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Options, Equity Risks, and the Value of Capital Structure Adjustments*

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This version: October, 2016

Abstract

We use exchange-traded options to identify risks relevant to capital structure adjustments in firms. These forward-looking market-based risk measures provide significant explanatory power in predicting net leverage changes in excess of accounting data. They matter most during contractionary periods and for growth firms. We form market-based indices that capture firms' magnitudes of, and propensity for, net leverage increases. Firms with larger predicted leverage increases outperform firms with lower predicted increases by 3.1% to 3.9% per year in buy-and-hold abnormal returns. Finally, consistent with the quality, leverage, and distress risk puzzles, firms with lower predicted leverage increases are riskier but earn lower abnormal returns.

Keywords: Capital Structure, Financial Leverage, Options, Implied Volatility

JEL classification: G30, G32, G12, G14

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1 Introduction

Firms adjust their capital structure by balancing the benefits and costs of using debt. As cash flow risk increases, the likelihood of a firm entering a state of default increases, thereby increasing the expected costs of bankruptcy. Thus, all else equal, increases in cash flow risk should to lead to increases in the cost of debt and consequently to decreases in firm leverage. Empirical research on capital structure has relied primarily on firm characteristics obtained from accounting statements to proxy for firm risks that factor into the cost of capital, leaving substantial variation in capital structure unexplained.[1] The equity market, in comparison, is a relatively untapped source of information on firm risks for explaining leverage dynamics.[2]

The intuition for this approach comes from the Leland (1994) model of optimal capital structure, "Equity return volatility will be stochastic, changing with the level of firm asset value, V" (p. 1249). Prior literature has noted the usefulness of equity markets in capturing underlying firm risk relevant to financing decisions (e.g., Myers, 1977; Myers, 1984; Marsh, 1982; Loughran and Ritter, 1995; Leary and Roberts, 2014; Schwert and Strebulaev, 2015; Chen, Wang, and Zhou, 2015). Using the Campbell (1991) decomposition of stock returns into to cash flow news and expected returns news, Vuolteenaho (2002) finds that firm-level stock returns are mainly driven by cash flow news, rather than expected returns news. Cash flow news affect the firm's bankruptcy cost and while they are not directly observable, they will affect risk measures from the equity market. Thus, these cash flow risk measures should provide useful information for capital structure decisions. More recently, Welch (2004) finds that stock returns explain 40% of capital structure dynamics and Frank and Goyal (2009) show that both stock returns and stock volatility correlate negatively to leverage levels.

In this paper, we study the ability of risk measures derived from the equity option market to predict changes to a firm's capital structure. Studying changes in capital structure, rather than levels, enables us to identify a firm's reaction to relevant risks and better understand the dynamics of capital structure. Specifically, we model net increases in firm leverage using market

[1] See Harris and Raviv (1991) and Graham and Leary (2011) for surveys of the capital structure literature.

[2] The literature linking equity markets to capital structure have been largely focused on using leverage to explain the cross-section of returns. See, e.g., Fama and French (1993), Dichev (1998), Vassalou and Xing (2004), Penman, Richardson, and Tuna (2007), Campbell, Hilscher, and Szilagyi (2008), Gomes and Schmid (2010), George and Hwang (2010), and Kapadia (2011). We reverse the relationship by using equity risk measures to explain leverage changes.

expectations about risks estimated from equity options. Previous studies have documented the power of option prices in identifying investor expectations about the future performance of the underlying asset.[3] Investor beliefs about the firm's equity become impounded in option markets, increasing the price and implied volatility of certain option contracts relative to others (Bollen and Whaley, 2004; Garleanu, Pedersen and Poteshman, 2009). We follow recent findings in the option pricing literature to identify risk measures from these volatility differences across three orthogonal dimensions. Despite informativeness about future performance, options data have seen very limited applications in corporate events, in which ex-ante market expectations should be a valuable signal. To the best of our knowledge, there have only been three such applications. They have been used to predict the likelihood of takeovers (Subramanian, 2004; Barraclough, Robinson, Smith, and Whaley, 2013; Borochin, 2014), to measure the impact of regulatory legislation (Borochin and Golec, 2016), and to measure uncertainty about the firm around earnings announcements (Dubinsky and Johannes, 2006). We add to this literature by using options to derive market-based measures of risk and apply these measures to the challenge of explaining, as well as predicting, within-firm capital structure changes.

Using options-based risk measures offers three main advantages. First, they are direct and specific measures of risk based on stock and option price volatilities, rather than proxies of risk using firm characteristics. For a single underlying firm, there exists a variety of contracts with different features, such as type (call versus put) and moneyness (in-the-money versus out-of-the-money). These cross-sections of data allow us to examine orthogonal dimensions of risk in the same firm and to evaluate the importance that different types of risk in the firm's leverage decisions. Second, they are forward looking and take investor attitudes and beliefs regarding the future of the firm into account, making them more relevant than backward looking book proxies of risk. This is important given that investor attitudes factor significantly in a firm's ability to access external financing (McLean and Zhao, 2014) and adjust its capital structure. Third, market information is available at higher frequencies than a firm's accounting filings, which are updated, at best, at a quarterly frequency. Given the time-varying nature of leverage changes (see Figure 1), this makes high-frequency explanatory variables potentially more informative, and therefore better able to

[3] See, e.g., Bakshi, Cao, and Chen (1997), Ait-Sahalia, Wang, and Yared (2001), Liu, Pan, and Wang (2005), Broadie, Chernov, and Johannes (2007), Cremers and Weinbaum (2010), and Xing, Zhang, and Zhao (2011).

address standing challenges in capital structure research.[4] For these reasons, it is worthwhile to ask whether and how risk measures from the equity market can explain capital structure decisions.

We use options data to derive three market-based measures that capture different dimensions of risk potentially relevant to a firm's capital structure: 1) the spread between the implied volatility extrapolated from long maturity call options and realized volatility from historical returns to capture changes in perceived riskiness of the firm, 2) the implied volatility spread between short maturity out-of-the-money (OTM) and in-the-money (ITM) puts to capture expectations about a left tail or "crash" event in stock prices, and 3) the spread between the implied volatilities in short maturity calls and short maturity puts to capture expectations about the direction of future stock performance. These three measures are studied extensively in the asset pricing literature.[5] Here, we demonstrate their power in explaining capital structure adjustments. To the extent that market expectations about these risks reflect or impact the firm's cost of capital and access to financing, they will impact the firm's decision to change its capital structure.

Our main measure for capital structure changes is the net levering up ratio, defined as net debt issuance plus net share repurchases over total assets. This variable captures the debt and equity dynamics that lead to net changes in capital structure and summarizes these changes in the direction of increasing leverage in the firm. Importantly, net levering ratio eliminates mechanical changes in leverage driven by changes in equity value, isolating direct managerial decisions about leverage change. This measure (and its variations) has been used in prior capital structure research for this purpose (e.g. Kisgen, 2006; Binsbergen, Graham, and Yang, 2010; Leary and Roberts, 2014). Using the net levering up ratio to measure capital structure adjustments, we examine the power of our options-based measures in predicting capital structure decisions within a firm over the next quarter. To the extent that investors respond to perceived changes in a firm's cash flow risk, we expect these measures to impact the firm's capital structure decisions. Specifically, the riskier the firm, the larger the decreases in net leverage.

We find a consistently negative relationship between measures of equity risk and future leverage

[4]In their recent survey of the capital structure literature, Graham and Leary (2011) draw attention to the inability of standard firm characteristics to explain leverage changes within firms, as well as their declining explanatory power within industries.

[5]See, e.g., Goyal and Saretto (2009), Bali and Hovakimian (2009), Cremers and Weinbaum (2010), Xing, Zhang and Zhao (2010).

changes. The implied volatility spread between short maturity OTM and ITM puts, measuring equity tail risk, provides the strongest and most robust effect as a significant predictor of future leverage decreases. Additionally, higher spreads between the implied volatility of long maturity calls and realized volatility, as well as realized volatility by itself, also predict leverage decreases. A higher spread between the implied volatilities of short term calls and puts, as a measure of investor optimism, predicts leverage increases. These results are statistically and economically significant. In other words, firms with more (less) risky equity, and therefore more (less) cash flow risk, will decrease (increase) net leverage. It is important to note that this finding is opposite to what a mechanical relationship between implied volatility and leverage would imply, eliminating market anticipation of capital structure changes as a driving explanation. Furthermore, these option-based risk measures provide unique explanatory power in addition to that provided by standard controls using firm characteristics and backward-looking measures of risk based on accounting data. In other words, equity-based risk measures contain relevant information on firm risk for predicting capital structure decisions that is not available in existing accounting-based proxies for firm risk.

The results indicate that market-based measures predict changes in capital structure in ways consistent with risk-based interpretations. To the extent that equity markets will influence the information regarding risk or availability of funds and resources, it will impact the firm's real or perceived cash flow risk and therefore its corporate decisions such as access to external financing (McLean and Zhao, 2014) and, therefore, capital structure. Recent evidence by Foucault and Fresard (2016) also suggests that even firm managers rely on the equity market as a source of information regarding the firm. This strand of literature suggest that both firm insiders and outsiders can learn about firm risks from the equity market and influence decision-making within the firm. Our results are consistent with this interpretation.

The resulting changes in capital structure policy reflect the combination of both supply-side and demand-side financing concerns. To isolate supply-driven and demand-driven effects, we examine the predictive power of our measures in sub-samples of variable macroeconomic supply and firm demand for capital, respectively. In addition, expansionary and recessionary periods enable us to better identify the importance of our risk measures on levering up by exogenously shocking the supply of capital and injecting volatility into or removing it from the equity markets. We expect our measures to have the most predictive power over sub-samples where cash flow risk matters most. Our results show that the predictive power of market-based measures on capital structure adjustments is strongest during periods of economic recession, when default is more likely and the marginal utility of investors is highest, and among growth firms, which have the most significant need for financing. This is consistent with the counter-cyclicality of leverage in Korajczyk and Levy (2003), Hackbarth, Miao, and Morellec (2006), and Chen (2010). We obtain the highest adjusted R^2 for high growth firms during economic downturns. That is, our options-based measures are most informative when predicting capital structure adjustments for high demand firms during low supply periods.

One potential concern is that option risks will change simply due to market anticipation of capital structure change. If that were the case, we should observe a positive relationship between option-based risks and leverage, as a more levered firm is inherently more risky. We observe a consistently negative relationship, indicating that our findings are not merely driven by the anticipation of capital structure policy, but are measures of equity risks that limit leverage increases. This is consistent with Chen, Wang, and Zhou (2015) and Schwert and Strebulaev (2015).

Another concern in using options-based measures is that only firms for which options data is available are included. We corroborate our main results by using simplified market-based measures that do not rely on having detailed options data. In addition, as stated previously, one advantage of using market-based measures is their availability at higher frequencies. We therefore also consider a monthly, rather than quarterly, aggregation of our measures to predict net levering up decisions. Finally, we use a binary version of the net levering up ratio as the dependent variable to capture the direction, rather than magnitude, of capital structure changes and estimate the propensity to lever up using logistic analysis. This allows us to focus on the ability to lever up and abstract away from the decision of how much to lever up. In all cases, market-based measures retain significant explanatory power for net leverage changes (in excess of accounting controls) with more risky firms decreasing net leverage.

Using our results, we propose new indices for predicting net leverage increases by taking linear combinations of our options-based measures, with and without controls. Sorting the indices into terciles, we examine the characteristics of firms that increase leverage. Firms that fall into the top tercile of net levering up are larger, with higher Altman (1968) Z-scores, larger cash flows, and more likely to pay dividends and have credit ratings than firms that fall into the bottom tercile. In addition, firms that lever up have characteristics consistent with those associated with low financing constraints in the literature, and score lower on the Whited and Wu (2006) and Hadlock and Pierce (2010) indices of financing constraint.

Next, we use these indices of net levering up to quantify the value of capital structure adjustments for shareholders. Sorting on the net leverage increase indices, we form equal-weighted portfolios of firms that fall into the top tercile of net levering up (HIGH) and firms that fall into the bottom tercile of net levering up (LOW). We follow their buy-and-hold abnormal returns over the following year as a measure of firm performance. On average, high levering up portfolios earn between 2.8% to 3.1% in abnormal returns over one year, while low levering up portfolios realize slightly negative abnormal returns over the year (averaging from -0.4% to -1.0%). As a result, a buy-and-hold trading strategy of buying the top tercile and selling the bottom tercile nets abnormal returns of 3.2% to 3.9% over the following year. In other words, HIGH levering up firms outperform LOW levering up firms on average.

The above results suggest that higher net leverage increases are associated with *lower* firm risk and higher returns. To explore the pricing implications of this observation, we create zero-cost portfolios long on firms with LOW levering up and short on firms with HIGH levering up from our predictive indices. We find the zero-cost portfolios produce negative and significant monthly alphas when using equal-weighed portfolios and mostly insignificant monthly alphas when using value-weighted portfolios relative to the Pástor and Stambaugh (2003) 5-factor model. This corroborates the long-term performance results above. Although we use *changes* in leverage, these results are also consistent with the leverage and distress risk puzzles that find lower returns for firms with higher *levels* of leverage or higher bankruptcy risk.[6] More broadly, they are consistent with superior performance by quality (lower-risk) firms in terms of profitability, share repurchases, low beta, high growth, and low accruals.[7]

[6]See, e.g., Fama and French (1993), Dichev (1998), Vassalou and Xing (2004), Penman, Richardson, and Tuna (2007), Campbell, Hilscher, and Szilagyi (2008), Gomes and Schmid (2010), George and Hwang (2010), and Kapadia (2011).

[7]See Sloan (1996), Baker and Wurgler (2002), Mohanram (2005), Richarson, Sloan, Soliman and Tuna (2005), Pontiff and Woodgate (2008), McLean, Pontiff and Watanabe (2009), Novy-Marx (2013), Frazzini and Pedersen (2014), and Asness, Frazzini and Pedersen (2015).

To the best of our knowledge, this study is the first to use options-based measures of equity risk to predict changes in capital structure and to propose market-based indices for predicting leverage changes. Our results establish the usefulness of options data in providing risk-based interpretations for and predicting capital structure decisions. This allows us to create new market-based measures for capital structure adjustments. The predictive power of our measures establishes a promising connection between market expectations and capital structure decisions. This is particularly relevant in the wake of the financial crisis as investors and regulators re-evaluate the timeliness of accounting-based measures of firm risk (e.g., bank capital ratios) and consider market-based alternatives. Using market-based measures allows us to more directly study specific risk channels that impact financing behavior rather than rely on accounting proxies. Additionally, our approach allows us to bypass the issue of measuring changes in capital structure using limited and low-frequency data due to real-time availability and updating of market data.

Existing theories on the relationship between capital structure and firm risk, following the seminal work of Modigliani and Miller (1958) and the subsequent static tradeoff (Kraus and Litzenberger, 1973) and dynamic tradeoff (Fischer, Heinkel, and Zechner, 1989) approaches, suggest a positive relationship between leverage and firm risk. That is, if equity investors are reacting to expected managerial decisions to increase leverage, rather than managers reacting to increased investor perceived risks to the cash flows of the firm, we should observe a positive relationship between equity risk and leverage changes. In contrast, our main empirical result finds a negative relationship between leverage increases and risk. This apparent contradiction is addressed by George and Hwang (2010) who find that firms with low (high) bankruptcy costs and low (high) systematic risk are the ones that choose to hold high (low) leverage, resolving the leverage and distress puzzles. Notably, the theoretically implied positive relationship between leverage and equity risk suggests that our findings of a negative relationship between risk and future leverage changes are driven by investor expectations of firm risk and not by market expectations of increased leverage.

2 Data and Hypothesis Development

2.1 Options-based Measures of Risk

We use previously established connections between the equity risk and capital structure dynamics (e.g., Myers, 1977; Myers, 1984; Marsh, 1982; Leland, 1994; Loughran and Ritter, 1995), mediated through the channel of cash flow risk (Campbell, 1991; Vuolteenaho, 2002), to create option-based measures of risk relevant to capital structure changes. Cash flow risk, whether factual or merely perceived, will increase the cost of debt and reduce the benefits of leverage. As a firm's cash flow risk is not directly observable, our measures of equity risk provide potentially valuable proxies. Specifically, using options allows us to study the impact of different dimensions of cash flow risk on leverage changes.

To form our option-based measures of equity risk, we use daily single-stock option data from OptionMetrics which covers all exchange-traded puts and calls and reports closing bid and ask prices and implied volatilities from 1996 onward. We aggregate daily implied volatility data from 1996 to 2012 into quarterly averages by option type (calls versus puts), maturity (long versus short), and moneyness (in-the-money versus out-of-the-money) to match the frequency of our accounting data. According to the price pressure argument (Bollen and Whaley, 2004; Garleanu, Pedersen, and Poteshman, 2009), the shapes of the implied volatility functions reflect excess demand for certain types of options. As a result, the implied volatility reflects the level of risk associated with the underlying asset of an option contract for specific values of option type, maturity, and moneyness. To isolate risks associated with these dimensions, we take differences in average quarterly implied volatilities by firm across each dimension. From these differences we construct three firm-specific implied volatility spread variables that capture expectations about the riskiness of the firm that we hypothesize to be relevant to capital structure adjustments. Each variable is calculated for all firms i in quarters t.

2.1.1 (Perceived) Changes in Risk

Our first variable is the difference between the average implied volatility of long-term calls over the quarter and the historical, realized volatility over the year:

$$IVspread_{hist,i,t} = IV_{c,long,i,t} - RealizedVolatility_{i,t} \tag{1}$$

where $IVspread_{hist,i,t}$ measures the changes in overall (perceived) risks of a firm. Long-term options are those with more than 200 days to expiration. Excluding a maturity filter produces similar, but slightly weaker, results. $RealizedVolatility_{i,t}$, the historical volatility for the preceding year, is a measure of the historical risk level of the firm. This measure provides the benchmark level for overall existing firm risk and therefore should be relevant to leverage decisions by itself.

Goyal and Saretto (2009) and Bali and Hovakimian (2009) demonstrate that option implied volatilities deviate from historical levels based on investor beliefs about firm risk. Goyal and Saretto (2009) find evidence consistent with the Barberis and Huang (2001) hypothesis of investor overreaction: investors expect firms that have realized losses to be riskier in the future than firms that have realized gains, which causes a divergence and a subsequent reconvergence of implied and historical volatilities. We take an agnostic position on whether the deviation of implied volatility from the historical level is an overreaction or a rational expectation of firm risk on the part of investors and focus on this difference as an indicator of perceptions about changes in the riskiness of firms. A perceived increase in the expected riskiness of a firm, regardless of whether it is accurate, may be sufficient to limit the firm in its ability to increase leverage. Thus, the difference between implied and historical volatility is a relevant measure of firm risk and we hypothesize that a positive difference between implied and realized volatilities negatively affects a firm's ability to increase leverage, consistent with a perceived increase in firm risk.

Hypothesis 1. *A positive spread between implied and realized volatilities is positively related with cash flow risk and therefore negatively correlated with an increase in firm leverage.*

2.1.2 Tail Risk

Our second variable is the difference between the quarterly average implied volatilities of short-term, out-of-the-money (OTM) puts and short-term, in-the-money (ITM) puts:

$$IVspread_{mon,i,t} = IV_{p,OTM,i,t} - IV_{p,ITM,i,t} \tag{2}$$

where moneyness is defined as the ratio of the spot price to the strike price. Short-term options are those with less than 40 days to expiration. Out-of-the-money puts are those with moneyness less than 0.8 and in-the-money puts are those with moneyness greater than 1.2.[8] Conceptually, $IVspread_{mon,i,t}$ captures the risk of left-tail or "crash" events.

This measure is motivated by the famous implied volatility "smile" in index options, which is explained either by a price pressure argument on OTM put options as a form of insurance against the risk of a "crash" event (Bollen and Whaley, 2004; Garleanu, Pedersen, and Poteshman, 2009) or from the perspective of price drops due to stochastic volatility and jump processes (Bakshi, Cao, and Chen, 1997; Bates, 2000; Ait-Sahalia, Wang, and Yared, 2001; Liu, Pan, and Wang, 2005; Broadie, Chernov, and Johannes, 2007). In both interpretations a negative slope in the implied volatility function is indicative of the possibility of a crash: the more negative the slope, the bigger the crash. Therefore we consider the presence of an implied volatility smile in single-stock options as a signal of left-tail "crash" risk. If $IVspread_{mon,i,t}$ is positive, the out of the money puts are more valuable than ones in the money, indicating market concern about left-tail "crash" risk and therefore negatively affecting the firm's ability to increase leverage.

Hypothesis 2. *A positive spread between short-term OTM and ITM put implied volatilities is positively correlated with cash flow risk and therefore negatively correlated with an increase in firm leverage.*

[8]For robustness, we alternatively define {OTM, ITM} puts as those with moneyness: i) {less than 0.7, greater than 1.3}, and ii) {less than 0.9, greater than 1.1}. Our results are similar using these definitions. Defining OTM less than 0.8 and ITM greater than 1.2 yields the highest explanatory power by making the optimal tradeoff between dispersion in implied volatilities and number of observations.

2.1.3 Growth Expectations

Finally, our third measure is the difference between quarterly averages of short-term call implied volatility and short-term put implied volatility:

$$IVspread_{cp,i,t} = IV_{c,short,i,t} - IV_{p,short,i,t} \tag{3}$$

where $IVspread_{cp,i,t}$ reflects expectations about the direction of firm performance. Short-term options are those with less than 40 days to expiration.

Cremers and Weinbaum (2010) find that differences in call and put implied volatilities are a predictor of future firm performance. Informed investors buy (sell) a call (put) option if performance is expected to be positive, and buy (sell) a put (call) if it is to be negative. This price pressure causes the implied volatilities of call options to exceed those of puts for firms whose investors have optimistic outlooks, and the opposite for those whose investors are pessimistic. This gap in implied volatilities acts as a barometer of investor sentiment about the firm and provides an indicator of growth expectations. Regardless of whether this expectation is realized, it alone may affect a firm's ability to obtain funds and change its capital structure.[9] For example, McLean and Zhao (2014) find that a firm's ability to obtain external financing is sensitive to the Baker and Wurgler (2006) investor sentiment index. As such, we hypothesize that a positive difference between the implied volatility of calls and puts positively affects a firm's ability to lever up, consistent with a positive signal about expected performance.

Hypothesis 3. *A positive spread between short-term call and put implied volatilities indicates positive growth expectations, and therefore is positively correlated with an increase in firm leverage.*

2.2 Modeling Changes in Capital Structure

We examine the impact of the options-based measures on capital structure by studying the effect these measures have on the change in net leverage. We follow prior literature (e.g. Kisgen, 2006; Binsbergen, Graham, and Yang, 2010; Leary and Roberts, 2014) in using a deflated measure of changes in capital structure to summarize the decisions made within the firm. Firms may choose

[9] Cremers and Weinbaum (2010) do find significant abnormal performance in firms classified using their measure of difference in call and put implied volatilities, suggesting these expectations generally materialize.

to adjust their capital structure through issuing and paying down debt, and issuing or repurchasing equity. To account for these changes, we use the net levering up ratio of the firm as our main dependent variable. Net levering up ratio is defined as net debt issuances plus net equity reductions (i.e., share repurchases) as a fraction of total assets:

$$NLEVR_{i,t} = \frac{(D_{iss,i,t} - D_{red,i,t}) + (E_{red,i,t} - E_{iss,i,t})}{TA_{i,t}} \tag{4}$$

where $D_{iss,i,t}$ is the long-term debt issuance for firm i over quarter t, $D_{red,i,t}$ is the long-term debt reduction, $E_{red,i,t}$ is the equity reduction, and $E_{iss,i,t}$ is the equity issuance.[10] This variable accounts for both debt and equity capital structure adjustments in the direction of increasing leverage for the firm. One advantage in using NLEVR is that it allows us to capture capital structure adjustments as explicitly reported by the firm, rather than rely on calculating changes in leverage ratios. That is, using such a measure allows us to exclude changes in leverage ratios that may be induced mechanically and not reflect actual capital structure adjustments.[11]

Equation (5) presents the baseline model we use to examine how market-based measures explain and predict changes in capital structure using the net levering up ratio, NLEVR, as our dependent variable:[12]

$$NLEVR_{i,t} = \alpha + \beta_1 X_{i,t-1} + fe_t + \varepsilon_{i,t} \tag{5}$$

where $X_{i,t-1}$ reflects our three options-based measures, $\{IVspread_{hist}$, $IVspread_{mon}$, and $IVspread_{cp}\}$, for firm i in quarter $t-1$ (i.e., lagged one quarter). To obtain the previous quarter's market-based variables, we calculate averages of the 3-month, 4-month, and 5-month lags of the options-based and historical volatility variables at monthly frequency.[13] We expect

[10]For robustness, we also deflate using the firm's total assets from the previous quarter. All results hold.

[11]For example, poor firm performance can reduce the value of equity, resulting in a change in leverage ratio without any capital structure decisions being made by the management.

[12]Studies of capital structure adjustments commonly employ partial adjustment models to study the speed of adjustment to target leverages. See, e.g., Leary and Roberts (2005), Flannery and Rangan (2006), Huang and Ritter (2009), Öztekin and Flannery (2012), Faulkender, Flannery, Hankins, and Smith (2012). Given the use of NLEVR, we bypass the need to compute a target leverage or to rely on computed changes to leverage ratios. When following a partial adjustment model using leverage ratios and the Blundell-Bond (1998) GMM estimation framework with firm fixed effects, reassuringly, we find qualitatively similar results.

[13]We cannot use the 2-month, 1-month, or 0-month lags of option data in estimating the model since we want to establish a predictive relationship between market data and leverage change. This precludes the use of the current quarter's price data since firm leverage may have changed at any point over the current quarter. However, contemporaneous option data may be used in explanatory (rather than predictive) applications.

$IVspread_{hist}$ and $IVspread_{mon}$ to be negatively correlated with net levering up behavior, as stated in Hypotheses 1 and 2, respectively, and $IVspread_{cp}$ to be positively correlated with net levering up behavior, in accord with Hypothesis 3. We examine all measures individually and jointly in our model specifications. We also include year fixed effects to absorb any other time-varying trends in the liquidity of capital markets and investor risk aversion, as well as quarter fixed effects to absorb cyclicality. All standard errors are two-way clustered by firm and year-quarter as in Petersen (2009).

It is important to note that our options-based measures reflect spreads. As such, when estimating equation (5) using our options-based measures, we also include the corresponding right-hand side variable that is being differenced away. For example, when estimating equation (5) using $IVspread_{hist}$, we also include $RealizedVolatility$ in the estimation; when using $IVspread_{mon}$, we include $IV_{p,ITM}$; when using $IVspread_{cp}$, we also include $IV_{p,short}$. This allows us to control for the baseline level of risk.

Since factors other than the options-based risk measures may impact the capital structure decision, we include control variables commonly believed to impact capital structure in our full model, specified in equation (6). Prior literature has relied on accounting measures to proxy for cash flow risk.[14] We include two such measures: the volatility of the prior five years (i.e., 20 quarters) of earnings normalized by total assets and the volatility of the prior five years of sales normalized by total assets.[15] Additional firm-specific controls include the firm's returns over the prior year, firm size, book-to-market ratio, Altman's Z-score, the Blouin, Core, Guay (2010) marginal tax rate, long-term debt ratio, and the Whited and Wu (2006) financing constraint index. We also include the 3-digit SIC industry long-term debt ratio to control for industry influences and the credit spread to control for the economy-wide lending environment, in addition to time fixed effects.

$$\begin{aligned} NLEVR_{i,t} = \alpha &+ \beta_1 X_{i,t-1} + \beta_2 RealizedReturn_{i,t-1} + \beta_3 lnTA_{i,t-1} + \beta_4 BTM_{i,t-1} \\ &+ \beta_5 Zscore_{i,t-1} + \beta_6 MTR_{i,t-1} + \beta_7 \sigma_{Earnings,t-1} + \beta_8 \sigma_{Sales,t-1} + \beta_9 LTDR_{i,t-1} \\ &+ \beta_{10} IndLTDR_{i,t-1} + \beta_{11} CredSpread_{t-1} + \beta_{12} WW_{i,t-1} + fe_t + \varepsilon_{i,t} \end{aligned} \tag{6}$$

[14]See, e.g. Bradley, Jarrell, and Kim (1984), Titman and Wessels (1988), Leary and Roberts (2005), Lemmon, Roberts, and Zender (2008), and Graham and Leary (2011).

[15]We also include the volatility of the prior five years of cash flows normalized by total assets. As it is highly correlated with the two mentioned, we remove this variable to reduce multicollinearity.

where $X_{i,t-1}$ includes our three option-based measures and $RealizedVolatility_i$, $RealizedReturn$ is the firm's cumulative monthly stock return over the prior year, $lnTA$ is firm size measured by the natural log of total assets, BTM is the ratio of book equity to market equity, $Zscore$ is the Altman's (1968) Z-score that measures the financial health of a firm, $\sigma_{Earnings}$ is the 5-year volatility of earnings normalized by total assets, σ_{Sales} is the 5-year volatility of sales normalized by total assets, MTR is the Blouin, Core, and Guay (2010) post-financing marginal tax rate, $LTDR$ is the firm's long-term debt ratio, $IndLTDR$ is the firm's 3-digit SIC industry long-term debt ratio, $CredSpread$ is the credit spread between Moody's Baa bonds and Moody's Aaa bonds, and WW is the Whited and Wu (2006) measure of firm financing constraints. All control variables are lagged one quarter. As before, we include year and quarter fixed effects and the model is estimated with standard errors double clustered by firm and by quarter.

Previous literature in capital structure suggests that large, value firms that are not in financial distress have higher leverage ratios. In addition, based on the static tradeoff theory of capital structure, interest deductibility of debt offers a tax benefit for using debt. Therefore, marginal tax rates and changes in tax rates are useful for isolating the demand for debt (Binsbergen, Graham and Yang, 2010; Farre-Mensa and Ljungqvist, 2014).[16] The firm's long-term debt ratio serves to benchmark the firm's target leverage ratio and to control for any persistence in leverage levels (Lemmon, Roberts, and Zender, 2008). Furthermore, Frank and Goyal (2009) find that a firm's long-term debt ratio is largely determined by its industry's long-term debt ratio and Leary and Roberts (2014) find that firms tend to mimic the industry leverage ratio, suggesting that industry leverage plays a large role in a firm's chosen capital structure. The credit spread reflects the current macroeconomic environment and, as a result, the availability of funds in the economy. Finally, the Whited and Wu (2006) index captures a firm's financial constraints, which may affect the firm's ability to adjust its capital structure.[17]

Next, we modify our full model to study both the level and change effects of our main variables and control variables to the net levering up decision. To do this, we decompose the first lags of our option-based risk measures and control variables into the second lags of levels and first

[16] Graham and Mills (2008) note that while the pre-financing marginal tax rate is useful for explaining leverage levels, the post-financing marginal tax rate is appropriate for predicting changes in leverage.

[17] For robustness, we use the Hadlock and Pierce (2010) size-age index in place of the Whited and Wu (2006) index. All results hold. Both measures are highly correlated with firm size and with each other.

lags of changes following the identity relationship: $X_{i,t-1} \equiv X_{i,t-2} + \Delta X_{i,t-2,t-1}$. This modified specification splits each explanatory variable in equation (6) into two terms, a second lag of the level and a first lag of the difference:

$$NLEVR_{i,t} = \alpha + \beta X_{i,t-2} + \gamma \Delta X_{i,t-2,t-1} + \sum_{c \in C} (\beta_c c_{i,t-2} + \gamma_c \Delta c_{i,t-2,t-1}) + fe_t + \varepsilon_{i,t} \qquad (7)$$

where X_i are our three option-based risk measures and $RealizedVolatility_i$, and C_i are our control variables as previously defined in equation (6).

The above analysis predicts the continuous measure of net levering up behavior, $NLEVR$. For robustness, we also define a dummy variable to capture any net increase in leverage as:

$$NLEVD_{i,t} = \begin{cases} 1 & \text{if } NLEVR_{i,t} > 0, \\ 0 & \text{otherwise.} \end{cases} \qquad (8)$$

While $NLEVR$ allows us to study whether our various measures can explain the magnitude or degree of capital structure changes, $NLEVD$ allows us to test whether our measures have power in explaining the levering up decision. Indeed, while it can be argued that the magnitude of capital structure adjustments is a combination of a firm's demand and supply for financing, the binary decision of whether a firm levers up or not may be more indicative of its ability and restrictions to doing so. We use a logistic model to examine the impact of our market based measures and control variables on $NLEVD$:

$$\begin{aligned} NLEVD_{i,t} = \alpha &+ \beta_1 X_{i,t-1} + \beta_2 RealizedReturn_{i,t-1} + \beta_3 lnTA_{i,t-1} + \beta_4 BTM_{i,t-1} \\ &+ \beta_5 Zscore_{i,t-1} + \beta_6 MTR_{i,t-1} + \beta_7 \sigma_{Earnings,t-1} + \beta_8 \sigma_{Sales,t-1} + \beta_9 LTDR_{i,t-1} \\ &+ \beta_{10} IndLTDR_{i,t-1} + \beta_{11} CredSpread_{t-1} + \beta_{12} WW_{i,t-1} + fe_t + \varepsilon_{i,t} \end{aligned} \qquad (9)$$

The predicted value from the logistic analysis provides us with the propensity score for whether the firm is likely to lever up.

Panels A and B of Figure 1 describe the time-series variations of the net levering up ratio, $NLEVR$, and the binary decision to net lever up, $NLEVD$, respectively. Both series of net leverage changes exhibit significant time-series variation. While leverage *levels* are persistent (Lemmon, Roberts and Zender, 2008), Figure 1 demonstrates that leverage *changes* vary substantially across time. This is consistent with the findings of Graham and Leary (2011) and highlights the potential usefulness of higher-frequency measures in explaining capital structure dynamics.

2.3 Financial Statement and Returns Data

We obtain corporate financial statement data from Standard & Poor's Compustat North American quarterly database from 1996 to 2012 and Moody's Baa and Aaa rates from the Federal Reserve Board historical interest rate website. These databases are used to construct the net levering up ratio ($NLEVR$) and control variables discussed above. All dollar amounts are chained to 2000 dollars using CPI to adjust for inflation. We remove any firms with negative book asset value, market equity, book equity, capital stock, sales, dividends, debt, and inventory. Such firms have either unreliable Compustat data or are likely to be distressed or severely unprofitable. Although distressed and unprofitable firms are likely to be restricted from increasing leverage, financially constrained firms need not be distressed or unprofitable in general.[18] In addition, we delete observations in which book assets or sales growth over the quarter is greater than 1 or less than -1 and firms worth less than $5 million in 2000 dollars in book value or market value to remove observations that have abnormally large changes due to acquisitions or small asset bases. Next, we remove outliers defined as firm-quarter observations that are in the first and 99th percentile tails for all relevant variables used in our analysis. Following standard practice in the literature, we remove all firms in the financial and insurance, utilities, and public administration industries as they tend to be heavily regulated.

Our returns data comes from the daily and monthly CRSP database from 1995 to 2012. We measure realized volatility, $RealizedVolatility_{i,t}$, on the first of each month using a one-year backward-looking window of daily returns. We annualize the resulting standard deviation to obtain the realized volatility for the preceding year. This captures the historical level of firm risk and is an input into $IVspread_{hist,i,t}$, our measure for the perception of change in firm risk.[19] Additionally,

[18] The distinction between financial distress and financing constraint has been drawn by prior work, e.g. Kaplan and Zingales (1997), Kisgen (2006), and Whited and Wu (2006).

[19] For robustness, we also consider conditional value-at-risk (CVaR) calculated over the previous year at the 1% level as an alternative measure of historical firm risk. As expected, the two measures are highly negatively correlated and yield consistent results. We retain realized volatility in our main specification due to superior significance and explanatory power.

we use monthly CRSP returns to compute $Realized\,Return_{i,t}$, by compounding monthly returns over the prior year. The monthly CRSP database is also used for expected and abnormal returns following the five-factor returns model that includes the Pastor and Stambaugh (2003) liquidity factor.

Finally, requiring the resulting sample to contain at least one non-missing options-based measure gives us a sample of 5,087 firms spanning 110,456 firm-quarter observations between 1996 to 2012. To more accurately compare across model specifications, we restrict our sample to those with non-missing observations for all relevant variables, giving us a sample of 3,700 firms spanning 56,041 firm-quarter observations. Variable definitions are provided in Appendix A. Table I provides the summary statistics for all relevant variables for both samples. Reassuringly, both samples appear to be statistically similar and with no obvious biases when restricting the sample.

Table II provides the pairwise correlation between all relevant variables. The pairwise correlations between the three implied volatility spreads (rows (19) through (21)) are under 10%, consistent with a partitioning of risk into unique components and with previous findings from the option pricing literature. Furthermore, while the IV *spread* measures are largely uncorrelated, the implied volatility *levels* (rows (14) through (18)) are highly correlated with each other. In addition, the implied volatility levels are highly correlated with $Realized\,Volatility$ (row (13)), with correlations ranging from 71.1% to 83.3%.

3 Predicting Changes in Capital Structure

In order to examine and compare the impact of the options-based risk measures on changes in net leverage, we test the significance and power of each measure, individually and jointly, on predicting a firm's net levering up behavior as detailed in Section 2.2 using the restricted sample.

3.1 Baseline Model

We start with our baseline model by regressing the net levering up ratio, $NLEVR$, on our options-based measures without any controls, as defined in equation (5). Table III present the results for our baseline model. Columns (1) through (3) report the coefficients for our three implied volatility spreads, $IV spread_{hist}$, $IV spread_{mon}$, and $IV spread_{cp}$, and their corresponding right-hand side volatility levels, respectively. If options-based measures contain unique information on investor beliefs regarding the cash flow risk of the firm, rather than simply reflecting expected managerial leverage decisions, we should expect to see higher risk levels resulting in decreases in net leverage. That is, we expect the coefficients on all volatility level variables to be negative as they reflect risk levels. Indeed, the results confirm that the riskier the firm actually is or perceived to be in terms of realized and implied volatility, the less the firm will lever up. Based on Hypotheses 1 and 2 motivated in Section 2.1, we expect the coefficients on $IVspread_{hist}$ and $IVspread_{mon}$ to be negative in columns (1) and (2), respectively, and find corroborating results. However, contrary to Hypotheses 3, the coefficient on $IVspread_{cp}$ is negative in column (3) of the baseline model.

In column (4) of Table III, we include all options-based measures in one specification. Table II documented that the implied volatility level variables are highly correlated, causing multicollinearity concerns when combined into one model. To alleviate this issue, we use $RealizedVolatility$ in place of all volatility level variables from columns (1) through (3) to account for the baseline risk level of the firm. This measure is negative and significant at the 1% level, consistent with the idea that firms with higher historical total risk are less likely to increase leverage going forward. Consistent with previous results, $IVspread_{hist}$ and $IVspread_{mon}$ remain negative and significant at the 1% and 5% levels, respectively. However, the coefficient on $IVspread_{cp}$ becomes positive and significant at the 5% level, consistent with Hypothesis 3 and existing literature. This suggests that the previous negative coefficient in column (3) may contain omitted risks captured in $IVspread_{hist}$ and $IVspread_{mon}$ that is now controlled for under column (4).

3.2 Full Model

Next, we present the findings for our options-based risk measures alongside accounting-based proxies of cash flow risk and other common control variables in Table IV. Column (1) shows the significance and explanatory power of the control variables alone in predicting levering up in firms. In general, the coefficients on the control variables are consistent with existing literature on capital structure and financial constraints. Large, financially healthy firms engage in larger net levering up. Moreover, firms with higher book-based measures of cash flow risk, earnings volatility and sales volatility, decrease net leverage. Consistent with Binsbergen, Graham and Yang (2010) and Farre-

Mensa and Ljungqvist (2014), firms with a higher marginal tax rate increase net leverage. Firms with high long-term debt ratios reduce net leverage, consistent with mean reversion of leverage (Lemmon, Roberts, Zender 2008). Book-to-market and financing constraints do not have significant explanatory power for leverage changes controlling for the other common factors. Neither the industry leverage level nor credit spreads explain changes in leverage as well.

In columns (2) through (4), we examine the effect of our implied volatility spreads. We continue to substitute $RealizedVolatility$, the historical level of firm risk, in all instances of the right-hand side volatility level to alleviate multicollinearity concerns and for ease of interpretation. With the inclusion of control variables, the negative coefficient on $IVspread_{hist}$ in column (2) is -0.0103 significant at the 1% level, consistent with Hypothesis 1. This coefficient is highly economically significant: a one standard deviation change in $IVspread_{hist}$ results in a 150% (= 0.0103*0.146/0.001) change in net leverage increase relative to the median level of -0.001. It is important to note that this is a 150% change in the leverage *change*, not a 150% increase in leverage *level*. The coefficient on $IVspread_{mon}$ in column (3) is negative and significant at the 1% level. A one standard deviation change in $IVspread_{mon}$ results in a 66% change in net leverage increase relative to the median level. The coefficient on $IVspread_{cp}$ in column (4), though positive per Hypothesis 3, is insignificant both statistically and economically. The increase in adjusted R^2 and reduction of significance in the intercept term in columns (2) through (4) relative to column (1) provides further evidence that the options-based measures have explanatory power in excess of existing controls for capital structure.

In column (5) of Table IV, we include all three options-based measures along with the controls into one specification. The coefficients on $IVspread_{hist}$ and $IVspread_{mon}$ remain negative and highly significant at the 1% level. Similar to column (4) of Table III, when all three risk measures are combined the coefficient on $IVspread_{cp}$ becomes positive and significant, at the 10% level. This full model produces an adjusted R^2 of 4.19%, which is the highest of all specifications considered. Our R^2 results do not necessarily indicate that equation (6) is the optimal model specification for studying changes in leverage. However, they confirm that forward-looking option-based measures of cash flow risk provide unique information in predicting leverage increases that is not available in specifications that use only backward-looking book measures, and have high economic significance.

Next, we present the results to the modified version of the full model in Table V by decomposing the first lagged levels of the explanatory variables into first lagged differences and second lagged levels as in equation (7). This decomposition allows us to jointly examine the impact that changes of risk as well as levels of risk have on net leverage increases. The results are largely consistent with those previously discussed. Reassuringly, both levels and changes in our options-based measures $IVspread_{hist}$ and $IVspread_{mon}$ retain their power in explaining and predicting capital structure changes over the next quarter in excess of that provided by levels and changes in controls. Although $IVspread_{cp}$ becomes insignificant, it remains positive in both the change and level. These results confirm that the options-based risk measures have predictive power for leverage changes in both the change and level in addition to any risks proxied by lagged levels or changes in firm characteristics.

Overall, our findings suggest that when investors expect firm risk to increase in the future relative to now ($IVspread_{hist}$) or when the firm is expected to experience higher probabilities of a crash event ($IVspread_{mon}$), the firm will decrease net leverage. On the other hand, when investors are more optimistic than pessimistic regarding the future of the firm ($IVspread_{cp}$), the firm will increase net leverage. These effects are significant on top of traditional accounting-based measures in predicting changes in capital structure. In other words, we document a negative relationship between risk and leverage increases. Higher levels, as well as increases, in options-based risk measures reflect investor belief regarding increases in the future cash flow risk of the firm, leading to higher costs of debt and, as a result, to reductions in net levering up behavior. However, if investors are expecting managers to increase leverage and these capital structure expectations, rather than cash flow risk expectations, drive options trading behavior, we should expect to see a positive relationship between the options-based measures of risk and net levering up behavior, based on existing capital structure theories that suggest leverage increases lead to higher equity risk. As such, our results suggest that options-based risk measures have significant informativeness about net increases in leverage, in excess of that provided by accounting-based control variables. Furthermore, this result is economically significant.

3.3 Supply and Demand Analysis

So far, we show that our risk-based measures are broadly useful in predicting changes in capital structure. Because existing literature demonstrates that firm leverage decisions are made at the intersection of supply and demand (e.g. Faulkender and Petersen, 2005; Binsbergen, Graham and Yang, 2010; Farre-Mensa and Ljungqvist, 2014), it is important to understand the channels through which these risks affect changes in capital structure and the situations under which these measures may have the most impact on capital structure. To do this, we test the informativeness of our market-based measures for net increase in leverage in sub-samples that isolate variation in supply and demand.

We consider variation in the supply of capital by repeating our main analysis during periods of macroeconomic expansion and contraction. Periods of macroeconomic expansion provide a greater availability of financing with more relaxed lending standards, with opposite effects during periods of macroeconomic contractions (e.g. Asea and Blomberg, 1998) and have been shown to matter for capital structure and capital raising (Korajczyk and Levy, 2003; Hackbarth, Miao, and Morellec, 2006; Chen, 2010; Almeida, Campello, Laranjeira, and Weisbenner, 2011; Erel, Julio, Kim, and Weisbach, 2012; Campello and Graham, 2013). In addition, expansionary and recessionary periods enable us to better identify the importance of our risk measures on levering up by exogenously shocking the supply of capital and injecting volatility into or removing it from the equity markets. We examine variation in demand by repeating our analysis on sub-samples of growth and value firms. Growth firms have a higher demand for additional financing compared to value firms with fewer growth opportunities.

3.3.1 Univariate Case

First, we consider the effects of univariate variation of supply and demand for financing using the option-based measures. Table VI applies our full model in equation (6) to four independent sub-samples. Columns (1) and (2) of Table VI display coefficient estimates for variation in capital supply. To capture this variation, we select sub-sample periods of macroeconomic expansion (1996Q1 through 1999Q4 and 2005Q1 through 2007Q2) and contraction (2001Q1 through 2002Q4 and 2007Q3 through 2009Q2). We select the periods right before and after the dot-com and financial market crashes to isolate the fastest rates of expansion and contraction. These events have been used for this purpose in existing literature. Campello and Graham (2013) use the technology bubble as a positive supply shock for financing; while Duchin, Ozbas, and Sensoy (2010) and Almeida, Campello, Laranjeira, and Weisbenner (2011) use the financial crisis as a negative supply shock. Our expansion and contraction periods capture the same shocks to tease apart the effects of supply variation.[20]

Column (1) of Table VI estimates the full model from equation (6) for net levering up over the expansion years and column (2) provides the estimates over the contraction years. All control variables have coefficients largely consistent with those observed in Table IV. Importantly, the coefficient estimates for the options-based variables are largely similar to those observed in Tables III and IV. Specifically, both $IVspread_{hist}$ and $IVspread_{mon}$ are negative and significant in both high and low capital supply environments. While, $IVspread_{cp}$ is positive, it is insignificant for both expansionary and contractionary periods.

The adjusted R^2 for the boom years, 3.93%, is lower than that of the bust years, 4.70%. The higher quality of fit in column (2) relative to column (1) suggests that a risk-based model of net change in leverage has more predictive power in supply contractions.[21] Consistent with Asea and Blomberg (1998), a relaxation of lending standards in boom periods enables a larger pool of firms to obtain financing, regardless of risk. Conversely, a tightening of lending standards means that firm risk becomes a more significant determinant of access to financing. In other words, cash flow risk matters more when capital supply contracts than when it expands, consistent with Hackbarth, Miao, and Morellec (2006) and Chen (2010).

Columns (3) and (4) of Table VI examine the variation in firm demand for capital by sorting firms each quarter into terciles based on their book to market ratio. We expect low (high) BTM firms, or high (low) growth firms, to have stronger (weaker) demand for leverage in order to fund the expected growth. In performing this analysis, we implicitly assume that growth and value firms

[20]An alternative definition of boom and bust based on terciles of the credit spread as indicator of macroeconomic credit risk yields similar, though slightly weaker, results.

[21]One potential concern with market-based measures of risk is that they may fail when the market becomes more illiquid, such as during an economic recession. Our market-based measures have *higher* explanatory power during the economic downturn sub-sample than in both the full sample and economic expansion sub-sample, demonstrating that this is not a problem in our application.

have different investment profiles which potentially leads to different capital structure dynamics.[22] That is, we expect a growth firm's capital structure to respond differently to changes in firm risk than that of a value firm at any given point in time. Therefore, we expect to see better (worse) predictive power of our measures among low (high) BTM firms. We find results consistent with this assumption.

Column (3) of Table VI presents the results for low BTM (high growth) firms and column (4) presents the results for high BTM (low growth) firms. All three of the options-based measures are significant for the high growth firms in column (3) with $IVspread_{hist}$ and $IVspread_{mon}$ negative and significant at the 5% and 1% levels respectively and $IVspread_{cp}$ positive and significant at the 5% level, consistent with all three hypotheses. In contrast, there is weak explanatory power for the high BTM (low growth) firms with $IVspread_{hist}$ being negative and marginally significant at the 10% level. $IVspread_{mon}$ is insignificant with a coefficient close to 0 and although $IVspread_{cp}$ is significant at the 10% level, the coefficient is negative and runs counter to a risk-based interpretation. Furthermore, the adjusted R^2 for low BTM (high growth) firms is 6.68%, the highest of all samples previously considered; while the adjusted R^2 for high BTM (low growth) firms is 2.29%, the lowest of all samples previously considered.

These sub-sample results provide intuition and a sensibility check to our interpretation that implied volatility spreads contain useful information about firm cash flow risk. Realized volatility, representing total historical risk, is a significantly and consistently negative predictor of leverage increases in all supply and demand environments. However, forward-looking estimates of specific risks from our implied volatility spreads are able to explain net levering up behavior substantially better in environments where macroeconomic conditions are poor (low supply) and firms are more likely to seek out financing (high demand). That is, our model fits best during recessions and for high growth firms, during when and for whom cash flow risk matters most.

3.3.2 Bivariate Case

Next, we interact variation in supply with demand by further breaking our sample into four bivariate sub-samples combining variation in supply with demand. Specifically, we create four sub-samples

[22] One motivation for this assumption is the q-theory of investment. See, e.g., Hayashi (1985).

permuting high and low growth firms within boom and bust periods, with each sub-sample as previously defined. Table VII present estimates of our full model in equation (6) to the four sub-samples of bivariate supply/demand variation.

Column (1) of Table VII, consisting of high growth firms in boom years, finds results largely consistent with prior analysis. However, $IVspread_{mon}$, measuring tail risk, falls in significance to the 10% level, while $IVspread_{hist}$, measuring (perceived) changes in risk, rises in significance at 1% level, relative to the results in column (3) of Table VI. In other words, when both supply and demand for capital are high, crash risk is somewhat less relevant to levering up, while overall changes in investor beliefs become more important. Column (2) repeats the analysis for low growth firms in boom years, with a substantial reduction in explanatory power, as expected based on the results from the univariate analysis. All options-based risk measures become insignificant and the R^2 falls to 2.34%. This suggests that the model has less predictive power for changes in capital structure in firms with a low demand for financing, even during times of high capital supply.

Column (3) of Table VII considers high growth firms in bust years. These are firms with the strongest need for financing during periods with the tightest capital supply. As such, we expect that investor expectations about firm risks to be substantially valuable and informative in predicting leverage changes. Indeed, the explanatory power of our model is the highest among any of the previously considered samples with an R^2 of 7.37%. This supports the results from the univariate analysis above: our market-based measures are most informative during situations where cash flow risk matters most. Consistent with solvency concerns during recessions, $IVspread_{mon}$, or tail risk, is the sole significant determinant of leverage increases among the three options-based measures when demand is high but supply is low. Neither $IVspread_{hist}$ nor $IVspread_{cp}$ are significant; even $RealizedVolatility$ is insignificant. Finally, column (4) presents results for low demand in low supply environments. As expected based on previous results, $IVspread_{hist}$ is negative and significant at the 10% level, $IVspread_{mon}$ is essentially zero and insignificant, and $IVspread_{cp}$ is negative and significant at the 10% level. The R^2 in the sample is low at 2.27%.

To test whether the coefficients on the options-based measures are statistically different from each other in the above sub-samples, shown in columns (1) through (4) of Table VII, we run seemingly unrelated regressions for each of the supply/demand sub-samples, and perform the χ^2

test of differences in coefficients estimated for our supply and demand variation sub-samples. These tests of differences between pairs of our four samples are reported in columns (5) through (8) of Table VII.

Column (5) compares the boom period, high-growth sample coefficients from column (1) to those from the bust, high-growth sample in column (3). The 10% statistically significant difference on the coefficient on realized volatility between the two sub-samples suggests the importance of the overall level of firm risk in predicting capital structure changes due to variation in capital supply. That is, the predictive power of realized volatility is sensitive to the pro-cyclical supply of capital when the demand for capital is high. Column (6) compares the boom period, low-growth sub-sample coefficients in column (2) to those from the bust period, low-growth sub-sample in column (4). The absence of significant differences confirms that fluctuations in supply do not affect the importance of our measures for low-growth firms with low demand for financing.

Column (7) compares the boom period, high-growth coefficients from column (1) to the boom period, low-growth coefficients from column (2), finding a significant difference in expected direction of risk, $IVspread_{cp}$. Comparing the bust period, high-growth coefficients in column (3) and bust period, low-growth coefficients in column (4), reported in column (8), finds this difference also as well as a stronger difference in $IVspread_{mon}$. This suggests that variations in capital demand drive the predictability of $IVspread_{cp}$ and $IVspread_{mon}$. In particular, directional risk captured by $IVspread_{cp}$ matters less for low-growth firms with low demand for financing. As observed previously, the ability of $IVspread_{mon}$, tail risk, in predicting changes in net levering up is strongest among high-growth firms during bust periods when the supply of capital is tight. We compute F-tests for overall differences in coefficients on all four of our market-based risk measures. Of these, the difference between bust period, high-growth coefficients in column (3) and bust period, low-growth coefficients in column (4) is significant at the 10% level.

The bottom line is that differences in the significance of the market-based risk measures exist between firms with high versus low growth in both boom and bust periods. However, differences in significance between boom and bust periods exist only for the high growth firms, but not for low growth firms. This is consistent with demand variation being the stronger determinant of the relevance of market-based risk measures in predicting capital structure adjustments.

3.4 Robustness

So far, we have shown the usefulness of market-based measures in predicting changes in capital structure in the direction of increasing leverage. Here, we examine the robustness of these results. First, we relax the sample selection criteria to reduce potential sample bias. The restricted sample we use in the above analysis is dependent on having option implied volatility data. We test whether simpler market-based measures have explanatory power for predicting the net levering up ratio in cases where implied volatility data is unavailable. Second, one advantage that market-based measures have over accounting-based measures is the more frequent availability of data. We test whether the higher updating frequency of the market-based measures does in fact contribute to their superior explanatory power relative to accounting-based measures by examining monthly, rather than quarterly, data. Finally, as mentioned in Section 2.2, we use an indicator variable for levering up, $NLEVD$, as our dependant variable, rather than the continuous net levering up ratio, $NLEVR$. This allows us to test whether our measures have power in explaining the levering up decision.

3.4.1 Simplified Market-Based Measures

Our previous analyses rely on firms having available options data to compute the three implied volatility spreads ($IV spread_{hist}$, $IV spread_{mon}$, and $IV spread_{cp}$). One concern is whether this limits the applicability of using market-based measures in predicting capital structure adjustments. A related concern is that by selecting firms with liquid option markets necessary to compute implied volatilities at both long and short horizons we may potentially have a biased sample. Here, we consider more basic characteristics of the option market and examine simpler measures that are more widely available. This serves three purposes: providing a less restrictive and therefore less biased sample, a consistency check for the hypothesis that options convey information about leverage changes, and more general market-based measures applicable to firms with sparse or unavailable option data.

We introduce four simple options-based measures. First, we create a dummy variable, $Has\,Tradeable\,Options$, that indicates whether the firm has any positive open interest option contracts within the past three months. Second, we define $Log\,Total\,Tradeable\,Options$ as the logarithm of the firm's total option open interest contracts for both puts and calls. We take the daily count for both calls and puts and compute the quarterly average of the three monthly averages of this count. Finally, we create two measures for the liquidity of each firm's option market, $Log\,Total\,Open\,Interest$ and $Log\,Total\,Volume$. We calculate $Log\,Total\,Open\,Interest$ by taking the logarithm of the quarterly average of the three monthly averages of daily open interest amount. $Log\,Total\,Volume$ is the logarithm of the traded volume for both puts and calls. These variables are set to zero for the firms without applicable options data, enabling us to analyze a substantially larger sample size with 183,032 firm-quarters in Table VIII. In other words, we consider whether the existence, size, and liquidity of a firm's options market can increase the firm's ability to lever up, hypothesizing a positive relation through superior information transmission.

Column (1) of Table VIII reports that the existence of an option market on the firm's stock, $Has\,Tradeable\,Options$, is insignificant to the degree of net levering up beyond that explained by $RealizedVolatility$ and accounting controls. However, in column (2), the number of tradeable options, $Log\,Total\,Tradeable\,Options$, increases net levering up behavior, with a positive coefficient that is significant at the 1% level. Results are similar for $Log\,Total\,Open\,Interest$, and $Log\,Total\,Volume$, each having a positive and highly significant coefficient, as presented in columns (3) and (4), respectively. These results support the idea that even the simpler measures based on the options market have power in explaining and predicting net levering up behavior. They also demonstrate how our methodology can be applied to firms with sparse or nonexistent implied volatility data that precludes the use of our main implied volatility spread measures.

3.4.2 Monthly Market-based Measures

The preceding analysis finds that market-based measures contain information relevant to capital structure decisions in excess of that obtainable from accounting-based controls. Tables III through VII use the average implied volatility measures over the past quarter, i.e., the average implied volatility spread from five months ago to three months ago. We take the quarterly average for two reasons: first, to improve the number of observations in our sample to include firms that may not have data for all three months in the past quarter and second, to smooth any kinks in the options data. While it is reassuring to find relevance in market-based measures for predicting net levering up behavior using the past quarterly average, in taking the average we lose one of the key features of using market data - the more frequent availability of information. For robustness, we restrict our sample to firms with options data in all three months in the past quarter and repeat our analysis using monthly option averages instead of quarterly averages in Table IX.[23] This reduces our sample to 22,964 firm-quarter observations. If market-based measures indeed contain useful information about changes in net leverage, we should see that options data at monthly frequency, at minimum, retains explanatory power relative to the quarterly frequency and, at best, improves on it. Furthermore, we can observe how the informativeness of these measures in predicting capital structure changes evolves through time.

Column (1) of Panel A of Table IX replicates the quarterly results from column (5) of Table IV for comparison with the higher frequency data. Column (2) of Panel A uses the fifth lag of monthly market-based measures, i.e., the end of the first month in the past quarter. This is the month immediately following the release of accounting data from two quarters ago. While $IVspread_{hist}$ and $IVspread_{mon}$ remain negative and highly significant at the 1% and 5% levels, respectively, $IVspread_{cp}$ loses significance entirely. However, R^2 increases to 4.86% from 4.19% in column (1).

Column (3) of Panel A uses the fourth lag of monthly market-based measures, i.e., the second month in the past quarter. Though the market has not received any new accounting information, the options data advanced by one month and we should expect significant findings if this fresher data is more informative. Indeed, we see that the significance for $IVspread_{hist}$ remains high at the 1% level. Moreover, the significance of $IVspread_{mon}$ improves to the 1% level. The adjusted R^2, 4.82%, remains superior to using quarterly data in column (1).

Finally, column (4) of Panel A uses the third lag of monthly market-based measures, i.e., the last month in the past quarter. This coincides with a release of new accounting information from one quarter ago. $IVspread_{hist}$ loses its significance, suggesting the impact of concurrent accounting data. However, $IVspread_{mon}$ remains highly significant at the 1% level and adjusted R^2 remains higher than column (1) at 4.74%. It is reassuring that using the fifth and fourth lags of market-based measures provides more significant results compared to the third lag in terms of information content, as that data contains updated market information without corresponding updates to accounting

[23]We require all three months of data to be present to enable a meaningful comparison of the quality of fit across months.

information. This highlights the information advantage of using timely market-based measures.

One possible concern is that capital structure changes may be determined more than one quarter in advance, resulting in information leakage that is picked up by the prior quarter's option prices, driving the results in previous tables. While this would not detract from the usefulness of options relative to accounting data in predicting firm leverage, it would reverse the relationship between risk and leverage increases, as discussed previously. We repeat the analysis in column (1) of Table IX with options data from two quarters ago (suppressed for brevity) and find similarly strong significance for the market-based risk measures on net levering up. This supports our interpretation that equity risks contain information that drives leverage changes (rather than the other way around).

3.4.3 Propensity to Lever Up

So far, we use $NLEVR$ as our dependent variable in measuring changes in capital structure. This captures not only the direction but also the magnitude that market-based risk measures have on the net levering up ratio of the firm. For robustness, we define a binary variable, $NLEVD$, in equation (8) that takes the value of 1 for firms that increases net leverage in a particular quarter and 0 otherwise. This allows us to focus on the effectiveness of the options-based measures in predicting the decision to lever up while abstracting away from the decision on the degree of levering up.

Columns (5) through (8) of Table IX present the results using $NLEVD$ as the dependent variable in a logistic model, as detailed in equation (9). The control variables generally have the same qualitative effect on $NLEVD$ as in the continuous case. However, the Whited and Wu (2006) index of financing constraints, WW, becomes significant, consistent with the interpretation of $NLEVD$ as being more indicative of a firm's ability and restrictions to levering up. In addition, the constant term becomes significant suggesting that some variation in $NLEVD$ is not as well explained as in $NLEVR$. Column (5) of Panel B uses the quarterly averages of options data to predict the likelihood of levering up, analogous to column (1) for the continuous measure of net levering up. Using quarterly data, all three $IVspread$ measures as well as $RealizedVolatility$ are significant and with the expected signs.

Columns (6) through (8) predicts the likelihood of levering up using the fifth, fourth, and third lag of monthly market-based measures, respectively. Similar to the results using $NLEVR$, the monthly variables at higher frequency produce a higher quality of fit compared with the quarterly measures, with improved R^2's. Furthermore, both $IVspread_{hist}$ and $IVspread_{mon}$ are significant for the fifth and fourth lags while $IVspread_{cp}$ is not. As before, when examining the third lag, only $IVspread_{mon}$ and realized volatility remain significant, consistent with market measure losing some, but not all, predictive power with a new, concurrent release of accounting information.

4 Market-Based Indices of Leverage Increases

The results from Section 3 provide evidence that market-based risk measures are useful predictors of changes in capital structure. In this section, we use our previous results to create market-based indices that predict net leverage increases in firms. These indices are linear combinations of our options-based measures and control variables. It should be noted that these indices reflect a specific and unique linear combination of its constituents (based on our previous results) and are therefore indices of predicted net levering up behavior.[24] As such, these indices may or may not behave in ways different from its individual constituents.

4.1 Degree of Net Leverage Increase Indices

In creating our indices, we use the variable coefficients from column (5) of Table IV. We retain statistically significant coefficients to create two market-based indices for net leverage increases. In the first index, we include only the three options-based measures and $RealizedVolatility$:

$$\begin{aligned} LIMkt_{1,i,t} = &-0.0100 * IVspread_{hist,i,t-1} - 0.0047 * IVspread_{mon,i,t-1} \\ &+ 0.0041 * IVspread_{cp,i,t-1} - 0.0177 * RealizedVolatility_{i,t-1} \end{aligned} \tag{10}$$

where $IVspread_{hist}$ is the difference between the implied volatility of long-term calls and realized volatility, $IVspread_{mon}$ is the difference between the implied volatility of short-term out-of-the-money puts and short-term in-the-money puts, $IVspread_{cp}$ is the difference between the implied volatility of short-term calls and short-term puts, and $RealizedVolatility$ is the realized volatility

[24] For other examples of popular indices proposed in the literature, see Altman (1968), Kaplan and Zingales (1997), Lamont, Polk, and Saá-Requejo (2001), Whited and Wu (2006), Hadlock and Pierce (2010), and Binsbergen, Graham and Yang (2010).

of the underlying asset over the past year. The first measure gives us an index based only on market-based risk measures while controlling for common firm characteristics.

In the second index for leverage increase we use the first index and additionally include the significant control variables:

$$
\begin{aligned}
LIMkt_{2,i,t} = {} & LIMkt_{1,i,t} - 0.0022 * Realized\,Return_{i,t-1} + 0.0017 * LnTA_{i,t-1} \\
& + 0.0009 * Zscore_{i,t-1} - 0.0114 * \sigma_{Sales,i,t-1} \\
& - 0.0166 * LTDR_{i,t-1} + 0.0067 * IndLTDR_{i,t-1}
\end{aligned} \tag{11}
$$

where $Realized\,Return$ is the realized stock return of the underlying asset over the prior year, $LnTA$ is the natural log of total assets, $Zscore$ is the Altman (1968) Z-score, σ_{Sales} is the 5-year volatility of sales normalized by total assets, $LTDR$ is the firm's long-term debt ratio, and $IndLTDR$ is the firms' 3-digit SIC industry level of leverage. Both measures are increasing in net leverage and capture the direction and magnitude of net leverage increases.

4.2 Propensity to Lever Up Indices

We use the predicted values from the logistic analysis using quarterly data from column (5) of Table IX to calculate the probability of an increase in net leverage, regardless of magnitude. This provides us with two additional market-based indices that capture whether is likely to change its net leverage at all. As with the first two indices, we create an index using only the three options-based $IVspread$ measures and $Realized\,Volatility$ and an index that also includes the control variables. This gives us our third and fourth measures for leverage changes:

$$
\begin{aligned}
LIMkt_{3,i,t} = {} & -0.8579 - 0.3344 * IVspread_{hist,i,t-1} - 0.2829 * IVspread_{mon,i,t-1} \\
& + 0.3527 * IVspread_{cp,i,t-1} - 1.4776 * Realized\,Volatility_{i,t-1}
\end{aligned} \tag{12}
$$

and

$$
\begin{aligned}
LIMkt_{4,i,t} = {} & LIMkt_{3,i,t} - 0.1186 * Realized\,Return_{i,t-1} + 0.1215 * LnTA_{i,t-1} \\
& + 0.0425 * Zscore_{i,t-1} - 0.9517 * WW_{i,t-1}
\end{aligned} \tag{13}
$$

where $IVspread_{hist}$ is the difference between the implied volatility of long-term calls and realized volatility, $IVspread_{mon}$ is the difference between the implied volatility of short-term out-of-the-money puts and short-term in-the-money puts, $IVspread_{cp}$ is the difference between the implied volatility of short-term calls and short-term puts, and $RealizedVolatility$ is the realized volatility of the underlying asset over the past year. $RealizedReturn$ is the realized stock return of the underlying asset over the prior year, $LnTA$ is firm size measured by the natural log of total assets, $Zscore$ is the Altman's (1976) Z-score that measures the financial health of a firm, and WW is the Whited and Wu (2006) index of financing constraints. These indices are increasing in the likelihood (rather than magnitude) of levering up. It is interesting to note that the Whited and Wu (2006) index of financing constraints affects ability of the firm to obtain leverage, but not the degree to which it increases leverage.

Table X presents the descriptive statistics for our four market-based indices of leverage increase in Panel A. Panel B displays the pairwise correlation coefficients. The four market-based indices are strongly correlated with each other, ranging from 74.32% to 98.01%.

4.3 Risk Characteristics of Firms that Increase Leverage

Equipped with four potential market-based indices for net leverage increases, $LIMkt_1$ through $LIMkt_4$ based on equations (10) through (13) respectively, we examine the characteristics of firms associated with increasing leverage. To do this, in each quarter we sort firms based on $LIMkt_1$ into three equal-sized bins: LOW, MED, and HIGH. The LOW bin reflects firms with values of $LIMkt_1$ falling into the bottom tercile in any given quarter, i.e., firms with lower net levering up ratios. The HIGH bin reflects firms with values of $LIMkt_1$ ranking in the top tercile in any given quarter, i.e., firm with higher net levering up ratios. We repeat this procedure to create LOW, MED, and HIGH bins based on the other three $LIMkt$ measures.

Table XI compares common characteristics for firms in the LOW and HIGH bins of $LIMkt_1$, which uses only market-based risk measures, and for $LIMkt_2$ which uses both market-based risk measures and control variables.[25] The differences in characteristics between LOW and HIGH firms in Table XI demonstrate significant spreads in firm quality and riskiness, as expected given the

[25] The results for $LIMkt_3$ and $LIMkt_4$ are very similar, consistent with the high correlations observed in Table X, and are therefore suppressed for brevity.

creation of these indices based on our option-based measures of risk. Firms ranking in the bottom tercile of net levering up based on $LIMkt_1$ are smaller with lower Altman Z-scores and lower cash flows than firms ranking in the upper tercile of $LIMkt_1$. These firms are also less likely to pay dividends, to have investment-grade credit ratings, and to have investment-grade ratings conditional on having a rating. Furthermore, firms ranking LOW hold more cash and have higher Whited and Wu (2006) and Hadlock and Pierce (2009) size-age indices, consistent with facing more financing constraints. The LOW $LIMkt_1$ firms also have lower leverage, consistent with George and Hwang (2010) who find that leverage and firm risk are endogenous and firms with higher leverage are less risky resulting in their ability to obtain leverage. All differences in mean firm characteristics between the LOW and HIGH firms are statistically significant at the 1% level.

Many of these quality and characteristics have been documented to have performance implications in several distinct areas of the literature. Their consistent observation is that high-quality firms exhibit stronger abnormal performance. Firms that rank HIGH in net leverage increases have several key characteristics associated with low risk and abnormally positive performance: lower leverage (Penman, Richardson and Tuna, 2007; George and Hwang, 2010), higher Z-score and credit ratings (Altman, 1968; Campbell, Hilscher, Szilagyi, 2008), higher profitability (Novy-Marx, 2013), and higher dividend payouts (Asness, Frazzini, Pedersen, 2015). All these characteristics are associated with low risk, high quality, and, paradoxically, superior performance (Asness, Frazzini, Pedersen, 2015). Selecting firms by predicted leverage increases based on the $LIMkt_1$ index captures all of these desirable characteristics simultaneously, and from using market data alone.

The comparisons when sorting on $LIMkt_2$ are largely the same with the exception of leverage. Recall that $LIMkt_2$ includes the significant control variables, one of which is the long-term debt ratio. That is, $LIMkt_2$ also controls for existing debt usage. Interestingly, firms ranking LOW based on $LIMkt_2$ have more leverage than firms ranking HIGH on $LIMkt_2$. This may reflect increased expected default risks due to having higher leverage, as evidence by the substantially lower Altman's Z-score. This is consistent with Whited and Wu (2006) who find that existing leverage is a significant determinant of financing constraints. In either case, firms that rank LOW in net levering up have characteristics consistent with having higher cash flow risk and being riskier firms and firms that rank HIGH in net levering up are associated with characteristics consistent with lower cash flow risk and being less risky firms. These results suggest that the market-based $LIMkt$ indices are useful for identifying firms with high-risk characteristics associated with limited access to capital markets.

5 The Value of Capital Structure Adjustments

In their survey, Graham and Harvey (2001) find that the ability to adjust capital structure is ranked as a top concern by CFOs. Our results establish a strong connection between equity risks, firm quality, and capital structure adjustments. The tercile sorts in Table XI identify the HIGH net leverage increase tercile as significantly less risky than those in the LOW net leverage increase tercile, and these same risk characteristics have been shown in prior literature to have significant performance implications. Therefore, the firm's ability to increase leverage should have an economically significant impact for shareholders. In this section we explore the performance and value implications of the market-based leverage increase indices defined previously. That is, we measure firm performance by quantifying shareholder value of the firm's expected increase in net leverage.

For this section of the analysis we create rolling versions of our $LIMkt$ indices based on the past five years (20 quarters). This avoids any look-ahead bias in our performance findings, and provides out-of-sample testing for the indices. The results are qualitatively very similar to those obtained by using the coefficients in equations (10) through (13) estimated on the full sample.

5.1 Predicted Leverage Increases and Firm Performance

To measure firm performance and quantify the value of the firm's expected net increase in leverage, we consider whether a buy-and-hold strategy using our market-based indices generates abnormal returns. First, we create monthly indices for our market-based indices introduced above, $LIMkt_1$ to $LIMkt_4$ in equations (10) through (13), using information available at the beginning of the month. As in Table XI, we sort each of our four $LIMkt$ indices into equal-sized LOW, MED, and HIGH bins, with monthly rebalancing. We follow a buy-and-hold strategy by compounding abnormal returns over the 12 months following portfolio creation. Abnormal returns are calculated based on the coefficients obtained from the Pástor and Stambaugh (2003) 5-factor model using a rolling window of the prior 60-months.

Panels A through D of Figure 2 plot the buy-and-hold abnormal returns for the HIGH, LOW, and HIGH-LOW leverage increase portfolios based on the four $LIMkt$ indices respectively. For $LIMkt_1$ in Panel A, buy-and-hold abnormal returns for the HIGH bin reaches 1.5% by month six and 2.8% by month 12, while the LOW bin declines slightly to -0.4% by month six and remains at -0.4% by month 12. Similarly, for $LIMkt_2$ through $LIMkt_4$, the HIGH leverage increase portfolio generates buy-and-hold abnormal returns of 3.1%, 2.9%, and 2.9% over the following year, respectively, while the LOW leverage increase portfolio returns -0.4%, -0.9%, and -1.0% over the same period. In other words, the HIGH leverage increase portfolios outperforms the LOW leverage increase portfolios over the following year and a buy-and-hold trading strategy of buying the tercile with the highest net leverage increase and selling the tercile with the lowest net leverage increase nets abnormal returns of 3.18%, 3.48%, 3.84%, and 3.89% over one year based on $LIMkt_1$ through $LIMkt_4$, respectively. These abnormal returns are driven almost entirely by the HIGH leverage increase portfolios. Furthermore, $LIMkt_1$ generates a HIGH minus LOW abnormal return of 3.18% in comparison to the 3.48% generated by $LIMkt_2$. This suggests that the abnormal returns are almost entirely driven by the market-based risk measures ($IVspread_{hist}$, $IVspread_{mon}$, $IVspread_{cp}$, and $RealizedVolatility$) rather than by the control variables.

At first glance these results may seem trivial, considering that our indices are functions of implied volatility spreads that have already been shown to predict abnormal returns in the options literature from which they originate.[26] However, recall that we use these implied volatility spreads to first predict the degree of leverage increases in $LIMkt_1$ and $LIMkt_2$ or propensity to increase leverage in $LIMkt_3$ and $LIMkt_4$. Then, we form portfolios based on the predicted leverage increase indices. As a result, we isolate net leverage increases as the channel affecting future realized returns, using specific linear combinations of these implied volatility spreads. While each individual IV spread has been shown to explain returns in the literature, this by itself does not imply that our indices of predicted net levering up would do so as well. In other words, it is the predicted net increase in leverage, consistent with lower risk and higher quality as demonstrated in Table XI, that results in

[26]See Bali and Hovakimian (2009), Cremers and Weinbaum (2010), and Xing, Zhang, and Zhao (2010).

between 3.2% and 3.9% abnormal firm performance.

5.2 Net Levering Up Indices and the Quality Anomaly

Previous results document a robust, negative relationship between options-based risk measures and net levering up. This relationship is corroborated by Table XI, which shows that firms that fall into the bottom tercile of levering up sorting on the $LIMkt$ indices are smaller, have lower Altman's Z-scores, lower cashflows, and are less likely to pay dividends and have credit ratings, all consistent with having higher risk and lower quality. In other words, firms that are more (less) risky in terms of the three volatility spreads and realized volatility lever up less (more). Given these findings, it is natural to ask whether the quality anomaly observed in similar characteristics by Asness, Frazzini, and Pedersen (2015) also exists here.

As before, we start by creating monthly indices for $LIMkt_1$ through $LIMkt_4$ using information available at the beginning of each month and sort each of the four $LIMkt$ indices into equal-sized LOW, MED, and HIGH bins each month. We form zero-cost portfolios by taking the average return of the LOW (higher risk and lower quality) bin minus the average return of the HIGH (lower risk and higher quality) bin for each index, giving us a time series of monthly returns for each portfolio long on firms that fall into the top tercile of predicted net leverage increases and short on firms that fall into the bottom tercile of predicted net leverage increases.[27] If a quality anomaly exists here, we should expect to see significant and negative alpha consistent with a negative risk premium on the riskier firms that have low net leverage increases. We create both equal-weighted and value-weighted portfolios and benchmark performance using the Pástor and Stambaugh (2003) 5-factor expected returns model estimated using a rolling five-year window. Table XII presents the alphas for portfolios formed on sorts of $LIMkt_1$ through $LIMkt_4$.

Panel A of Table XII presents the monthly alphas for the zero-cost portfolio in our full sample using equal-weighted portfolios in columns (1) through (4) and value-weighted portfolios in columns (5) through (8). An equal-weighted portfolio based on $LIMkt_1$ generates a -0.98% monthly alpha in column (1), which is significant at the 1% level. Zero-cost portfolios based on $LIMkt_2$ through $LIMkt_4$ generate monthly alphas of -1.54%, -1.39%, and -1.48% respectively in columns (2) through

[27]To avoid possible contamination due to delayed release of the previous quarter's accounting data, we also measure returns three months after portfolio formation. The results are similar to those presented.

(4), all significant at the 1% level, consistent with the quality anomaly discussed in Asness, Frazzini, Pedersen (2015). Panels B and C of Table XII present the 5-factor alphas for the LOW and HIGH halves of the zero-cost portfolios from Panel A, respectively. There are highly significant negative alphas for all LOW portfolios in columns (1) through (4) of Panel B and significant positive alphas for the equal-weighted HIGH portfolios in Panel C, consistent with the results in Figure 2.

When we turn to the value-weighted portfolios in columns (5) through (8) of panel A, for $LIMkt_1$, which uses only the market-based risk measures without controls, there is a positive alpha, significant at the 5% level, inconsistent with a quality anomaly. However, for $LIMkt_2$ through $LIMkt_4$, there are insignificant alphas. The lack of abnormal returns is driven by the positive and significant alphas generated in both the LOW and HIGH groups in panels B and C off-setting each other, in contrast to the equal-weighted portfolios. Value-weighting emphasizes the effect of large firms in both terciles, compressing the cross-section of quality which correlates with size, as demonstrated in Table XI, and therefore compresses the variation of returns. Taken altogether, the findings in Table XII suggest that, unconditional on firm size (as is the case with equal-weighted portfolios), more risky, leverage decreasing (LOW) firms display significant underperformance which drives the negative alphas of the zero-cost portfolios.

These results are consistent with the leverage and distress risk puzzles that find lower returns for firms with higher leverage or higher default risk (Fama and French, 1993; Dichev, 1998; Vassalou and Xing, 2004; Penman, Richardson, and Tuna, 2007; Campbell, Hilscher and Szilagyi, 2008; George and Hwang 2010). As the ability to increase leverage correlates with financial constraints (as seen in Table XI), this also relates to the financial constraints puzzle which finds that firms with higher financing constraints earn lower returns than firms with lower constraints (Lamont and Polk, 2001; Whited and Wu, 2006). These results are also consistent with recent findings on pricing anomalies in which quality firms with lower risk, as measured across several firm characteristics, outperform their high-risk counterparts (Novy-Marx, 2013; Frazzini and Pedersen, 2014; Asness, Frazzini, and Pedersen, 2015). According to our findings the leverage decision, as forecasted using options market data, encapsulates these characteristics.

6 Conclusion

We provide new evidence connecting market-based measures of equity risk to firm capital structure decisions. To the extent that equity market prices are informative about the firm's cash flow risk, market-based measures of equity risk should be informative regarding the firm's capital structure decisions. We recover investor expectations about risks relevant to financing constraint from option prices and demonstrate their predictive power for changes in firm leverage. Using options-based measures to explore changes in leverage has three main advantages. First, options-based measures reflect investor and market attitudes and expectations regarding future risks of the firm and as such are forward-looking. Second, market information is updated and available more frequently than book-based measures. Third, having various types of options associated with one underlying asset allows us to measure distinct dimensions of risk for the same firm, enabling us to directly measure risks rather than proxy for them using accounting-based firm characteristics.

Option implied volatility spreads that capture investor perceptions of the change in risk, left-tail "crash" risk, and direction of risk have significant predictive power for future leverage changes at the firm. This informativeness persists in the presence of historical volatility and accounting-based controls including book-based measures of cash flow risk and financing constraints. These effects become particularly strong when firm demand for financing is high, especially during periods of economic contraction. The results are robust to using simpler option measures and monthly option measures. Furthermore, option based measures are useful for explaining both the degree as well as the decision to lever up.

We demonstrate that our market-based measures identify lower-quality firms with higher credit risk, lower cash flows, lower payouts, and smaller size as significantly more unlikely to increase leverage. This is consistent with cash flow risk as the channel linking equity risks identified in our implied volatility measures to capital structure decisions, and supports earlier findings (e.g. George and Hwang, 2010) suggesting that capital structure is endogenous in firm risk.

Finally, we examine abnormal buy-and-hold firm performance to quantify the value of the firm's ability to make capital structure adjustments, identified as qualitatively valuable in the Graham and Harvey (2001) CFO survey. The 12-month abnormal return on buying a portfolio of firms in the upper tercile of predicted net leverage increases while shorting the portfolio of firms in the lower tercile of predicted net leverage increases earns from 3.2% to 3.9% over the next year. We find that a zero-cost portfolio long firms that are not predicted to increase leverage and short firms that are generates a negative risk premium using equal-weighted portfolios, suggesting a negative risk premium on the inability to increase leverage, consistent with the leverage and distress puzzles as well as other firm quality-related anomalies.

These findings provide promising insight into the link between market-based estimates of investor expectations outside the firm and managerial decision-making within it. Our results show that these market-based measures capture information that is not contained in established accounting-based measures and provide better risk based measures than those proxied from firm characteristics. They are also more broadly suggestive of additional potential applications for the use of market data in estimating corporate decisions previously treated only with book-based measures. One logical extension is to the area of financing constraints. The Whited and Wu (2006) accounting-based index has been shown to have predictive power for the binary decision to increase leverage, alongside our market-based risk measures. Furthermore, the firms we identify as likely to increase leverage have higher Whited and Wu (2006) and Hadlock and Pierce (2010) scores. The present application of estimating the otherwise ex ante unobservable ability of firms to increase leverage is just one case of a potentially large set of connections between investor expectations and firm operations and the risks and frictions that moderate these connections.

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Appendix A

We detail the construction of our variables below. Summary statistics of these variables are reported in Table I.

Realized Volatility
: Annualized standard deviation from the first of each month using a one-year backward-looking window of daily returns

Long Call Implied Vol-Realized Vol Diff ($IVspread_{hist}$)
: Spread between quarterly average implied volatility from long-maturity call options and Realized Volatility. Long maturity options are those with >200 days to expiration. See Section 2.1 for details.

Short OTM Put-ITM Implied Vol Diff ($IVspread_{mon}$)
: Spread between quarterly average implied volatility from short-term out-of-the-money put options and in-the-money put options. Short maturity options are those with <40 days to expiration. Out-of-the-money options are those with spot/strike < 0.8 and in-the-money options are those with spot/strike > 1.2. See Section 2.1 for details.

Short Call-Short Put Implied Vol Diff ($IVspread_{cp}$)
: Spread between quarterly average implied volatility from short-maturity call options and short-maturity put options. Short maturity options are those with <40 days to expiration. See Section 2.1 for details.

Net Levering Up Ratio ($NLEVR$)
: $\frac{(D_{iss,i,t}-D_{red,i,t})+(E_{red,i,t}-E_{iss,i,t})}{TA_{i,t}}$
where D_{iss} is long-term debt issuance (DLTIS), D_{red} is long-term debt reduction (DLTR), E_{red} is equity repurchases (PRSTKC), and E_{iss} is equity issuance (SSTK). See Section 2.2 for details.

Net Levering Up Dummy ($NLEVD$)
: is 1 if $NLEVR > 0$, and 0 otherwise. See Section 2.2 for details.

Total Assets
: Assets - Total (ATQ) * Adjustment to 2000 Dollars

Total Market Capitalization
: Price-Close-Quarter (PRCCQ) * Common Shares Outstanding (CSHOQ) * Adjustment to 2000 Dollars

Realized Return
: Annualized returns using a one-year backward-looking window of monthly returns

Ln Total Assets (LnTA)
: ln{Assets - Total (ATQ) * Adjustment to 2000 Dollars}

Book-to-Market Ratio (BTM)
: $\frac{\text{Total Common Equity (CEQQ)}}{\text{Price-Close-Quarter (PRCCQ) * Common Shares Outstanding (CSHOQ)}}$

Altman's Zscore (Zscore)

$\frac{\text{3.3*Pretax Income (PIQ) + 1.0*Net Sales (SALEQ) + 1.4*Retained Earnings (REQ) + 1.2*Working Capital}}{\text{Total Assets (ATQ)}}$

where Working Capital = Current Assets-Total (ACTQ) - Current Liabilities-Total (LCTQ)

BCG Marginal Tax Rate (MTR)

Blouin, Core, Guay (2010)'s post-financing marginal tax rate

Earnings / TA 5-Yr Volatility ($\sigma_{earnings}$)

Standard deviation of past 20 quarters of $\frac{\text{Income Before Extraordinary Items (IBQ)}}{\text{Total Assets (ATQ)}}$

Sales / TA 5-Yr Volatility (σ_{sales})

Standard deviation of past 20 quarters of $\frac{\text{Sales (SALEQ)}}{\text{Total Assets (ATQ)}}$

Long-term Debt / TA (LTDR)

$\frac{\text{Long-Term Debt-Total (DLTTQ)}}{\text{Total Assets (ATQ)}}$

SIC3 Long-term Debt / TA (IndLTDR)

$\frac{\sum_{i=1}^{N} \text{Long-Term Debt-Total (DLTTQ)}}{\sum_{i=1}^{N} \text{Total Assets (ATQ)}}$ for each firm i in its SIC3 industry

Credit Rating Spread (CS)

Moody's Baa Rate - Moody's Aaa Rate

Whited and Wu (2006) Financing Constraint Index (WW)

$-0.091 \times CF_{i,t} - 0.062 \times DDIV_{i,t} + 0.021 \times LTD_{i,t} - 0.044 \times SIZE_{i,t} + 0.102 \times ISG_{i,t}$
$-0.035 \times SG_{i,t}$

where CF is cashflows over total assets, DDIV is an indicator for a dividend-paying firm, LTD is long-term debt over total assets, SIZE is the natural log of book assets, ISG is the sales growth in the firm's 3-digit SIC industry, and SG is the firm's one quarter sales growth

Hadlock and Pierce (2010) Size-Age Financing Constraint Index

$-0.737 \times FirmSize_{i,t} + 0.043 \times FirmSize^2_{i,t} - 0.040 \times FirmAge_{i,t}$

where FirmSize is the log of book assets adjusted for inflation using 2004 dollars and replaced with log($4.5billion) if the actual value is greater, and FirmAge is the number of years the firm has been on Compustat with a non-missing stock price and replaced with 37 if the actual age is greater

Table I: Sample statistics of options-based measures and common firm characteristics. Options-based measures are defined in Section 2.1. Common firm characteristics and control variables are defined in Appendix A. Panel A presents the summary statistics for the full sample with at least one non-missing options variable and panel B presents the summary statistics for the sample restricted to those with non-missing observations for all relevant variables.

Panel A: Unrestricted Sample w/ At Least One Non-Missing Options-Based Measure								
	No. Obs	Mean	Std Dev	1%	25%	50%	75%	99%
Total Assets ($ millions)	110456	5587.9	19479.8	35.7	337.0	1012.3	3358.4	81981.0
Total Market Capitalization ($ millions)	110456	6355.2	21159.2	62.7	436.8	1154.3	3595.7	102294.5
Log Total Assets	107787	6.933	1.672	3.563	5.730	6.815	7.997	11.125
Book-to-Market Ratio	107787	0.500	0.377	0.070	0.251	0.408	0.638	1.933
Altman's Zscore	100080	1.558	4.696	-19.379	0.691	2.456	4.036	7.491
BCG Marginal Tax Rate	94841	0.284	0.095	0.008	0.259	0.333	0.346	0.352
Earnings / TA 5-Yr Volatility	107686	0.022	0.020	0.002	0.008	0.016	0.029	0.090
Sales / TA 5-Yr Volatility	107541	0.055	0.047	0.003	0.023	0.040	0.070	0.231
Long-term Debt / TA	106344	0.168	0.167	0.000	0.002	0.136	0.280	0.637
SIC3 Long-term Debt / TA	110456	0.196	0.096	0.044	0.126	0.172	0.247	0.519
Credit Rating Spread	107787	1.054	0.487	0.550	0.780	0.920	1.210	3.090
Whited-Wu Index	97962	-0.322	0.094	-0.526	-0.388	-0.316	-0.255	-0.107
Net Levering Up / TA	110456	0.000	0.047	-0.195	-0.008	-0.001	0.009	0.138
Net Levering Up > 0	110456	0.372	0.483	0.000	0.000	0.000	1.000	1.000
Realized Return	110455	0.192	0.815	-0.772	-0.199	0.072	0.378	3.026
Realized Volatility	110452	0.530	0.265	0.174	0.347	0.471	0.650	1.406
Implied Vol: Long Calls	103913	0.487	0.208	0.187	0.335	0.442	0.595	1.147
Implied Vol: Short Calls	106946	0.566	0.225	0.233	0.409	0.522	0.674	1.299
Implied Vol: Short Puts	105364	0.593	0.232	0.246	0.434	0.546	0.701	1.374
Implied Vol: OTM Puts	101920	0.618	0.219	0.275	0.466	0.580	0.727	1.319
Implied Vol: ITM Puts	87662	0.598	0.244	0.233	0.423	0.550	0.723	1.369
$IVspread_{hist}$	103906	-0.042	0.151	-0.517	-0.092	-0.021	0.030	0.282
$IVspread_{mon}$	81303	0.050	0.141	-0.408	-0.004	0.061	0.119	0.368
$IVspread_{cp}$	104929	-0.028	0.086	-0.303	-0.053	-0.019	0.004	0.165

Panel B: Restricted Sample w/ All Non-missing Relevant Variables								
	No. Obs	Mean	Std Dev	1%	25%	50%	75%	99%
Total Assets ($ millions)	56041	4457.5	10890.3	41.0	348.0	1039.4	3510.7	47482.0
Total Market Capitalization ($ millions)	56041	5815.3	18045.9	74.0	466.1	1195.9	3685.0	80309.0
Log Total Assets	56041	6.939	1.617	3.724	5.748	6.817	8.027	10.624
Book-to-Market Ratio	56041	0.491	0.363	0.069	0.246	0.402	0.630	1.842
Altman's Zscore	56041	1.654	4.523	-18.290	0.710	2.477	4.108	7.554
BCG Marginal Tax Rate	56041	0.284	0.093	0.012	0.255	0.331	0.346	0.352
Earnings / TA 5-Yr Volatility	56041	0.023	0.020	0.002	0.009	0.016	0.030	0.091
Sales / TA 5-Yr Volatility	56041	0.056	0.047	0.006	0.024	0.042	0.072	0.226
Long-term Debt / TA	56041	0.163	0.167	0.000	0.001	0.127	0.274	0.636
SIC3 Long-term Debt / TA	56041	0.189	0.093	0.038	0.125	0.161	0.236	0.519
Credit Rating Spread	56041	1.088	0.508	0.550	0.800	0.930	1.250	3.090
Whited-Wu Index	56041	-0.320	0.094	-0.529	-0.385	-0.312	-0.253	-0.107
Net Levering Up / TA	56041	0.001	0.044	-0.174	-0.008	-0.001	0.008	0.137
Net Levering Up > 0	56041	0.362	0.481	0.000	0.000	0.000	1.000	1.000
Realized Return	56041	0.156	0.778	-0.771	-0.239	0.024	0.342	2.945
Realized Volatility	56041	0.558	0.261	0.184	0.377	0.502	0.678	1.406
Implied Vol: Long Calls	56041	0.507	0.194	0.210	0.367	0.468	0.610	1.116
Implied Vol: Short Calls	56041	0.594	0.219	0.247	0.441	0.554	0.702	1.305
Implied Vol: Short Puts	56041	0.617	0.229	0.255	0.458	0.573	0.729	1.377
Implied Vol: OTM Puts	56041	0.632	0.210	0.290	0.486	0.599	0.739	1.296
Implied Vol: ITM Puts	56041	0.581	0.231	0.231	0.416	0.537	0.700	1.321
$IVspread_{hist}$	56041	-0.051	0.146	-0.516	-0.105	-0.026	0.029	0.237
$IVspread_{mon}$	56041	0.053	0.138	-0.401	0.000	0.065	0.122	0.356
$IVspread_{cp}$	56041	-0.023	0.070	-0.245	-0.044	-0.016	0.004	0.130

Table II: Pairwise correlation matrix of options-based measures and common firm characteristics. Options-based measures are defined in Section 2.1. Common firm characteristics and control variables are defined in Appendix A.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Net Levering Up / TA							
(2) Log Total Assets	0.1113						
(3) Book-to-Market Ratio	0.0054	0.1051					
(4) Altman's Zscore	0.1466	0.3067	0.0366				
(5) BCG Marginal Tax Rate	0.1328	0.3333	-0.0674	0.6840			
(6) Earnings / TA 5-Yr Volatility	-0.1090	-0.4113	-0.0893	-0.4727	-0.4622		
(7) Sales / TA 5-Yr Volatility	-0.0310	-0.2094	0.0022	0.0461	0.0002	0.2540	
(8) Long-term Debt / TA	-0.0199	0.3776	0.1272	-0.0262	-0.0250	-0.1770	-0.1457
(9) SIC3 Long-term Debt / TA	0.0168	0.2120	0.1478	0.0384	0.0333	-0.1989	-0.1146
(10) Credit Rating Spread	-0.0096	0.0858	0.1905	0.0335	-0.0183	-0.0930	-0.1075
(11) Whited-Wu Index	-0.1075	-0.8793	-0.0820	-0.3435	-0.3566	0.4099	0.1941
(12) Realized Return	-0.0451	-0.0652	-0.2824	-0.0040	-0.0263	0.0792	0.0353
(13) Realized Volatility	-0.1442	-0.4450	0.0717	-0.3046	-0.4022	0.4001	0.1956
(14) Implied Vol: Long Calls	-0.1443	-0.5169	0.1322	-0.3723	-0.4260	0.4377	0.2124
(15) Implied Vol: Short Calls	-0.1277	-0.4701	0.1328	-0.2988	-0.3438	0.3727	0.1929
(16) Implied Vol: Short Puts	-0.1246	-0.4553	0.1294	-0.2826	-0.3271	0.3554	0.1904
(17) Implied Vol: OTM Puts	-0.1426	-0.4744	0.1323	-0.3177	-0.3816	0.3806	0.1850
(18) Implied Vol: ITM Puts	-0.1160	-0.4808	0.1337	-0.2913	-0.3268	0.3509	0.1900
(19) $IVspread_{hist}$	0.0653	0.1078	0.0468	0.0488	0.1514	-0.1326	-0.0666
(20) $IVspread_{mon}$	-0.0221	0.0808	-0.0209	0.0050	-0.0322	-0.0079	-0.0355
(21) $IVspread_{cp}$	0.0095	0.0191	-0.0054	-0.0099	-0.0071	0.0016	-0.0195

	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(9) SIC3 Long-term Debt / TA	0.4791						
(10) Credit Rating Spread	0.0420	0.0699					
(11) Whited-Wu Index	-0.2881	-0.1915	-0.1114				
(12) Realized Return	-0.0518	-0.0453	-0.1789	0.0572			
(13) Realized Volatility	-0.1360	-0.1205	0.0022	0.4545	0.0930		
(14) Implied Vol: Long Calls	-0.1306	-0.1228	0.0566	0.5282	-0.0032	0.8330	
(15) Implied Vol: Short Calls	-0.1205	-0.1029	0.1201	0.4766	-0.0237	0.7783	0.9135
(16) Implied Vol: Short Puts	-0.1120	-0.0891	0.1396	0.4583	-0.0269	0.7595	0.8846
(17) Implied Vol: OTM Puts	-0.1058	-0.0869	0.1602	0.4781	0.0061	0.7805	0.8929
(18) Implied Vol: ITM Puts	-0.1126	-0.0797	0.0371	0.4769	-0.0341	0.7109	0.8291
(19) $IVspread_{hist}$	0.0692	0.0516	0.0671	-0.1096	-0.1670	-0.6778	-0.1606
(20) $IVspread_{mon}$	0.0289	0.0030	0.1815	-0.0695	0.0709	-0.0027	-0.0285
(21) $IVspread_{cp}$	-0.0101	-0.0306	-0.0808	-0.0091	0.0138	-0.0549	-0.0395

	(15)	(16)	(17)	(18)	(19)	(20)
(16) Implied Vol: Short Puts	0.9516					
(17) Implied Vol: OTM Puts	0.9055	0.9196				
(18) Implied Vol: ITM Puts	0.8392	0.8673	0.8168			
(19) $IVspread_{hist}$	-0.1770	-0.1820	-0.2082	-0.1684		
(20) $IVspread_{mon}$	-0.0264	-0.0529	0.1522	-0.4256	-0.0328	
(21) $IVspread_{cp}$	0.0101	-0.2863	-0.1770	-0.2142	0.0460	0.0921

Table III: Results from the estimation of the baseline model without controls, as in equation (5). The dependent variable is the net levering up ratio ($NLEVR$), defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. $IV spread_{hist}$ measures the difference between the implied volatility on long-term call options and the realized, historical volatility for the firm. Realized volatility is the average historical volatility of the firm's returns over the past year. $IV spread_{mon}$ measures the difference between out-of-the-money and in-the-money put options. $IV_{p,ITM}$ is the implied volatility of the in-the-money put options. $IV spread_{cp}$ is the difference between the implied volatility of short-term call options and the short-term put options for a firm. $IV_{p,short}$ is the implied volatility of the long-term put options. All market-based measures reflect the average of the three months in the lagged quarter. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	Net Levering Up / TA ($NLEVR$)			
	(1)	(2)	(3)	(4)
$IV spread_{hist,t-1}$	-0.0261 ***			-0.0261 ***
	(0.0024)			(0.0024)
$IV spread_{mon,t-1}$		-0.0271 ***		-0.0032 **
		(0.0020)		(0.0015)
$IV spread_{cp,t-1}$			-0.0203 ***	0.0056 **
			(0.0027)	(0.0024)
Realized Volatility$_{t-1}$	-0.0387 ***			-0.0386 ***
	(0.0022)			(0.0022)
$IV_{p,ITM,t-1}$		-0.0350 ***		
		(0.0020)		
$IV_{p,short,t-1}$			-0.0319 ***	
			(0.0022)	
Constant	0.0192 ***	0.0200 ***	0.0187 ***	0.0191 ***
	(0.0016)	(0.0016)	(0.0016)	(0.0016)
Quarter Fixed Effects?	Y	Y	Y	Y
Year Fixed Effects?	Y	Y	Y	Y
No. Obs.	77389	77389	77389	77389
Adjusted R^2	0.0302	0.0272	0.0240	0.0303

Table IV: Results from the estimation of the full model with controls, as in equation (6). The dependent variable is the net levering up ratio ($NLEVR$), defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. $IVspread_{hist}$ measures the difference between the implied volatility on long-term call options and the realized, historical volatility for the firm. $IVspread_{mon}$ measures the difference between out-of-the-money and in-the-money put options. $IVspread_{cp}$ is the difference between the implied volatility of short-term call options and the short-term put options for a firm. Realized volatility is the average historical volatility of the firm's returns over the past year. All market-based measures reflect the average of the three months in the lagged quarter. All controls are defined in Appendix A. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	Net Levering Up / TA ($NLEVR$)				
	(1)	(2)	(3)	(4)	(5)
$IVspread_{hist,t-1}$		-0.0103 ***			-0.0100 ***
		(0.0027)			(0.0027)
$IVspread_{mon,t-1}$			-0.0048 ***		-0.0047 ***
			(0.0014)		(0.0014)
$IVspread_{cp,t-1}$				0.0028	0.0041 *
				(0.0023)	(0.0023)
Realized Volatility$_{t-1}$		-0.0180 ***	-0.0124 ***	-0.0125 ***	-0.0177 ***
		(0.0025)	(0.0018)	(0.0019)	(0.0025)
Realized Return$_{t-1}$	-0.0026 ***	-0.0022 ***	-0.0021 ***	-0.0022 ***	-0.0022 ***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Log Total Assets$_{t-1}$	0.0021 ***	0.0017 ***	0.0019 ***	0.0018 ***	0.0017 ***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Book-to-Market Ratio$_{t-1}$	-0.0008	0.0005	0.0000	0.0001	0.0004
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Altman's Zscore$_{t-1}$	0.0010 ***	0.0009 ***	0.0009 ***	0.0009 ***	0.0009 ***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
BCG Marginal Tax Rate$_{t-1}$	0.0082 **	0.0008	0.0018	0.0018	0.0008
	(0.0040)	(0.0040)	(0.0040)	(0.0040)	(0.0040)
Earnings / TA 5-Yr Volatility$_{t-1}$	-0.0401 **	-0.0122	-0.0175	-0.0181	-0.0121
	(0.0186)	(0.0177)	(0.0180)	(0.0181)	(0.0176)
Sales / TA 5-Yr Volatility$_{t-1}$	-0.0162 ***	-0.0116 *	-0.0125 **	-0.0125 **	-0.0114 *
	(0.0060)	(0.0062)	(0.0061)	(0.0061)	(0.0061)
Long-term Debt / TA$_{t-1}$	-0.0171 ***	-0.0167 ***	-0.0169 ***	-0.0170 ***	-0.0166 ***
	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
SIC3 Long-term Debt / TA$_{t-1}$	0.0092 ***	0.0067 **	0.0072 **	0.0073 **	0.0067 **
	(0.0032)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
Credit Rating Spread$_{t-1}$	-0.0015	-0.0011	-0.0018 *	-0.0018 *	-0.0010
	(0.0012)	(0.0011)	(0.0010)	(0.0010)	(0.0011)
Whited-Wu Index$_{t-1}$	-0.0032	0.0038	0.0027	0.0022	0.0039
	(0.0062)	(0.0062)	(0.0061)	(0.0061)	(0.0062)
Constant	-0.0121 ***	0.0033	-0.0010	-0.0005	0.0027
	(0.0025)	(0.0034)	(0.0031)	(0.0031)	(0.0034)
Quarter Fixed Effects?	Y	Y	Y	Y	Y
Year Fixed Effects?	Y	Y	Y	Y	Y
No. Obs.	56041	56041	56041	56041	56041
Adjusted R^2	0.0389	0.0417	0.0415	0.0413	0.0419

Table V: Results from the estimation of the modified full model with first lagged differences and second lagged levels, as in equation (7). The dependent variable is the net levering up ratio ($NLEVR$), defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. $IVspread_{hist}$ measures the difference between the implied volatility on long-term call options and the realized, historical volatility for the firm. $IVspread_{mon}$ measures the difference between out-of-the-money and in-the-money put options. $IVspread_{cp}$ is the difference between the implied volatility of short-term call options and the short-term put options for a firm. Realized volatility is the average historical volatility of the firm's returns over the past year. All market-based measures reflect the average of the three months in the lagged quarter. All controls are defined in Appendix A. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	Net Levering Up / TA ($NLEVR$)				
	(1)	(2)	(3)	(4)	(5)
$\Delta IVspread_{hist,t-2,t-1}$		-0.0099 ***			-0.0097 **
		(0.0038)			(0.0038)
$\Delta IVspread_{mon,t-2,t-1}$			-0.0043 **		-0.0038 **
			(0.0019)		(0.0019)
$\Delta IVspread_{cp,t-2,t-1}$				0.0015	0.0029
				(0.0027)	(0.0026)
ΔRealized Volatility$_{t-2,t-1}$		-0.0112 *	-0.0124 **	-0.0124 **	-0.0111 *
		(0.0062)	(0.0053)	(0.0053)	(0.0062)
ΔRealized Return$_{t-2,t-1}$	-0.0037 ***	-0.0037 ***	-0.0032 ***	-0.0033 ***	-0.0036 ***
	(0.0007)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
ΔLog Total Assets$_{t-2,t-1}$	-0.0110 ***	-0.0109 ***	-0.0107 ***	-0.0109 ***	-0.0107 ***
	(0.0034)	(0.0034)	(0.0034)	(0.0034)	(0.0034)
ΔBook-to-Market Ratio$_{t-2,t-1}$	0.0038 **	0.0046 ***	0.0040 ***	0.0041 ***	0.0045 ***
	(0.0016)	(0.0016)	(0.0015)	(0.0015)	(0.0016)
ΔAltman's Zscore$_{t-2,t-1}$	0.0011 ***	0.0010 ***	0.0011 ***	0.0011 ***	0.0010 ***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
ΔBCG Marginal Tax Rate$_{t-2,t-1}$	-0.0054	-0.0107	-0.0091	-0.0090	-0.0108
	(0.0090)	(0.0095)	(0.0094)	(0.0094)	(0.0095)
ΔEarnings / TA 5-Yr Volatility$_{t-2,t-1}$	-0.0710	-0.0412	-0.0492	-0.0480	-0.0422
	(0.0570)	(0.0559)	(0.0567)	(0.0567)	(0.0560)
ΔSales / TA 5-Yr Volatility$_{t-2,t-1}$	-0.0628 **	-0.0556 *	-0.0562 *	-0.0560 *	-0.0559 *
	(0.0310)	(0.0312)	(0.0311)	(0.0311)	(0.0311)
ΔLong-term Debt / TA$_{t-2,t-1}$	0.0200 ***	0.0200 ***	0.0194 ***	0.0196 ***	0.0199 ***
	(0.0074)	(0.0073)	(0.0073)	(0.0073)	(0.0073)
ΔSIC3 Long-term Debt / TA$_{t-2,t-1}$	0.0183	0.0163	0.0166	0.0169	0.0161
	(0.0113)	(0.0116)	(0.0116)	(0.0116)	(0.0116)
ΔCredit Rating Spread$_{t-2,t-1}$	-0.0019 **	-0.0018 **	-0.0024 ***	-0.0023 ***	-0.0018 **
	(0.0010)	(0.0009)	(0.0008)	(0.0008)	(0.0009)
ΔWhited-Wu Index$_{t-2,t-1}$	0.0057	0.0119 *	0.0102 *	0.0098	0.0121 *
	(0.0062)	(0.0063)	(0.0062)	(0.0062)	(0.0063)

Continued below.

Continued from above.					
	(1)	(2)	(3)	(4)	(5)
$IV spread_{hist,t-2}$		-0.0172 ***			-0.0168 ***
		(0.0035)			(0.0035)
$IV spread_{mon,t-2}$			-0.0060 ***		-0.0054 **
			(0.0023)		(0.0023)
$IV spread_{cp,t-2}$				0.0008	0.0037
				(0.0033)	(0.0033)
Realized Volatility$_{t-2}$		-0.0194 ***	-0.0104 ***	-0.0105 ***	-0.0190 ***
		(0.0027)	(0.0018)	(0.0018)	(0.0028)
Realized Return$_{t-2}$	-0.0026 ***	-0.0022 ***	-0.0020 ***	-0.0021 ***	-0.0021 ***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Log Total Assets$_{t-2}$	0.0024 ***	0.0022 ***	0.0024 ***	0.0023 ***	0.0022 ***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Book-to-Market Ratio$_{t-2}$	-0.0030 ***	-0.0015 *	-0.0022 ***	-0.0022 **	-0.0017 *
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Altman's Zscore$_{t-2}$	0.0009 ***	0.0009 ***	0.0009 ***	0.0009 ***	0.0009 ***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
BCG Marginal Tax Rate$_{t-2}$	0.0085 *	0.0021	0.0039	0.0040	0.0021
	(0.0045)	(0.0045)	(0.0046)	(0.0046)	(0.0045)
Earnings / TA 5-Yr Volatility$_{t-2}$	-0.0396 *	-0.0128	-0.0211	-0.0216	-0.0126
	(0.0205)	(0.0196)	(0.0200)	(0.0201)	(0.0196)
Sales / TA 5-Yr Volatility$_{t-2}$	-0.0116 *	-0.0069	-0.0084	-0.0085	-0.0067
	(0.0067)	(0.0067)	(0.0067)	(0.0067)	(0.0067)
Long-term Debt / TA$_{t-2}$	-0.0209 ***	-0.0204 ***	-0.0206 ***	-0.0207 ***	-0.0203 ***
	(0.0025)	(0.0025)	(0.0025)	(0.0025)	(0.0025)
SIC3 Long-term Debt / TA$_{t-2}$	0.0099 ***	0.0077 **	0.0084 **	0.0084 **	0.0077 **
	(0.0037)	(0.0036)	(0.0036)	(0.0036)	(0.0036)
Credit Rating Spread$_{t-2}$	-0.0045 ***	-0.0035 ***	-0.0041 ***	-0.0043 ***	-0.0033 ***
	(0.0012)	(0.0013)	(0.0012)	(0.0012)	(0.0013)
Whited-Wu Index$_{t-2}$	-0.0028	0.0100	0.0063	0.0056	0.0102
	(0.0081)	(0.0080)	(0.0079)	(0.0080)	(0.0080)
Constant	-0.0100 ***	0.0054	-0.0013	-0.0006	0.0046
	(0.0032)	(0.0040)	(0.0036)	(0.0036)	(0.0040)
Quarter Fixed Effects?	Y	Y	Y	Y	Y
Year Fixed Effects?	Y	Y	Y	Y	Y
No. Obs.	44105	44105	44105	44105	44105
Adjusted R^2	0.0408	0.0432	0.0426	0.0424	0.0433

Table VI: Results from the estimation of the full model, as in equation (6), using unconditional sub-samples of varying supply and demand for financing. Columns (1) and (2) sub-sample all observations into boom and bust years. We use two events to define boom and bust years: the dot-com bubble and the financial crisis. Boom periods are defined to be 1996Q1 through 1999Q4 and 2005Q1 through 2007Q2. Bust periods are defined to be 2001Q1 through 2002Q4 and 2007Q3 through 2009Q2. Colunns (3) and (4) sub-sample all firms into three equal-sized bins based on the book-to-market ratio each quarter with Low BTM defined as the bottom tercile and High BTM defined as the top tercile. The dependent variable is the net levering up ratio ($NLEVR$), defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. $IVspread_{hist}$ measures the difference between the implied volatility on long-term call options and the realized, historical volatility for the firm. $IVspread_{mon}$ measures the difference between out of the money and at the money put options. $IVspread_{cp}$ is the difference between the implied volatility of long-term call options and the long-term put options for a firm. Realized volatility is the average historical volatility of the firm's returns over the past year. All explanatory variables are lagged at one quarter. All market-based measures reflect the average of the three months in the past quarter. All controls are defined in Appendix A. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

Net Levering Up / TA ($NLEVR$)				
	Boom Years (1)	Bust Years (2)	Low BTM (3)	High BTM (4)
$IVspread_{hist,t-1}$	-0.0149 ***	-0.0097 **	-0.0122 **	-0.0069 *
	(0.0042)	(0.0044)	(0.0048)	(0.0037)
$IVspread_{mon,t-1}$	-0.0057 **	-0.0064 **	-0.0112 ***	-0.0003
	(0.0025)	(0.0028)	(0.0030)	(0.0017)
$IVspread_{cp,t-1}$	0.0056	0.0019	0.0159 **	-0.0048 *
	(0.0042)	(0.0038)	(0.0073)	(0.0026)
Realized Volatility$_{t-1}$	-0.0226 ***	-0.0146 ***	-0.0194 ***	-0.0141 ***
	(0.0039)	(0.0036)	(0.0035)	(0.0028)
Realized Return$_{t-1}$	-0.0040 ***	-0.0020 ***	-0.0013 ***	-0.0015 **
	(0.0007)	(0.0005)	(0.0005)	(0.0007)
Log Total Assets$_{t-1}$	0.0007	0.0025 ***	0.0020 ***	0.0009 *
	(0.0007)	(0.0006)	(0.0007)	(0.0005)
Book-to-Market Ratio$_{t-1}$	0.0008	-0.0008	0.0184 ***	-0.0012
	(0.0016)	(0.0011)	(0.0049)	(0.0009)
Altman's Zscore$_{t-1}$	0.0010 ***	0.0010 ***	0.0011 ***	0.0002
	(0.0001)	(0.0002)	(0.0002)	(0.0001)
BCG Marginal Tax Rate$_{t-1}$	0.0107	-0.0069	0.0011	0.0045
	(0.0071)	(0.0075)	(0.0076)	(0.0053)
Earnings / TA 5-Yr Volatility$_{t-1}$	-0.0156	-0.0026	-0.0052	0.0093
	(0.0274)	(0.0280)	(0.0288)	(0.0208)
Sales / TA 5-Yr Volatility$_{t-1}$	-0.0148 *	-0.0092	-0.0023	-0.0176 **
	(0.0079)	(0.0090)	(0.0117)	(0.0079)
Long-term Debt / TA$_{t-1}$	-0.0113 ***	-0.0246 ***	-0.0070 **	-0.0190 ***
	(0.0041)	(0.0035)	(0.0035)	(0.0029)
SIC3 Long-term Debt / TA$_{t-1}$	0.0175 ***	0.0080 *	-0.0032	0.0114 ***
	(0.0053)	(0.0042)	(0.0052)	(0.0042)
Credit Rating Spread$_{t-1}$	0.0016	-0.0040 ***	0.0000	-0.0006
	(0.0042)	(0.0010)	(0.0015)	(0.0009)
Whited-Wu Index$_{t-1}$	-0.0017	0.0059	-0.0071	0.0066
	(0.0100)	(0.0089)	(0.0108)	(0.0087)
Constant	0.0025	0.0046	-0.0066	0.0080 *
	(0.0068)	(0.0056)	(0.0049)	(0.0044)
Quarter Fixed Effects?	Y	Y	Y	Y
Year Fixed Effects?	Y	Y	Y	Y
No. Obs.	17771	18444	18871	18186
Adjusted R^2	0.0393	0.0470	0.0668	0.0229

Table VII: Results from the estimation of the full model, as in equation (6), using conditional sub-samples of varying supply and demand for financing. Columns (1) and (2) sub-sample all observations in the boom years, defined as 1996Q1 through 1999Q4 and 2005Q1 through 2007Q2, by low and high book-to-market firms. Columns (3) and (4) sub-sample all observations in the bust years, defined as 2001Q1 through 2002Q4 and 2007Q3 through 2009Q2, by low and high BTM firms. Low (High) BTM is defined as firms in the the bottom (top) tercile when sorting on book-to-market ratio each quarter. Columns (5) through (8) report the differences in coefficients between the sub-sampled analysis, p-values, and significance. The dependent variable is the net levering up ratio ($NLEVR$), defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. $IV spread_{hist}$ measures the difference between the implied volatility on long-term call options and the realized, historical volatility for the firm. $IV spread_{mon}$ measures the difference between out of the money and at the money put options. $IV spread_{cp}$ is the difference between the implied volatility of long-term call options and the long-term put options for a firm. Realized volatility is the average historical volatility of the firm's returns over the past year. All explanatory variables are lagged at one quarter. All market-based measures reflect the average of the three months in the past quarter. All controls are defined in Appendix A. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). p-values are reported in the brackets based on χ^2 test and F-test of equality between coefficients. Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	Net Levering Up / TA ($NLEVR$)							
	Boom Years		Bust Years		Differences			
	Low BTM (1)	High BTM (2)	Low BTM (3)	High BTM (4)	(1)-(3) (5)	(2)-(4) (6)	(1)-(2) (7)	(3)-(4) (8)
$IV spread_{hist,t-1}$	-0.0175 ***	-0.0062	-0.0035	-0.0100 *	-0.0140	0.0038	-0.0113	0.0066
	(0.0060)	(0.0077)	(0.0081)	(0.0053)	[0.2197]	[0.6430]	[0.3006]	[0.4631]
$IV spread_{mon,t-1}$	-0.0107 *	-0.0030	-0.0143 **	-0.0001	0.0036	-0.0030	-0.0077	-0.0142 **
	(0.0061)	(0.0035)	(0.0056)	(0.0042)	[0.6389]	[0.5916]	[0.2438]	[0.0381]
$IV spread_{cp,t-1}$	0.0202 *	-0.0064	0.0140	-0.0105 *	0.0063	0.0042	0.0266 *	0.0245 *
	(0.0111)	(0.0050)	(0.0143)	(0.0055)	[0.7187]	[0.6360]	[0.0612]	[0.0670]
Realized Volatility$_{t-1}$	-0.0237 ***	-0.0157 **	-0.0083	-0.0173 ***	-0.0155*	0.0017	-0.0081	0.0091
	(0.0053)	(0.0063)	(0.0054)	(0.0038)	[0.0641]	[0.7889]	[0.3588]	[0.1061]
Realized Return$_{t-1}$	-0.0027 ***	-0.0032	-0.0008	-0.0008				
	(0.0009)	(0.0020)	(0.0006)	(0.0014)				
Log Total Assets$_{t-1}$	0.0007	0.0004	0.0032 ***	0.0006				
	(0.0008)	(0.0010)	(0.0011)	(0.0008)				
Book-to-Market Ratio$_{t-1}$	0.0323 ***	-0.0015	0.0063	-0.0021 *				
	(0.0099)	(0.0017)	(0.0054)	(0.0011)				
Altman's Zscore$_{t-1}$	0.0010 ***	0.0002	0.0015 ***	0.0001				
	(0.0003)	(0.0004)	(0.0003)	(0.0002)				
BCG Marginal Tax Rate$_{t-1}$	0.0003	0.0180	-0.0154	0.0047				
	(0.0158)	(0.0120)	(0.0136)	(0.0089)				
Earnings / TA 5-Yr Volatility$_{t-1}$	0.0054	-0.0401	-0.0131	0.0443				
	(0.0390)	(0.0505)	(0.0469)	(0.0274)				
Sales / TA 5-Yr Volatility$_{t-1}$	-0.0088	-0.0219	-0.0043	-0.0198				
	(0.0135)	(0.0141)	(0.0155)	(0.0143)				
Long-term Debt / TA$_{t-1}$	-0.0053	-0.0195 ***	-0.0122 *	-0.0217 ***				
	(0.0070)	(0.0050)	(0.0063)	(0.0051)				
SIC3 Long-term Debt / TA$_{t-1}$	0.0031	0.0261 ***	-0.0050	0.0103 *				
	(0.0089)	(0.0083)	(0.0080)	(0.0056)				
Credit Rating Spread$_{t-1}$	0.0080	-0.0051	-0.0046 **	-0.0021				
	(0.0064)	(0.0052)	(0.0023)	(0.0018)				
Whited-Wu Index$_{t-1}$	-0.0259 **	0.0077	-0.0055	0.0035				
	(0.0123)	(0.0158)	(0.0177)	(0.0148)				
Constant	-0.0079	0.0093	-0.0315 ***	0.0159 ***				
	(0.0097)	(0.0089)	(0.0083)	(0.0058)				
F-Test					[0.4358]	[0.9572]	[0.2295]	[0.0578]*
Quarter Fixed Effects?	Y	Y	Y	Y				
Year Fixed Effects?	Y	Y	Y	Y				
No. Obs.	6087	5928	6116	5978				
Adjusted R^2	0.0601	0.0234	0.0737	0.0227				

Table VIII: Results from the estimation of equation (6) using option counts in place of the options-based risk measures. The dependent variable is the net levering up ratio ($NLEVR$), defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. Has Tradeable Options is a dummy variable that equals 1 if the firm has tradeable options in the market over the three months in the past quarter and 0 otherwise. Log Total Tradeable Options is the natural log of the total number of tradeable options a firm has in the market over a month averaged over the three months in the past quarter. Log Total Open Interest is the natural log of the open interest a firm has in the market over a month averaged over the three months in the past quarter. Log Total Volume is the natural log of the total number of options traded in the market for the firm over a month averaged over the three months in the past quarter. All explanatory variables are lagged one quarter. All controls are defined in Appendix A. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

Net Levering Up / TA ($NLEVR$)				
	(1)	(2)	(3)	(4)
Has Tradeable Options$_{t-1}$	0.0004			
	(0.0004)			
Log Total Tradeable Options$_{t-1}$		0.0004 ***		
		(0.0002)		
Log Total Open Interest$_{t-1}$			0.0001 **	
			(0.0001)	
Log Total Volume$_{t-1}$				0.0002 ***
				(0.0001)
Realized Volatility$_{t-1}$	-0.0038 ***	-0.0041 ***	-0.0040 ***	-0.0042 ***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Realized Return$_{t-1}$	-0.0032 ***	-0.0032 ***	-0.0032 ***	-0.0032 ***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Log Total Assets$_{t-1}$	0.0014 ***	0.0011 ***	0.0012 ***	0.0011 ***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Book-to-Market Ratio$_{t-1}$	0.0014 ***	0.0017 ***	0.0016 ***	0.0016 ***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Altman's Zscore$_{t-1}$	0.0007 ***	0.0007 ***	0.0007 ***	0.0007 ***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
BCG Marginal Tax Rate$_{t-1}$	0.0053 **	0.0050 **	0.0052 **	0.0052 **
	(0.0024)	(0.0024)	(0.0024)	(0.0024)
Earnings / TA 5-Yr Volatility$_{t-1}$	-0.0489 ***	-0.0512 ***	-0.0511 ***	-0.0514 ***
	(0.0109)	(0.0109)	(0.0109)	(0.0109)
Sales / TA 5-Yr Volatility$_{t-1}$	-0.0055	-0.0053	-0.0054	-0.0055
	(0.0034)	(0.0034)	(0.0034)	(0.0034)
Long-term Debt / TA$_{t-1}$	-0.0153 ***	-0.0149 ***	-0.0150 ***	-0.0149 ***
	(0.0018)	(0.0018)	(0.0018)	(0.0018)
SIC3 Long-term Debt / TA$_{t-1}$	0.0114 ***	0.0117 ***	0.0116 ***	0.0117 ***
	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Credit Rating Spread$_{t-1}$	-0.0008	-0.0008	-0.0008	-0.0008
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Whited-Wu Index$_{t-1}$	-0.0055 *	-0.0062 *	-0.0061 *	-0.0062 *
	(0.0033)	(0.0033)	(0.0033)	(0.0033)
Constant	-0.0050 ***	-0.0037 **	-0.0040 **	-1.2994 ***
	(0.0015)	(0.0016)	(0.0016)	(0.0952)
Quarter Fixed Effects?	Y	Y	Y	Y
Year Fixed Effects?	Y	Y	Y	Y
No. Obs.	183032	183032	183032	183032
Adjusted R^2	0.0332	0.0333	0.0333	0.0333

Table IX: Results from the estimation of the full model as in equation (6) examining monthly market-based measures in the past quarter. Columns (1) and (5) use the average of the three months in the past quarter to calculate our market-based measures. For comparison, we use market-based measures lagged five months (i.e., first month in the past quarter) in columns (2) and (6), lagged four months (i.e., second month in the past quarter) in columns (3) and (7), and lagged three months (i.e., last month in the past quarter), in columns (4) through (8). The dependent variable in Panel A is Net Levering Up / TA ($NLEVR$), the net levering up behavior of the firm, defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. Panel B estimates a logit regression using an indicator for Net Levering Up (1 = Net Levering Up > 0, 0=otherwise), $NLEVD$. $IV spread_{hist}$ measures the difference between the implied volatility on long-term call options and the realized, historical volatility for the firm. $IV spread_{mon}$ measures the difference between out of the money and at the money put options. $IV spread_{cp}$ is the difference between the implied volatility of long-term call options and the long-term put options for a firm. Realized volatility is the average historical volatility of the firm's returns over the past year. All explanatory variables are lagged at one quarter. All controls are defined in Appendix A. Standard errors are reported in the parentheses and clustered by both firm and year-quarter as in Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	Net Levering Up / TA ($NLEVR$)				1 = Net Levering Up>0, 0 = otherwise ($NLEVD$)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$IV spread_{hist,t-1}$	-0.0100 ***	-0.0119 ***	-0.0118 ***	-0.0052	-0.3344 *	-0.8593 ***	-0.5682 *	-0.3044
	(0.0027)	(0.0036)	(0.0038)	(0.0036)	(0.1754)	(0.2832)	(0.3015)	(0.2947)
$IV spread_{mon,t-1}$	-0.0047 ***	-0.0056 **	-0.0075 ***	-0.0088 ***	-0.2829 ***	-0.9530 ***	-0.7000 ***	-0.5988 ***
	(0.0014)	(0.0028)	(0.0025)	(0.0028)	(0.0903)	(0.1769)	(0.1482)	(0.1913)
$IV spread_{cp,t-1}$	0.0041 *	0.0039	0.0058	0.0070	0.3527 **	0.0312	0.0258	0.0785
	(0.0023)	(0.0042)	(0.0049)	(0.0048)	(0.1513)	(0.2064)	(0.2641)	(0.2208)
Realized Volatility$_{t-1}$	-0.0177 ***	-0.0207 ***	-0.0190 ***	-0.0160 ***	-1.4776 ***	-1.6778 ***	-1.5499 ***	-1.4212 ***
	(0.0025)	(0.0030)	(0.0031)	(0.0035)	(0.1360)	(0.2320)	(0.2435)	(0.2367)
Realized Return$_{t-1}$	-0.0022 ***	-0.0021 ***	-0.0010 **	-0.1186 ***	-0.1186 ***	-0.0497	-0.0681	-0.1407 **
	(0.0004)	(0.0007)	(0.0004)	(0.0267)	(0.0267)	(0.0374)	(0.0493)	(0.0547)
Log Total Assets$_{t-1}$	0.0017 ***	0.0014 ***	0.0014 ***	0.0014 ***	0.1215 ***	0.1341 ***	0.1361 ***	0.1391 ***
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0238)	(0.0349)	(0.0354)	(0.0355)
Book-to-Market Ratio$_{t-1}$	0.0004	-0.0008	-0.0008	-0.0004	-0.0171	-0.1150	-0.1171	-0.1477 *
	(0.0008)	(0.0011)	(0.0011)	(0.0011)	(0.0487)	(0.0733)	(0.0755)	(0.0791)
Altman's Zscore$_{t-1}$	0.0009 ***	0.0008 ***	0.0008 ***	0.0009 ***	0.0425 ***	0.0488 ***	0.0490 ***	0.0495 ***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0078)	(0.0118)	(0.0118)	(0.0120)
BCG Marginal Tax Rate$_{t-1}$	0.0008	0.0029	0.0041	0.0043	0.1548	0.3895	0.4557	0.4883
	(0.0040)	(0.0049)	(0.0050)	(0.0050)	(0.2460)	(0.3547)	(0.3594)	(0.3622)
Earnings / TA 5-Yr Volatility$_{t-1}$	-0.0121	-0.0384	-0.0449 *	-1.7241	-1.7241	-2.6145	-2.7122	-2.8089
	(0.0176)	(0.0242)	(0.0243)	(1.1656)	(1.1656)	(1.7781)	(1.7901)	(1.8002)
Sales / TA 5-Yr Volatility$_{t-1}$	-0.0114 *	-0.0099	-0.0095	-0.1597	-0.1597	-0.3293	-0.3797	-0.3634
	(0.0061)	(0.0081)	(0.0082)	(0.4299)	(0.4299)	(0.6228)	(0.6234)	(0.6216)
Long-term Debt / TA$_{t-1}$	-0.0166 ***	-0.0211 ***	-0.0210 ***	-0.0209 ***	-0.0650	-0.4545 **	-0.4602 **	-0.4666 **
	(0.0022)	(0.0029)	(0.0029)	(0.0029)	(0.1419)	(0.1922)	(0.1934)	(0.1940)
SIC3 Long-term Debt / TA$_{t-1}$	0.0067 **	0.0042	0.0046	0.0044	0.2957	0.1955	0.2129	0.2344
	(0.0031)	(0.0046)	(0.0046)	(0.0046)	(0.2006)	(0.3028)	(0.3036)	(0.3027)
Credit Rating Spread$_{t-1}$	-0.0010	-0.0021	-0.0017	-0.0015	-0.0489	-0.0933	-0.0834	-0.0932
	(0.0011)	(0.0014)	(0.0015)	(0.0014)	(0.0515)	(0.0662)	(0.0727)	(0.0736)
Whited-Wu Index$_{t-1}$	0.0039	0.0037	0.0032	0.0015	-0.9517 **	-1.0690 *	-1.1011 **	-1.1361 **
	(0.0062)	(0.0075)	(0.0076)	(0.0077)	(0.3795)	(0.5506)	(0.5580)	(0.5619)
Constant	0.0027	0.0082 *	0.0062	0.0065	-0.8579 ***	-1.0265 ***	-1.1067 ***	-1.2028 ***
	(0.0034)	(0.0045)	(0.0043)	(0.0042)	(0.1717)	(0.2994)	(0.3026)	(0.3014)
Quarter Fixed Effects?	Y	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects?	Y	Y	Y	Y	Y	Y	Y	Y
No. Obs.	56041	22964	22964	22964	56041	22964	22964	22964
Adjusted R^2	0.0419	0.0486	0.0482	0.0474	0.0709	0.0841	0.0832	0.0836

Table X: Options based indices of net leverage increase. Using the coefficients estimated from columns (1) and (5) in Table IX, we create market-based indices to measure net levering up behavior. $LIMkt_1$ is the options based net leverage increase index calculated according to equation (10), using only the coefficient estimates for $IVspread_{hist}$, $IVspread_{mon}$, $IVspread_{cp}$, and Realized Volatility obtained from column (1) of Table IX. $LIMkt_2$ is calculated according to equation (11), using $LIMkt_1$ and the coefficient estimates for the control variables obtained from column (1) of Table IX. $LIMkt_3$ and $LIMkt_4$ use the coefficient results from column (5) of Table IX and are calculated according to equations (12) and (13), respectively. Panel A provides the summary statistics for our four options based indices. Panel B reports the pairwise correlation matrix of our four options based indices.

Panel A: Sample Statistics

	No. Obs	Mean	Std Dev	1%	25%	50%	75%	99%
$LIMkt_1$	77389	-0.010	0.004	-0.022	-0.012	-0.009	-0.007	-0.003
$LIMkt_2$	69311	0.001	0.009	-0.027	-0.003	0.003	0.008	0.017
$LIMkt_3$	77389	-1.689	0.366	-2.859	-1.870	-1.616	-1.434	-1.132
$LIMkt_4$	64093	-0.479	0.654	-2.381	-0.843	-0.404	-0.017	0.680

Panel B: Pairwise Correlation

	(1)	(2)	(3)
(1) $LIMkt_1$			
(2) $LIMkt_2$	0.7697		
(3) $LIMkt_3$	0.9801	0.7432	
(4) $LIMkt_4$	0.8509	0.9198	0.8469

Table XI: Options based indices of net leverage increase. Using the coefficients estimated from columns (1) and (5) in Table IX, we create market-based indices to measure net levering up behavior. $LIMkt_1$ is the options based net leverage increase index calculated according to equation (10), using only the coefficient estimates for $IVspread_{hist}$, $IVspread_{mon}$, $IVspread_{cp}$, and Realized Volatility obtained from column (1) of Table IX. $LIMkt_2$ is calculated according to equation (11), using $LIMkt_1$ and the coefficient estimates for the control variables obtained from column (1) of Table IX. $LIMkt_3$ and $LIMkt_4$ use the coefficient results from column (5) of Table IX and are calculated according to equations (12) and (13), respectively. This table compares the means of common firm characteristics associated with firms with low and high leverage increases. We sort each measure into three equal bins each year-quarter. LOW tercile reflects the firms with lower leverage increases and HIGH reflects the firms with higher leverage increases. Means in each tercile are reported below and tested to see if they are statistically different from each other. Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	$LIMkt_1$: Options Only			$LIMkt_2$: With Controls		
	LOW	HIGH	DIFF	LOW	HIGH	DIFF
Total Assets ($ millions)	1580.1	14653.0	***	1043.4	15550.9	***
Total Market Capitalization ($ millions)	1411.8	17268.1	***	1047.0	19650.5	***
Log Total Assets	5.9347	8.2745	***	5.8648	8.3922	***
Book-to-Market Ratio	0.5416	0.4662	***	0.5065	0.4657	***
Altman's Zscore	-1.1041	3.1932	***	-2.0232	3.8563	***
Total Debt / TA	0.1538	0.2334	***	0.2059	0.1694	***
Long-term Debt / TA	0.1326	0.2001	***	0.1838	0.1372	***
Cash Flow / TA	0.0004	0.0275	***	-0.0014	0.0295	***
Cash / TA	0.3242	0.1134	***	0.3142	0.1367	***
Pays Dividend = 1	0.1069	0.6495	***	0.0832	0.6588	***
Has Long-term Debt Credit Rating	0.2205	0.6890	***	0.2608	0.6524	***
Has Investment Grade Long-term Debt	0.0174	0.5387	***	0.0055	0.5711	***
Whited-Wu Index	-0.2640	-0.3908	***	-0.2590	-0.3979	***
Hadlock-Pierce Size-Age Index	-3.2596	-3.9699	***	-3.2383	-4.0097	***

Figure 1: Time series of net levering up behavior. Net levering up ratio is defined as long-term debt issuance net of long-term debt reductions minus equity issuance net of equity reductions, as a ratio to total book assets. Panel A displays the average net levering up ratio by fiscal year. Panel B displays the proportion of firms that increase net leverage by fiscal year.

Table XII: Portfolio analysis based on equal-weighted and value-weighted portfolios of leverage increase. We sort firms based on our four market-based measures of leverage increase, $LIMkt_1$ through $LIMkt_4$, into terciles each month. Firms that fall into the top (bottom) tercile are classified as having higher leverage increases (lower leverages). Forming portfolios from each tercile, we find the equal-weighted average return in each portfolio and regress the time-series of the portfolio returns on the Pastor and Stambaugh (2003) 5-factor model in columns (1) through (4). We use the value-weighted return in each portfolio in the 5-factor model in columns (5) through (8). Panel A presents the full results for the zero-cost Low-High portfolio. Panels B and C report the Alphas from the factor regression for the Low and High portfolios, respectively. Standard errors are reported in the parentheses. Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	$LIMkt_1$ EW (1)	$LIMkt_2$ EW (2)	$LIMkt_3$ EW (3)	$LIMkt_4$ EW (4)	$LIMkt_1$ VW (5)	$LIMkt_2$ VW (6)	$LIMkt_3$ VW (7)	$LIMkt_4$ VW (8)
	Panel A: Low-High Portfolio							
Alpha	-0.0098 ***	-0.0154 ***	-0.0139 ***	-0.0148 ***	0.0085 **	-0.0011	0.0000	-0.0009
	(0.0030)	(0.0030)	(0.0031)	(0.0032)	(0.0043)	(0.0039)	(0.0043)	(0.0049)
No. Obs.	153	153	153	153	153	153	153	153
R^2	0.6554	0.5663	0.6767	0.5863	0.3769	0.4404	0.4687	0.3826
	Panel B: Low Portfolio							
Alpha	-0.0085 ***	-0.0115 ***	-0.0105 ***	-0.0111 ***	0.0126 ***	0.0061 **	0.0053	0.0067 *
	(0.0021)	(0.0021)	(0.0023)	(0.0023)	(0.0036)	(0.0027)	(0.0035)	(0.0035)
No. Obs.	153	153	153	153	153	153	153	153
R^2	0.9250	0.9102	0.9174	0.9060	0.8067	0.8662	0.8394	0.8353
	Panel C: High Portfolio							
Alpha	0.0013	0.0039 **	0.0034 **	0.0037 **	0.0042 **	0.0072 ***	0.0053 ***	0.0077 ***
	(0.0016)	(0.0016)	(0.0015)	(0.0016)	(0.0019)	(0.0023)	(0.0019)	(0.0024)
No. Obs.	153	153	153	153	153	153	153	153
R^2	0.8811	0.8744	0.8748	0.8744	0.7544	0.6981	0.7429	0.6838

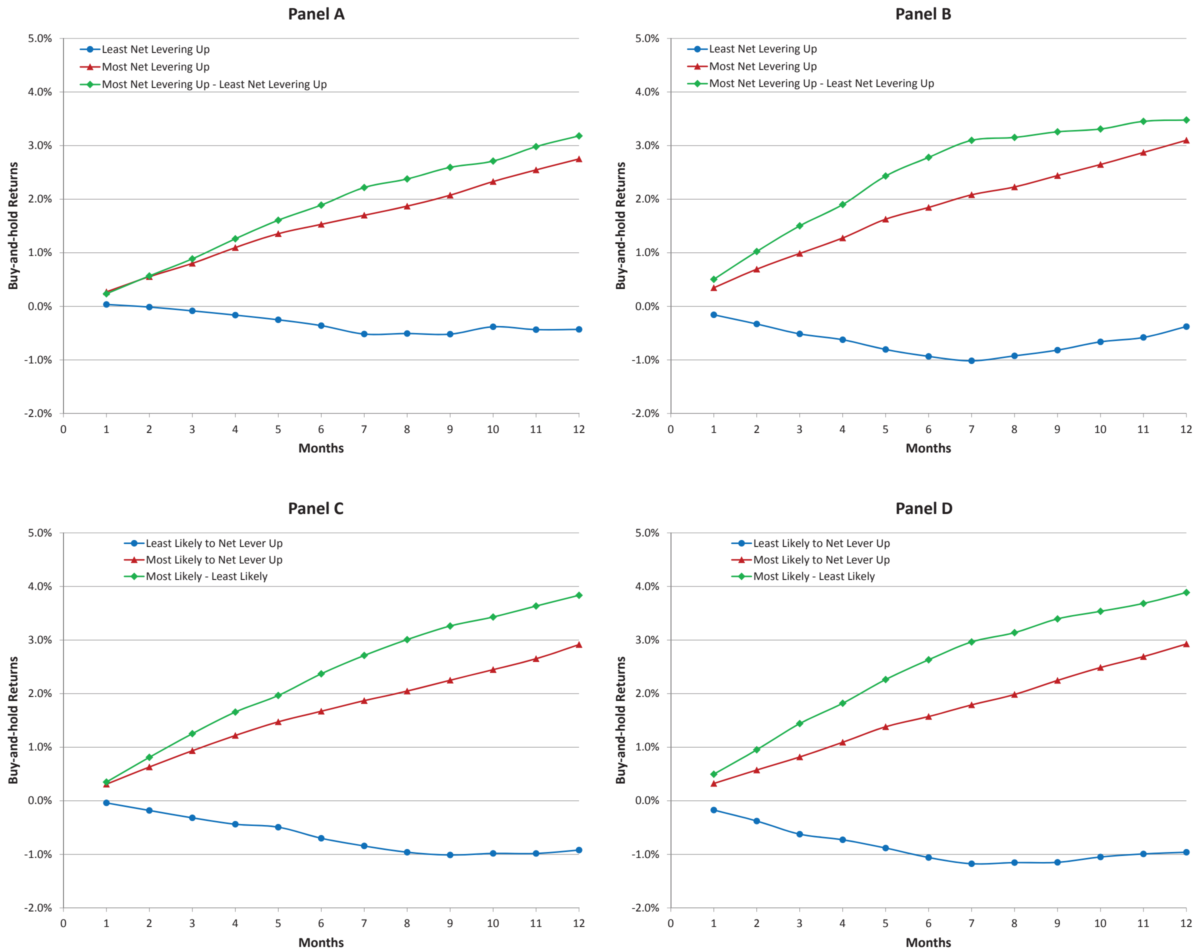

Figure 2: Buy-and-hold portfolios based on the four leverage increase measures. Panel A displays the buy-and-hold returns over the following year from a strategy of buying firms predicted to increase leverage and selling firms predicted to reduce it using the market-based measure, $LIMkt_1$, as defined in equation (10) using the significant market-based variable coefficients from column (9) in Table III. Abnormal returns are calculated based on the Pastor and Stambaugh (2003) 5-factor model. Panel B presents the buy-and-hold returns based on the market-based measure, $LIMkt_2$, as defined in equation (11) using significant market-based variable and control coefficients from column (9) in Table III. Panel C displays the buy-and-hold returns over the following year from a strategy of buying HIGH net leverage increase firms and selling LOW net leverage increase firms using the market-based measure, $LIMkt_3$, as defined in equation (12) using the significant market-based variable coefficients from column (5) in Table IX. Abnormal returns are calculated based on the Pastor and Stambaugh (2003) 5-factor model. Panel D presents the buy-and-hold returns based on the market-based measure, $LIMkt_4$, as defined in equation (13) using significant market-based variable and control coefficients from column (5) in Table IX.