile 10), there is a clear decrease in the mean level of constraints. The summary statistics also suggest a nonlinear pattern. Mean constraints drop sharply moving across the first few size deciles, and then the relation appears noticeably flatter as size continues to grow. The corresponding figures for age deciles also display a clear downward pattern in mean constraints moving from the youngest firms (decile 1) to the oldest firms (decile 10). In the case of age, however, constraints do not appear to drop as sharply over the first few deciles, although the data do suggest a flattening of the relation between age and constraints moving across the top two deciles. We will take these observations into account in our subsequent modeling.

As an alternative way of viewing the data, in panel B of table 5, we report the mean level of constraints for a 5×5 sorting of the sample based on size and age quintiles. The data again suggest a clear relation between both size and age and financial constraints. Holding the size quintile constant and moving downward across age quintiles toward older firms, the data suggest that mean constraints tend to drop. At the same time, holding age constant and moving right across size quintiles toward larger firms, the mean level of constraints in each cell also tends to drop.[11] These figures suggest that the general roles of size and age as predictors of financial constraints are generally quite robust.

3.2 Models of firm size, age, and financial constraints

Given the features of the data reported above, we estimate an ordered logit in which a firm's financial constraint status is modeled as a function of linear and quadratic terms for both firm size and age. As we report in Column 1 of table 6, the linear terms on size and age are both negative and significant, while the quadratic terms are both positive and significant. This confirms the character of the summary statistics discussed above and clearly indicates that as young and small firms grow, financial constraints tend to diminish.

One unrealistic feature of the Column 1 estimates in table 6 is that they imply that the roles of both size and age in financial constraints actually reverse in sign for very large/old firms. The turning points for both of these quadratic relations are close to the sample ninety-fifth percentiles. However, this appears to reflect a limitation of the quadratic model rather than an actual reversing of the underlying relation. Rounding the estimated turning points to nearby focal values of \$7.0 billion in assets and thirty-seven years in age, we estimate simple ordered logit models with a single linear explanatory variable (size or age) for the set of firms with the selected characteristic exceeding the turning point. The coefficient on size, for the large firm model, and on age, for the mature firm model, are both small, negative, and insignificant (estimates not reported). This indicates that the role of these factors in constraints is essentially flat above these points, a feature of the data that is not entirely surprising.

To recognize these flat regions, we cap size and age at these points (\$7 billion, thirty-seven years) and re-estimate the Column 1 quadratic regression (estimates not reported) in table 6. In this model, the quadratic coefficient on

[11] If we estimate ordered logit models holding the age quintile constant and using size as the only explanatory variable, the coefficient on size is negative and significant in all five models. If we hold the size quintile constant, the coefficient on age is negative in all five models and significantly so in four of the five cases.

Table 6
The Role of Firm Size and Age in Predicting Constraints

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Size	−0.744*** (0.056)	−0.737*** (0.059)	−1.071*** (0.109)	−0.548*** (0.068)	−1.871** (0.780)	−0.705*** (0.061)	−0.702*** (0.059)	−0.719*** (0.058)
$(\text{Size})^2$	0.042*** (0.007)	0.043*** (0.007)	0.073*** (0.012)	0.025*** (0.009)	0.138* (0.072)	0.040*** (0.007)	0.039*** (0.007)	0.041*** (0.007)
Age	−0.075*** (0.013)	−0.040*** (0.005)	−0.051*** (0.007)	−0.031*** (0.007)	−0.039** (0.019)	−0.041*** (0.005)	−0.040*** (0.005)	−0.040*** (0.005)
$(\text{Age})^2$	0.0010*** (0.0002)							
SEO activity								−10.114 *** (3.110)
Log-likelihood	−1729.494	−1730.412	−846.412	−848.238	−133.058	−1532.780	−1711.870	−1725.088
Pseudo-R^2	0.134	0.133	0.156	0.122	0.092	0.136	0.143	0.136
Observations	2,124	2,124	1,118	1,006	125	1,811	2,124	2124
Sample	All	All	First half 1995–1999	Second half 2000–2004	New 1990 sample	Original, levg. > 0	All, with year effects	All

All coefficient estimates are maximum likelihood estimates from an ordered logit model estimated over annual observations. Asymptotic standard errors are reported in parentheses under the coefficients. The timing convention in this table is the same as in prior tables. The dependent variable in all models is based on a firm's level of constraints using qualitative scheme 2 described in the text. The dependent variable is coded as an integer varying from 1 for the most unconstrained firms (NFC) to 5 for the most constrained (FC) firms. Firm size is defined to be the log of assets (inflation adjusted to 2004). Age is defined as the current year minus the first year that the firm has a non-missing stock price on the Compustat file. In Column 1, size and age are winsorized at the 1% and 99% tails. In Columns 2–8, we winsorize firm size and age at the 1% tails on the low end, and at the $4.5 billion and thirty-seven year points on the high end. SEO activity is the number of SEOs during the calendar year that corresponds to the fiscal year divided by number of public firms on Compustat as of the beginning of the year. The models in Columns 1, 2, 7, and 8 include the entire extended sample from 1995 to 2004 of observations with available data on size, age, and financial constraint status. The model in Column 3 (Column 4) includes the subsample of 1995–1999 (2000–2004) observations. The sample in Column 5 is a new sample of 125 random firms in 1990 with an electronic 10-K or annual report filing available. The sample in Column 6 includes all observations in the entire 1995–2004 sample in which the firm has a nonzero level of leverage. In Column 7, we use the entire sample and add year effects (year estimates not reported) to the model.

*Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

age becomes small and insignificant. This indicates that the earlier significant estimate on the quadratic term for age was driven by the flat region for very mature firms. When we estimate this model again with the quadratic age term dropped, the new estimated turning point for the relation between constraints and size drops to \$4.5 billion, a point that still exceeds the sample ninety-fifth percentile.[12]

Given these observations, in all of our subsequent analysis, we redefine firm size to be the log of Min(Firm Size, \$4.5 billion) and firm age to be Min(Age, thirty-seven years). This is essentially equivalent to lowering the upper winsorization points in the sample to these points to reflect the essentially flat relation between constraints and size/age for very large/mature firms. Using these new definitions, we present in Column 2 of table 6 estimates from a model in which constraints are modeled as a function of size, size squared, and age. As expected, all of the coefficients are highly significant.[13] These estimates can be used to create an index that we will refer to as the SA index. The index is calculated as: $(-0.737^*\ \text{Size}) + (0.043^*\ \text{Size}^2) - (0.040^*\text{Age})$, where size is the log of inflation adjusted (to 2004) book assets, and age is the number of years the firm has been on Compustat with a non-missing stock price. In calculating this index, size is replaced with log(\$4.5 billion) and age with thirty-seven years if the actual values exceed these thresholds. This index would appear to be a reasonable choice for measuring financial constraints in many contexts.[14]

3.3 Robustness of the SA index

While we believe that the SA index is an appealing measure, it is prudent to examine this index more closely. First, to check whether the quadratic role of firm size in constraints is a robust feature of the data, in unreported results, we experiment with estimating a piecewise linear model. In particular, we estimate a model that is analogous to Column 2 of table 6, but in which we replace the linear and quadratic size terms with separate size terms for assets above and below \$50 million (i.e., we allow the slope coefficient on size to change at \$50 million). While both of the size coefficients are negative and significant, the coefficient on size for firms below \$50 million in assets is significantly larger in magnitude. This helps confirm that the declining marginal role of firm size as an indicator of constraints is a robust feature of the data.

Next, we examine the stability of the SA index. In particular, we split the sample in half by time period (1995–1999 and 2000–2004). We then estimate

[12] The data again suggest that the relation between size and constraints is not actually increasing above this turning point, as the coefficient on size for a simple ordered logit model restricted to firms larger than \$4.5 billion is negative and insignificant.

[13] The Column 2 estimates also have the desirable feature that the estimated relation between size and constraints is declining over the entire region up to \$4.5 billion, a point after which our model assumes the relation is flat.

[14] As one would expect, SA index values tend to increase steadily for subsamples with higher levels of constraints. Using qualitative scheme 2, mean/median index values for each category are as follows: NFC, −3.678/−3.600; LNFC, −2.921/−2.973; PFC, −1.884/−2.058; LFC, −1.483/−1.620; and FC, −1.495/ −1.610.

ordered logit models for each subperiod. As we report in Columns 3 and 4 of table 6, the coefficient estimates for the subperiods are reasonably close to one another and to the sample-wide estimates. To make this more precise, we create three indexes based on coefficients from the models in Columns 2, 3, and 4. When we calculate index values for the entire Compustat universe, the resulting correlation between each pair of indexes is 0.98 or greater in all cases.[15] This indicates that the SA index is fairly stable across sample subperiods.

To further consider the stability issue, we collect out-of-sample data for 1990, a year substantially preceding our sample period. We randomly select 125 firms from 1990 with the requisite data available. Since larger and older firms were more likely to report their disclosure filings electronically in 1990, this sample is somewhat biased toward these mature firms. For the 1990 sample, we code the dependent variable in an analogous manner to our earlier coding.

Ordered logit estimates for the 1990 sample are reported in Column 5 of table 6. The coefficients are similar to those in the SA index. Moreover, when we calculate index values based on these 1990 estimates and correlate this with the SA index, the correlation is still a healthy 0.96. Thus, even if we choose an alternative sample with somewhat different characteristics from an earlier year, the SA index we propose is quite closely related to an index derived directly from the alternative sample.

Since earlier we raised the concern that we may under-detect constraints in firms with little or no leverage, in Column 6 of table 6, we report estimates restricted to the subsample of firms with some leverage. As the estimates reveal, this restriction does not have a major impact on the magnitude of the size and age coefficients. Moreover, the correlation between an index derived from these estimates and the SA index is 0.99.[16]

One might be concerned that the inclusion of multiple annual observations for a given firm may lead to inflated t-statistics because both firm characteristics and financial constraints are sticky over time. To investigate this concern, we estimate an ordered logit model with only a single observation for each firm based on the first annual observation for the firm in the sample. The estimates and significance levels for this subsample of observations are very similar to what we report for the sample as a whole (estimates not reported). Moreover, an index derived from these estimates has a correlation of over 0.99 with the index derived over the entire sample.

[15] Following our earlier treatment, we use the 1995–2004 period and winsorize all Compustat variables at the 1% tails when calculating index values. In addition, we eliminate financial firms, utilities, and foreign firms. We maintain this treatment throughout the rest of the article when calculating index correlations.

[16] We have also experimented with estimating the SA index only over the set of manufacturing firms in our sample (approximately 60% of the sample). The estimates for this subsample are similar to what we report for the sample as a whole, and an index derived from these estimates is highly correlated (above 0.98) with the index derived over the entire sample.

3.4 Time variation in financial constraints

The SA index we propose relies solely on firm characteristics that vary slowly over time. Consequently, this index, like many others, will be more effective in detecting the cross-sectional variation in constraints than the time variation. Given this feature, it would be prudent to include year fixed effects in any analysis that exploits the SA index. To assure that the index we propose is robust to the inclusion of year effects, in Column 7 of table 6, we report estimates for a model that also includes year effects. As can be seen from the table, this alteration has no substantive effect on the coefficient estimates.

To provide more systematic evidence on how financial constraints may vary over time, we augment our ordered logit models to include time-varying macrofactors. Here we borrow from Cohn (2008), who finds that financial constraints are related to SEO activity, yield spreads on corporate bonds, and GDP growth. We measure SEO activity as the number of SEOs during the most recent calendar year divided by the beginning-of-year number of firms on Compustat. Yield spreads are measured as the difference in rates between Baa and Aaa bonds as of the calendar year-end that corresponds to the firm's fiscal year-end. GDP growth is measured as the change in the log of real GDP between the most recent calendar year and the immediately preceding year. In addition, given its role in the work of Campello (2002) and Ashcraft and Campello (2007), we also consider the federal funds rate (less the ninety-day Treasury-bill rate).

When we add these variables, one at a time, to the baseline ordered logit model underlying the SA index (model 2 of table 6), the coefficients on the first three of these four variables are significant and have the expected sign, while the coefficient on the federal funds rate is small and insignificant (estimates not reported). These coefficients indicate that constraints are elevated during times of cold equity markets, high yield spreads, and low economic growth. Similar to the findings of Cohn (2008), this evidence suggests that there can be important time variation in the severity of constraints arising from financial market conditions and/or macroeconomic activity.

Given the collinearity of these macrofactors, it is not practical to include each of them together in a single model. The SEO activity variable has the most explanatory power, and thus in Column 8 of table 6, we report estimates for an augmented model that includes this factor. As we report, inclusion of this additional factor has little effect on the coefficients on the size and age variables. This suggests that the SA index is a reasonable cross-sectional indicator of constraints in many different economic environments. One might be tempted to use the Column 8 estimates to create an augmented index of constraints. However, we are hesitant to do so given the relatively short time period we study and the possibility that other events, for example the implementation of the Sarbanes–Oxley Act, may be driving some of the time variation in our sample. We view these results on macrovariation as suggestive of the possibility that constraints have substantial and measurable time variation, an issue that certainly merits additional study.

3.5 Corroboratory evidence

The preceding evidence indicates that firm size and age are closely related to qualitative disclosures regarding financial constraints. Moreover, the estimated relation between size, age, and financial constraints appears to be fairly robust. This suggests that the SA index should be a reasonable measure of constraints in a variety of contexts. However, the SA index of constraints, like all other measures, has some potential shortcomings. In particular, the model underlying the SA index relies on qualitative disclosures, and there could be substantial noise in these disclosures. While it is difficult to assess the magnitude of this problem and its impact on our estimates, certainly the case for the SA index could be strengthened with some corroboratory evidence. We present here both indirect and direct evidence of this type.

Much of the prior literature on financial constraints reveals that firm size, and to a lesser extent firm age, are both related to the presence of financing constraints. In many of these studies, it appears that size is the firm characteristic that is most closely related to constraints. For example, Hennessy and Whited (2007) report estimates suggesting that external financing costs are most closely related to firm size, with costs decreasing sharply as a firm grows. In a different vein, Gertler and Gilchrist (1994) report that decisions of small firms are much more affected by tight monetary policy than large firms. A host of related results appear in the literature.

To obtain more direct evidence, we check whether our index is successful in identifying constrained and unconstrained firms using the methodology of Almeida et al. (2004) (ACW). The ACW approach is appealing in that it uses only Compustat data, and thus it is easy to reproduce.[17] As ACW emphasize, their approach does not offer a direct measure of the magnitude of constraints. Instead, it allows one to detect the presence of nonzero constraints within a given population of firms by testing whether the population exhibits a significant sensitivity of cash holdings to cash flow.

To conduct this analysis, we examine whether the cash flow sensitivity of cash varies by constrained and unconstrained firms identified from our SA index. Following ACW, we select all Compustat observations from 1971 to 2004 and retain observations with data available on assets, sales, market capitalization, capital expenditures, and cash holdings. Similar to ACW, we eliminate observations in which cash exceeds total assets, asset or sales growth exceeds 100%, or market capitalization or PPE fall short of a \$10 million threshold in

[17] Several papers that study financial constraints, including Rauh (2006) and Fee et al. (2009), require unique data and thus are not suitable for checking our index. These authors report that firm size and age are both related to constraints in their studies. An alternative method for detecting constraints using only Compustat data is advanced by Almeida and Campello (2007).

1971 dollars. We winsorize all variables at the 1% tails. The only substantive difference between our treatment and that of ACW is that we do not restrict the sample to solely manufacturing firms, although we do exclude financial firms and utilities.

We calculate the beginning-of-year SA index value for every sample firm and place firms with index values in the top (bottom) tercile within the year cohort in the constrained (unconstrained) category. We follow the ACW treatment and regress a firm's annual change in normalized cash holdings against cash flow, Q, and a size variable (analogous to their table 3). The key coefficient of interest is the estimate on cash flow. If the SA index is a useful measure of constraints, we expect the constrained (unconstrained) subsample to display a positive and significant (small and insignificant) coefficient on cash flow. All regression variables and estimation techniques are taken directly from the ACW study.

As the estimates in Columns 1 and 2 of table 7 reveal, the cash flow sensitivity of cash is positive and highly significant for the constrained group, while it is small and insignificant for the unconstrained group. This provides corroboratory evidence that the SA index is useful in detecting financial constraints. We experiment with altering these regressions by (i) restricting attention to the most recent decade; (ii) identifying constrained and unconstrained firms based on sample-wide terciles rather than annual terciles; and (iii) restricting attention solely to manufacturing firms. With each of these alterations, we continue to find that constrained firms (unconstrained firms) have a significant (insignificant) sensitivity of cash to cash flow. Thus, the ACW approach for detecting constraints provides substantial support for the SA index approach that we advocate.

For completeness, in Columns 3 through 6 of table 7, we report analogous results on the cash flow sensitivity of cash for firms categorized as constrained/unconstrained using the KZ and WW indexes. As the figures in Columns 3 and 4 illustrate, when we use the KZ index to categorize constraints, we find no significant difference in the cash flow sensitivity of cash between constrained and unconstrained firms. This finding, which confirms similar results reported by ACW, adds further to our concerns regarding the KZ index. The figures in Columns 5 and 6 do suggest that the WW index has some ability to identify constrained firms, as the constrained firms (Column 5) exhibit a significant sensitivity of cash to cash flow, while the unconstrained firms (Column 6) do not. This is perhaps not surprising, given the fact that firm size figures prominently in the WW index and given our prior evidence that firm size is an important predictor of constraints.

Summarizing this evidence, the SA index we construct is robustly related to qualitative indicators of financial constraints within our sample. This index has intuitive appeal and relies on fairly exogenous firm characteristics. Moreover, prior work offers substantial evidence that the two components of this index are closely related to financial constraints. Finally, using an alternative approach to

Table 7
The Sensitivity of Cash Holdings to Cash Flow

	(1)	(2)	(3)	(4)	(5)	(6)
Q	0.001 (0.002)	0.002 (0.001)	0.004** (0.001)	0.002 (0.002)	0.002 (0.002)	0.001 (0.001)
Cash flow	0.065*** (0.014)	−0.003 (0.015)	0.022** (0.010)	0.032* (0.019)	0.047*** (0.011)	−0.011 (0.016)
Size	−0.000 (0.003)	−0.001 (0.002)	0.002 (0.001)	0.001 (0.003)	0.001 (0.003)	0.001 (0.002)
Adjusted R^2	0.198	0.064	0.212	0.162	0.188	0.092
# Observations	14,671	14,719	14,601	14,624	14,678	14,701
Which observations	SA index constrained	SA index unconstrained	KZ index constrained	KZ index unconstrained	WW index constrained	WW index unconstrained

The dependent variable in all models is the annual change in a firm's holdings of cash and marketable securities normalized by assets. All models are linear regressions estimated from 1971 to 2004 with firm fixed effects and an error structure that corrects for heteroscedasticity and for within-period error correlation using the White–Huber estimator. The universe of firms included begins with the Compustat universe and imposes certain restrictions outlined in the text and similar to the restrictions imposed by Almeida et al. (2004) (ACW). All model variables are defined as in ACW, and cash flow is normalized by beginning-of-year assets. Q and size (log of inflation adjusted assets) are measured as of the beginning of the observation year, and cash flow is measured contemporaneously with the investment decision. All variables in the regressions of the table are winsorized at the 1% tails. The samples in the odd-numbered (even-numbered) columns are firms with financial constraints index values in the top tercile (bottom tercile) of all observations in the annual cohort measured as of the beginning of the observation year using the indicated financial constraints index.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

detect constraints advanced by Almeida et al. (2004), we show that our index is successful in identifying constrained and unconstrained groups of firms. Thus, the overall case for using the SA index as a measure of constraints appears to be quite strong.

3.6 Relationship between various indexes

We briefly consider the relationship between the SA index and alternative index measures of financial constraints. The raw simple correlation between the SA index and the KZ index calculated over all Compustat observations from 1995 to 2004 is a very modest 0.05. If we instead use the SA index and the KZ index to classify all Compustat firms as either unconstrained (constraints = 0), indeterminate (constraints = 0.5), or constrained (constraints = 1) using annual tercile cutoffs, the correlation between the derived variables for the two indexes is −0.11. Similar to our earlier findings, these figures raise serious questions about the validity of the KZ index as a measure of financial constraints.

Turning to the WW index, the simple correlation of this index with the SA index across Compustat firms is a healthy 0.80. However, if we drop size from inclusion in the WW index, the correlation drops to 0.42. This indicates that a substantial part of the relationship between both measures reflects the common firm size component. If we classify firms as unconstrained/indeterminate/constrained using annual tercile cutoffs, the overall correlation for the two indexes in the derived discrete variable is 0.49. If we drop firm size from the WW index in this calculation, this correlation falls to 0.20. These figures again suggest that the WW index is primarily related to the SA index through the common size component that features prominently in both indexes.[18]

4. The Sensitivity of Investment to Cash Flow

The intent of the KZ paper was not to motivate an index of financial constraints but rather to comment on the usefulness of investment–cash flow sensitivities as measures of constraints. KZ demonstrate that in some cases, firms in the most constrained categories actually exhibit a relatively low sensitivity of investment to cash flow, casting serious doubt on the investment–cash flow approach. In this subsection, we briefly reexamine this important finding using our more refined data and our larger, broader, and more modern sample.

In Columns 1–3 of table 8, we report results for traditional investment–cash flow regressions. All variables are defined as in the corresponding KZ models, with year and firm fixed effects included but not reported. We impose an

[18] The bond rating (commercial paper rating) constraints dummy variable created earlier based on the work of ACW displays a correlation of approximately 0.44 (0.49), with a dummy variable indicating constraints derived from the SA index. The SA index cutoff points in this calculation are selected so that the sample proportion of constrained firms is the same using the SA index and the respective bond rating rule. The ACW payout variable has essentially no correlation with the SA index.

Table 8
The Sensitivity of Investment to Cash Flow

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Q	0.078*** (0.030)	0.023 (0.036)	0.009 (0.017)	0.062*** (0.023)	0.058*** (0.003)	0.058*** (0.003)	0.057*** (0.003)
Cash flow	0.183*** (0.053)	0.223*** (0.070)	0.147* (0.083)	0.185*** (0.044)	0.090*** (0.008)	0.096*** (0.004)	0.110*** (0.008)
Cash flow * (LFC or FC)				−0.129** (0.066)			
Cash flow * medium constraints					0.012 (0.009)	−0.015** (0.007)	−0.008 (0.008)
Cash flow * high constraints					−0.002 (0.009)	−0.034*** (0.011)	−0.027*** (0.009)
Adjusted R^2	0.299	0.223	0.247	0.265	0.204	0.205	0.205
# Observations	979	158	144	1281	32,334	32,122	32,271
Constraints procedure	Qualitative	Qualitative	Qualitative	Qualitative	Size–age index	KZ index	WW index
Which observations	Low constraints	Medium constraints	High constraints	All with qual. data	Compustat 1996–2004	Compustat 1996–2004	Compustat 1996–2004

The dependent variable in all models is a firm's annual spending on capital expenditures normalized by K (beginning-of-year property, plant, and equipment). All coefficients are estimated using OLS, and all models include firm fixed effects and year effects. The cash flow and Q variables are defined as in table 3, and cash flow is normalized by K. Q is measured as of the beginning of the observation year, and cash flow is measured contemporaneously with the investment decision. Observations in Columns 1–4 are for the 1996–2004 period drawn from the original sample of observations with available beginning-of-year qualitative information on financial constraints and non-missing values for the components of the KZ index. In Columns 1–3, we assign each firm to a single constraint category for the entire sample period and estimate a separate regression for the indicated set of firms. The constraint categories (low, medium, and high) are based on the entire set of the firm's annual constraints categorizations using qualitative scheme 2. We assign firms that are in the lowest two annual constraint categories (NFC and LNFC) for all years to the low constraint grouping. We assign firms that are ever in the highest two annual constraint categories (FC and LFC) in any year to the high constraint grouping. All other firms are placed in the medium constraints (Column 2) grouping. The interaction term in Column 4 is cash flow interacted with a dummy variable indicating whether a firm-year observation falls in the LFC or FC financial constraint groups as of the beginning of the observation year. Observations in Columns 5–7 are for the entire Compustat universe of firms over the 1996 to 2004 period excluding financial firms and utilities. In Columns 5–7, we assign each observation to a low, medium, or high constraint grouping depending on the beginning-of-year value of the indicated financial constraints index and the annual tercile breakpoints for the index. All variables in the regressions are winsorized at the 1% tails. In all models, we exclude all observations for which cash flow/$K \leq -1$.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

additional condition in all of these models that cash flow/$K \geq -1$, since without this requirement, the sample-wide sensitivity of investment to cash flow would not be significantly positive. This is not surprising, since large negative realizations of cash flow cannot result in negative levels of investment.

Proceeding in a similar manner to KZ, we assign firms to three groups based on their categorized level of constraints (using qualitative scheme 2). We assign firms that are in the lowest two constraint categories (NFC and LNFC) for all years to the low constraint grouping. We assign firms that are ever in the highest two constraint categories (FC and LFC) in any year to the high constraint grouping. All other firms are placed in the middle grouping. As we report in Columns 1–3 of table 8, the estimated sensitivity of investment to cash flow does not differ significantly across the three groups, and the most constrained group actually has the lowest estimated sensitivity. Similar to KZ, these estimates provide no support for the existence of a positive monotonic relation between investment–cash flow sensitivities and constraints.

To consider a model that allows constraints to change over time, in Column 4 of table 8, we include a term interacting cash flow with a dummy variable indicating whether the firm was in the FC or LFC category as of the beginning of the fiscal year. The coefficient on this interaction term is actually negative and significant, suggesting that the most constrained firms may actually display a lower sensitivity of investment to cash flow than other firms. Thus, we again confirm the main KZ finding that investment–cash flow sensitivities are not monotonically increasing in a firm's categorized level of financial constraints.

For completeness, we also consider the relation between other measures of financial constraints and investment–cash flow sensitivities. In particular, we divide all Compustat observations (excluding financial firms and utilities) over the sample period into low, medium, and high constraint groups based on a firm's beginning-of-year level of financial constraints as measured by the SA, KZ, and WW indexes. In Columns 5–7 of table 8, we include terms interacting a firm's cash flow with dummy variables for the firm's constraint level using these three alternative measures of constraints. As the figures in the table reveal, we continue to find no convincing evidence of a positive monotonic relation between constraint levels and investment–cash flow sensitivities using these alternative measures.

5. Conclusion

We exploit the approach of Kaplan and Zingales (1997) by gathering detailed qualitative information on financial constraints from statements made by managers in financial filings. Using the derived financial constraint categories, we estimate ordered logit models predicting a firm's constraint level as a function of a variety of different quantitative factors. This approach allows us to evaluate past measures of financial constraints and also to offer a new approach to measuring these constraints.

Our results cast serious doubt on the use of the popular KZ index as a measure of financial constraints. We find that only two of the five components of this index are reliably related to constraints in our sample in a manner that is consistent with the index. Moreover, the correlation between an updated version of the index created using our sample and the traditional index is approximately zero. Our evidence suggests that the principal problem underlying the original KZ index is a modeling flaw in which the same quantitative information is incorporated into both the dependent and the independent variables. Given our evidence regarding the KZ index, we strongly suggest that researchers consider alternative measures of financial constraints.

To provide guidance on alternative measures, we select factors that others have identified as indicators of constraints and examine the ability of these factors to predict constraints in our sample. Firm size and age emerge as particularly useful predictors of constraints. After controlling for these factors, we find that several other variables do not predict constraints, suggesting that these variables frequently proxy for firm size and/or age. The two variables that do appear to offer additional explanatory power for predicting constraints are cash flow and leverage. Since firm size, cash flow, and leverage constitute three of the six components of the WW index, our findings offer mixed empirical support for that index as a measure of constraints. Given our concerns about the endogeneity of leverage and cash flow, we advocate a conservative approach that uses only firm size and age in creating a measure of financial constraints.

Investigating more closely the role of firm size and age, we present evidence indicating that the role of these factors in financial constraints is nonlinear. For very large or mature firms, the estimated relation between constraints and these firm characteristics is essentially flat. Below certain cutoff points, we estimate a quadratic relation between size and constraints and a linear relation between age and constraints. Based on the estimates from one of our models, we represent this relation in what we refer to as the SA index. The estimates underlying this index appear to be fairly robust to sample choice, time period, and the inclusion of additional controls.

We argue that the SA index has much to recommend it over other approaches. First, this index has substantial intuitive appeal and relies on factors that are surely more exogenous than most of the alternatives. In addition, prior research identifies firm size and age as strong predictors of constraints in varied settings. Finally, we are able to provide direct corroboratory evidence for our index using the cash flow sensitivity of cash approach advanced by Almeida et al. (2004).

Kaplan and Zingales (1997) provide important evidence that investment–cash flow sensitivities are unlikely to be useful measures of financial constraints. In this article, we confirm that evidence. In addition, we show that a popular alternative measure of financial constraints, the KZ index, is also unlikely to be a valid measure of constraints. Moreover, we find that many other common measures of constraints may be, at best, only indirectly related to a firm's constraint status. Firm size and age are intuitively appealing measures of constraints that have a long tradition in corporate finance research. Our findings suggest that a simple index based on these two factors is likely to be a reasonable measure of financial constraints in a variety of contexts. Until a compelling case can be made for a more complicated measure, we suggest that researchers consider the simple alternative that we propose.

Appendix

We assign each statement to one of five mutually exclusive categories from 1 to 5, with lower (higher) numbers indicating a lack of (presence of) financial constraints. Statements coded as 1 are disclosures that indicate that a firm anticipates more than sufficient or more than adequate liquidity to fund its needs. Statements using the word "strong" or a similar adjective when describing the firm's financial position are also assigned this code. Specific examples of statements that received a code of 1 include: "Management believes these resources are more than sufficient to meet planned short-term needs and provide for working capital requirements associated with projected growth," and "Our balance sheet remains strong and gives us a great deal of flexibility."

Statements that indicate sufficient or adequate liquidity are assigned a code of 2. The principal difference between category 1 codes and category 2 codes is in the strength of the language describing the firm's financial position, particularly with regard to whether the firm indicates more than sufficient versus sufficient liquidity. Specific examples of statements with a code of 2 are: "It is expected that operating cash flows, supplemented as needed with financing arrangements, will be sufficient to meet the firm's needs," and "Management believes that the present working capital as well as its available line-of-credit is adequate to conduct its present operations."

Statements coded as 3 are statements that we found difficult to classify in that they are opaque in nature. Additionally, we assign a code of 3 to soft cautionary statements regarding future liquidity positions if certain scenarios were to come to fruition. The defining feature of statements coded as 3 is that they not only do not indicate any financial strength but they also do not indicate any current liquidity problem. Examples of statements coded as 3 include: "Funds raised in past periods should not be considered an indication of additional funds to be raised in any future periods. There is no assurance that such funds will be available to us on acceptable terms, if at all," and "There is no guarantee that the Company will be able to obtain the necessary financing."

Statements in which a firm indicates difficulty in raising financing or substantive current concerns about liquidity are coded as 4 as long as the firm does not reveal that the problem has actually affected its investment decisions. Examples of statements coded as 4 include: "During fiscal 2001 the firm initiated a private placement securities offering to raise capital to finance its acquisition program. In December 2001, the firm aborted this offering due to unfavorable market conditions," and "We were unable to complete a successful financing."

Finally, codes of 5 are reserved for all cases of clear financial problems/constraints including statements indicating that the firm: (i) is currently in violation of covenants; (ii) has been cut out of usual sources of capital; (iii) is renegotiating debt payments; (iv) is forced to reduce investment because of liquidity issues; (v) has received a going concern statement from an auditor; or (vi) has had an executive or director advance funds to the firm because of liquidity problems.

References

Acharya, V., H. Almeida, and M. Campello. 2007. Is Cash Negative Debt? A Hedging Perspective on Corporate Financial Policies. *Journal of Financial Intermediation* 16:515–54.

Almeida, H., and M. Campello. 2007. Financial Constraints, Asset Tangibility, and Corporate Investment. *Review of Financial Studies* 20:1429–60.

Almeida, H., M. Campello, and M. S. Weisbach. 2004. The Cash Flow Sensitivity of Cash. *Journal of Finance* 59:1777–804.

———. Forthcoming. Corporate Financial and Investment Policies When Future Financing Is Not Frictionless. *Journal of Corporate Finance*.

Alti, A. 2003. How Sensitive Is Investment to Cash Flow When Financing Is Frictionless? *Journal of Finance* 58:707–22.

Ashcraft, A. B., and M. Campello. 2007. Firm Balance Sheets and Monetary Policy Transmission. *Journal of Monetary Economics* 54:1515–26.

Calomiris, C., C. Himmelberg, and P. Wachtel. 1995. Commercial Paper, Corporate Finance, and the Business Cycle: A Microeconomic Perspective. *Carnegie-Rochester Conference Series on Public Policy* 42:203–50.

Campello, M. 2002. Internal Capital Markets in Financial Conglomerates: Evidence from Small Bank Responses to Monetary Policy. *Journal of Finance* 57:2773–805.

Cleary, S. 1999. The Relationship between Firm Investment and Financial Status. *Journal of Finance* 54:673–92.

Cohn, J. 2008. Investment, Cash Flow, and Financial Market Conditions: Evidence from Tax Loss Carryforwards. Working Paper, University of Texas.

Erickson, T., and T. M. Whited. 2000. Measurement Error and the Relation Between Investment and Q. *Journal of Political Economy* 108:1027–57.

Fazzari, S. M., R. G. Hubbard, and B. P. Petersen.1988. Financing Constraints and Investment. *Brookings Papers on Economic Activity* 1:141–95.

———. 2000. Investment–Cash Flow Sensitivities Are Useful: A Comment on Kaplan and Zingales. *Quarterly Journal of Economics* 115:695–705.

Fee, C. E., C. J. Hadlock, and J. R. Pierce. 2009. Investment, Financing Constraints, and Internal Capital Markets: Evidence from the Advertising Expenditures of Multinational Firms. *Review of Financial Studies* 22:2361–92.

Gertler, M., and S. Gilchrist. 1994. Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms. *Quarterly Journal of Economics* 109:309–40.

Hennessy, C. A., and T. M. Whited. 2007. How Costly Is External Financing? Evidence from a Structural Estimation. *Journal of Finance* 62:1705–45.

Kaplan, S. N., and L. Zingales. 1997. Do Investment–Cash Flow Sensitivities Provide Useful Measures of Financial Constraints? *Quarterly Journal of Economics* 112:159–216.

———. 2000. Investment–Cash Flow Sensitivities Are Not Valid Measures of Financial Constraints. *Quarterly Journal of Economics* 115:707–12.

Lamont, O., C. Polk, and J. Saa-Requejo. 2001. Financial Constraints and Stock Returns. *Review of Financial Studies* 14:529–54.

Moyen, N. 2004. Investment–Cash Flow Sensitivities: Constrained versus Unconstrained Firms. *Journal of Finance* 59:2061–92.

Opler, T., L. Pinkowitz, R. Stulz, and R. Williamson. 1999. The Determinants and Implications of Corporate Cash Holdings. *Journal of Financial Economics* 52:3–46.

Rauh, J. 2006. Investment and Financing Constraints: Evidence from the Funding of Corporate Pension Plans. *Journal of Finance* 61:33–72.

Whited, T., and G. Wu. 2006. Financial Constraints Risk. *Review of Financial Studies* 19:531–59.