How Does Accounting Quality Affect Option Returns?

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Abstract

This paper analyzes the impact of accounting quality on option contract prices and returns both theoretically and empirically. First, theory shows that the quality of the accounting information that firms disclose to investors can have a different effect on the behavior of option contract returns than it does on stock returns. Second, even if the risk caused by poor accounting quality is completely idiosyncratic and has no cost of equity capital (expected stock return) effect, nevertheless, theory shows that accounting quality has important implications for determining (i) stock return volatility, (ii) the prices and expected returns of option contracts, and (iii) the prices and returns of virtually all non-linear claims written on the firm's equity. These results obtain even in large economies where investors can hold fully diversified portfolios. Third, theory indicates that the differential behavior of stock and option returns to accounting quality is informative about the role that accounting quality plays in determining the firm's cost of equity capital. Consistent with the theory, the empirical findings of this study offer compelling evidence that accounting quality is significantly associated with the expected returns of call and put options even if there is no obvious relation to expected equity returns.

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1 Introduction

This paper examines whether the quality of accounting information provided to investors affects the value of option contracts and their returns. Prior theoretical and empirical research has tried to determine whether the quality of accounting information affects equity values through costs of capital (or expected stock returns).[1] However, the findings of these studies have yielded mixed results (both theoretically and empirically) and the relation between accounting quality and cost of capital remains controversial.

This study takes a different approach. Instead of exploring the relation between accounting quality (hereinafter, AQ) and cost of capital directly, this paper seeks to determine if there is a relation between AQ and the value and expected return of option contracts.[2] This approach offers evidence concerning the economic impact of AQ on a large, but relatively unexplored asset class, namely, equity options. This setting also offers a new way of testing for AQ's impact on cost of capital using option contracts.

The paper's central theoretical finding is that even if AQ does not affect firms' cost of equity capital, it still has an important impact on the pricing and behavior of option contracts and on virtually all non-linear equity claims in an economy.[3] Empirically, the theory developed in this paper is strongly supported. Both future call and put option returns are significantly associated with conventional AQ proxies. These option return associations are found to be economically large and statistically significant even when associations between AQ and cost of capital are difficult to detect.

The relation between AQ and option contracts is examined for two reasons. First, option contracts represent a large and important component of modern capital markets. Options and other derivatives are used for hedging, compensation, speculation, in the construction of a large number of exchange-traded funds (ETFs), and are the building blocks of numerous other structured finance products. As Fama (2011) notes, the work on derivatives starting with the papers of Black and Scholes (1973) and Merton (1973) "[a]re considered the most successful economics papers–ever–in terms of academics and applied impact... and the papers are the foundation of a massive industry in financial derivatives." Fama (2011, p. 9). However, despite the widespread popularity of derivative contracts, very little is known about how AQ affects the

[1] Armstrong et al. (2011); Core et al. (2008); Callen et al. (2012); Christensen et al. (2010); Duarte and Young (2009); Easley and O'Hara (2004); Francis et al. (2004, 2005); Hughes et al. (2007); Kim and Qi (2010); Lambert et al. (2007); and Mohanram and Rajgopal (2009) are just a few recent examples.

[2] This paper does not explore costs of debt, and the term "cost of capital" in this paper follows previous research (Botosan, 1997; Easton and Monahan, 2005; Gebhardt et al., 2001; Hughes et al., 2007; Lambert et al., 2007) and means "cost of equity capital" or "expected stock returns." The terms cost of capital and expected stock returns are used interchangeably throughout the paper.

[3] A specific example of a traded non-linear claim would be a variance swap, see Carr and Wu (2009).

pricing or expected returns of these assets.[4] This study offers the first theoretical and empirical evidence showing that there is an economically significant relation between the variation in AQ and option returns.

Second, option contracts represent a claim on future stock prices and, since stock prices represent a claim on future cash flows, it follows that option contracts also represent a claim on future cash flows. This relation allows us to observe simultaneously two claims written on the same underlying cash flows at the same time, thereby allowing each claim's relation to AQ to be examined differentially. Any differential impact that AQ has on stock and option returns is shown theoretically to be informative about the role that AQ plays in determining expected stock return volatility and the cost of capital. This setting is exploited empirically to provide the first direct evidence on the differential relation between AQ and stock and option contract pricing behavior over time.

In order to make *ex ante* empirical predictions about AQ's impact on equities and options, a rational expectations model is developed. Firm equity values are derived in terms of accounting data, including book value, long-run profitability, and current profitability. Intuitively, the key determinant of equity risk is the risk inherent in underlying firm profitability, and this risk is shown to drive the firm's stock return and its cost of capital (expected stock return). With the pricing framework in place, an information structure is introduced that allows for the analysis of how the quality of information disclosed by firms affects derivative values and derivative expected returns.

To capture the role that accounting practices, such as income smoothing (Ronen and Sadan, 1981; Subramanyam, 1996; Trueman and Titman, 1988) and other forms of disclosure (Healy and Palepu, 2001; Hope, 2003; Li, 2008, 2010; Verrecchia, 2001) play in signaling information to investors about firm fundamentals, this study builds on Pástor and Veronesi (2003, 2006) by assuming that investors can observe realizations of firm profitability through financial reports, but that the long-run profitability of the firm cannot be observed directly. Because long-term profitability is not observable, it is assumed instead that investors observe two sources of information which help them to learn about this value over time: the history of reported profitability and relevant additional information disclosed by the firm. Throughout the paper, AQ refers to the precision of each of these signals. If the information is noisy (or low quality), then learning is more difficult, which makes forecasts about future profitability less precise. This has the effect of raising stock return volatility, which, in turn, is shown to have a number of implications for firm-level asset pricing.

[4] According to the Chicago Board of Options Exchange 2011 Market Statistics annual report, option trading has seen dramatic and continued growth since 1973, and total option volume has increased from 1,119,177 contracts in 1973 to 4,562,748,194 in 2011.

More specifically, the model shows, holding all else equal, that firms with low AQ have higher stock return volatility than firms with high AQ.[5] This volatility effect suggests that AQ is pervasive, affecting everything from portfolio allocation decisions to the value of executive compensation contracts and virtually all non-linear claims written on the firm's equity. However, *how* AQ affects these important decisions and values depends in theory on whether AQ manifests in the form of (unpriced) idiosyncratic stock return volatility or (priced) systematic stock return volatility. For example, since AQ affects volatility, it will almost surely affect the value of a call option, but *how* AQ affects the subsequent expected return of that option depends on whether AQ affects idiosyncratic or systematic risk. As will be shown later, if AQ manifests in the form of idiosyncratic risk, then lower AQ has no impact on expected stock returns but lower AQ decreases the expected return of call options. Contrariwise, if AQ manifests in the form of systematic risk, lower AQ has the twofold effect of raising expected stock returns and raising the expected returns of call options and other derivative products whose payoffs increase with the stock price.[6]

To understand the intuition behind these results, consider, for example, a basic European call option contract. Assume that AQ is idiosyncratic and does not affect the expected return on the stock. Because low AQ firms have higher expected stock return volatilities than high AQ firms, the cost of purchasing a call option written on a low AQ firm will be higher than the cost of purchasing a call option written on an otherwise identical firm with higher AQ. Thus, all else equal, the expected return of the higher priced call option must necessarily be lower than the expected return of the lower priced call option. [7]

The intuition where AQ is systematic and does affect the expected return on the stock is more involved. As will be shown formally later in the paper, by purchasing a call option, an investor takes a leveraged position on the underlying equity (Black, 1975). This means that by investing in the call option, the investor is holding an asset that provides an expected return equal to the expected stock return (cost of capital) multiplied by the leverage implicit in the option. The lower AQ the higher the expected stock return because AQ is systematic. But, the lower AQ, the higher the return volatility and, as shown formally later, the lower the option leverage.[8] Moreover, as AQ decreases, the expected stock return increases at a faster rate than

[5]Ohlson (1979) also finds that changes in a firm's information-disclosure environment affect stock return variability.

[6]The opposite is true for put options and other derivative products with payoffs that decrease with stock price increases. For example a put option gives a positive return when the stock price falls, so firms with higher expected stock returns (higher systematic risk) will have lower expected put option returns.

[7]This inverse relation between expected call returns and idiosyncratic risk is known in the option pricing literature, see for example Johnson (2004).

[8]Option leverage is defined as the option's delta multiplied by the stock price to option price ratio, see for example Johnson and So (2012).

the rate at which the option leverage is reduced. As a consequence, the lower the AQ, the higher the return on the call option.

The theoretical results just described abstract from diversification. Consistent with prior research (e.g., Hughes et al., 2007), the model demonstrates that risk stemming from AQ is largely diversifiable in large economies so that AQ has no effect on a firm's cost of capital. However, because AQ affects the firm's risk, it does impact expected option returns. Thus, lower AQ firms are predicted to have lower (higher) call (put) option leverage and, hence, lower expected option returns. These predictions are tested empirically.

The empirical analysis confirms the model's predictions using a large sample of option and stock returns. In line with Botosan (1997); Cohen (2008); Core et al. (2008); and Kim and Qi (2010), I find little statistical evidence of a relation between expected stock returns and firm-level AQ.[9] However, the relation between option returns and AQ is highly significant. For example, firms in the lowest decile of AQ yield monthly call option returns that are between 4 and 5 percent lower than firms in the highest AQ deciles, depending on the AQ proxy employed. In the case of put options, option return spreads tend to be even higher. These associations hold in the cross-section after controlling for a large number of determinants for option and stock returns, indicating that the effect of AQ on the behavior of option returns is distinct and economically meaningful.

Furthermore, consistent with the model's predictions, firms with lower levels of AQ have lower (higher) *ex ante* call (put) option leverage. Depending on the AQ proxy used, the difference in call (put) leverage between firms in the lowest and highest AQ deciles is approximately between 3.1 and 5.4 (-3.0 and -5.0). These differences in option leverage lead to very large differences in expected option returns because expected (or ex ante) option returns are the product of option leverage and a firm's expected stock risk premium. For example, the average stock risk premium in the sample is around 0.7 percent per month, and, if one assumes that AQ does not affect firms' costs of capital, then varying call option leverage across AQ deciles implies that firms in the lowest AQ decile have expected option returns that are between 2.2 and 3.9 percent per month lower than firms in the highest AQ decile. Assuming for arguments sake that AQ does affect firms' cost of capital, for low AQ firms to have higher expected call option returns than high AQ firms would require firms in the lowest AQ decile to have a risk premium of at least 1.75 (calculated as the ratio of AQ decile leverages $\frac{5.4}{3.1} \approx 1.75$) times that of firms in the highest decile, a magnitude much higher than

[9]Kim and Qi (2010) find an association between stock returns and an AQ factor. However they do not find an association between stock returns and AQ as a characteristic.

that documented in extant research.[10] This suggests that the differential behavior caused by AQ in stock and option returns appears to be driven by (idiosyncratic) risk that is unpriced in the equity market.

The results presented in this paper make several contributions to the literature linking information quality to asset pricing. First, prior studies have explored potential cost of capital effects arising from the precision of future cash-flows (e.g. Lambert et al., 2007) or information asymmetry (e.g., Easley and O'Hara, 2004 and Hughes et al., 2007) in equilibrium. This study is most closely related to Lambert et al. (2007), who investigate the valuation effects of noise (measurement error) in disclosed information. My work extends this prior research to a dynamic setting, which allows for a richer analysis of the intertemporal relation between information and asset values. This setting uniquely allows for a simultaneous analysis of the impact of accounting information on the pricing of both stocks and contingent claims.

Second, this study builds on the dynamic investor learning literature (Berk and Stanton, 2007; Gennotte, 1986; Johnson, 2004; Pástor and Veronesi, 2003, 2006) by extending Pástor and Veronesi (2003) to allow for accounting practices such as income smoothing and other forms of disclosure to affect equity price and derivative contract behavior. While Pástor and Veronesi (2003, 2006) and Johnson (2004) provide results which are related to some presented in this paper, there are several important differences. In the Pástor and Veronesi (2003, 2006) models, it is assumed that investors are given information only by observing firms' profitability over time. This is extended by deriving a model that includes other forms of information provided to investors about firm fundamentals. Johnson (2004) builds on the Merton (1974) model to develop stock valuation and expected stock return expressions for a levered firm assuming that the market value of assets of the firm are not directly observed. However, Johnson (2004) does not derive equity returns based on actual accounting data nor does he show the differential impact that AQ has on stock and option returns. To my knowledge, this is the first study to relate firm-level AQ to derivative contracts written on a firm's equity and to provide a solved option pricing model incorporating AQ.

Third, this paper adds to the body of emerging literature that explores the determinants and behavior of option returns (Bakshi and Kapadia, 2003; Cao and Han, 2012; Coval and Shumway, 2001; Goyal and Saretto, 2009) by examining the role AQ plays in determining expected option returns. While recent research has begun to examine how implied volatilities react to earnings guidance (Rogers et al., 2009) and if option trading strategies based on firm fundamentals (Goodman et al., 2011) are profitable, there are no previous

[10]For example, Francis et al. (2004) report that their pooled average cost of capital estimates are 20.8 percent per year with a standard deviation of 7.76 percent. However, the effect of moving from the highest to lowest accrual quality deciles corresponds to only a 3.71 percent spread in cost of capital.

studies which examine AQ's effect on the behavior of option contracts or on the differential impact of AQ on stock and option returns.[11]

Finally, Duffie and Lando (2001) link imperfect accounting information to credit derivatives. This paper offers the first direct link between imperfect accounting information and equity derivatives. In particular, this paper shows that AQ always affects expected option returns, regardless of whether it affects expected equity returns. The differential effect of AQ on stock and option contracts offers a new theoretically derived empirical methodology to help disentangle whether AQ is perceived by market participants as priced risk. In particular, this study shows that the effect of AQ on options is not redundant to the effect of AQ on equity prices. This new result may prove fruitful to future research by providing a means of obtaining a forward looking implied AQ measure using market traded products.

The remainder of the paper is organized as follows. Section 2 presents the model for stock returns and the accounting information structure. Section 3 derives option prices and option returns that incorporate accounting quality. Section 4 tests the empirical predictions of the model using stock and option data. Finally, Section 5 concludes the paper. All proofs and derivations are detailed in the Appendix.

2 The Model and Information Structure

In this section I outline a tractable model that is used to link firm fundamentals to stock returns. The development of the stock returns model is crucial in providing a rigorous link between AQ and stock returns. The model is then used to study the effect of AQ on the behavior of stock returns and valuation of options and other derivative contracts.

2.1 Relating Returns and Firm Fundamentals

To connect firm specific stock returns to firm fundamentals I make use of the Vuolteenaho (2002) log linearization (see also Callen and Segal, 2004; Callen et al., 2005; Callen, 2009; Easton and Monahan, 2005). Based on the Clean Surplus Relation, this linearization allows firm-specific log returns, r_{t+1}, to be expressed in terms of book-to-market ratios and return on equity [12]

[11] To avoid any potential confusion, the definition of option returns in Goodman et al. (2011) is based on the return from holding a straddle position, not the return from holding an option position. In this paper, an option return is defined as the return from holding an option position.

[12] Log linearizations are used extensively in empirical and theoretical asset pricing, see for example, Bansal and Yaron (2004); Campbell and Shiller (1988b); Campbell and Shiller (1988a); Campbell (1993) and Pástor et al. (2008).

$$r_{t+1} = bm_t - k_1 bm_{t+1} + roe_{t+1}. \tag{1}$$

Here, $bm_t = \log(\frac{B_t}{S_t})$ is the book-to-market ratio, B_t is book value, S_t is the market value of equity, $roe_{t+1} = \log(1 + \frac{X_{t+1}}{B_t})$ is return on equity (ROE henceforth), X_{t+1} represents firm earnings for period $t+1$, and k_1 is a cross-sectional constant.[13]

2.2 Stock Returns Under Perfect Information

To solve for stock returns, I use the standard no-arbitrage condition for determining the price of an equity, S_t, in a large economy at time t:

$$S_t = E_t[\frac{M_{t+1}}{M_t}(S_{t+1} + D_{t+1})]. \tag{2}$$

Equation (2) says that the price of the stock is determined by discounting future stock growth, S_{t+1}, and future dividends, D_{t+1}, with $\frac{M_{t+1}}{M_t}$, where $\frac{M_{t+1}}{M_t}$ is a discount factor representing the marginal rate of substitution of consumption between two periods for a representative agent in the economy.[14]

In order to derive tractable stock price and stock return equations, I make specific assumptions about firm ROE and the discount factor. In the spirit of Dichev and Tang (2009), Freeman et al. (1982), Lee et al. (1999), and Pástor and Veronesi (2003), I assume that ROE follows a mean-reverting AR(1) process of the form:

$$roe_{t+1} = (1-\omega)\mu + \omega roe_t + \sigma_s \varepsilon_{S,t+1} + \sigma_I \varepsilon_{I,t+1}, \tag{3}$$

where $\varepsilon_{S,t+1}, \varepsilon_{I,t+1} \sim N(0,1)$ and IID. $\varepsilon_{S,t+1}$ is a systematic shock that is common to all firms in the economy and $\varepsilon_{I,t+1}$ is an idiosyncratic shock that is unique to the firm. σ_s and σ_I are volatility parameters, with σ_s representing the amount of volatility that is caused by systematic shocks and σ_I is the amount of volatility caused by idiosyncratic shocks. μ is the long-run value of ROE and ω is a persistence parameter.

To model the discount factor, I follow Ang and Liu (2001) and Pástor and Veronesi (2003) and assume

[13] The value of k_1 is approximately 0.97. See Callen and Segal (2010).

[14] For more elaborate discussions on this approach in pricing, see, Ang and Liu (2001); Cochrane (2001); Feltham and Ohlson (1999); Johnson (2004); Lyle et al. (2012); Nekrasov and Shroff (2009); Pástor and Veronesi (2003).

that it takes a basic log-linear form

$$\log(\frac{M_{t+1}}{M_t}) = m_{t+1} = -r_f - \frac{1}{2}\sigma_m^2 - \sigma_m \varepsilon_{S,t+1}. \tag{4}$$

Here, r_f is the risk-free rate and σ_m is the level of risk in the economy. This form of the discount factor ensures that $\frac{M_{t+1}}{M_t}$ is always non-negative and that its expectation gives the price of a risk-free bond, $E_t[\frac{M_{t+1}}{M_t}] = \exp(-r_f)$.[15] Both of these conditions must be met for the economy to be free from arbitrage (see Cochrane, 2001).

Using equations (1), (2), (3) and (4) allows for stock returns to be expressed purely in terms of ROE. The following proposition summarizes the behavior of firms' stock returns assuming perfect information.

Proposition 1. *Given the dynamics of ROE in equation (3), then under perfect information stock returns have the following properties:*

(a) Innovations in firm stock returns are driven by shocks from realized ROE:

$$R_{t+1} - 1 = \underbrace{E_t[R_{t+1} - 1]}_{\textit{Expected Return}} + \theta_1 \underbrace{(roe_{t+1} - E_t[roe_{t+1}])}_{\textit{Shock from ROE}}. \tag{5}$$

(b) Stock return variance, σ_t^2, is

$$\sigma_t^2 = \underbrace{\theta_1^2(\sigma_S^2 + \sigma_I^2)}_{\textit{Variance from ROE}} \tag{6}$$

(c) Stock risk premiums, π_t, are given by

$$\pi_t = -cov_t(m_{t+1}, r_{t+1}) \tag{7}$$

$$= \theta_1 \sigma_S \sigma_m, \tag{8}$$

where $\theta_1 = \frac{1}{1-k_1\omega}$.

Equation (5) of Proposition 1 provides a parsimonious description of stock returns in terms of ROE in

[15] To see that these to conditions are met; notice that the variable $\sigma_m \varepsilon_{S,t+1}$ is normally distributed with mean zero and variance σ_m^2, then $\frac{M_{t+1}}{M_t} = \exp(m_{t+1}) = \exp(-r_f - \frac{1}{2}\sigma_m^2 - \sigma_m \varepsilon_{S,t+1})$ is conditionally log-normal which is always non-negative. Since $\sigma_m \varepsilon_{S,t+1}$ is normally distributed, the conditional expectation, $E_t[\exp(\sigma_m \varepsilon_{S,t+1})]$, is given by $\exp(E_t[\sigma_m \varepsilon_{S,t+1}] + \frac{1}{2}V_t[\sigma_m \varepsilon_{S,t+1}])$ where $V_t[\cdot]$ is the conditional variance operator. Using this property the expectation of $E_t[\frac{M_{t+1}}{M_t}] = e^{-r_f - \frac{1}{2}\sigma_m^2 + \frac{1}{2}\sigma_m^2} = e^{-r_f}$ is the value of a risk free bond.

a world of perfect information. All shocks to stock returns come from shocks to ROE, and the stock return variance is determined solely by the ROE variance. Intuitively, firm risk premia stem from the level of risk in firm profitability; higher levels of systematic risk (represented by σ_S) in ROE induces higher costs of capital.[16] Since stock returns are driven by ROE, the amount of systematic risk in ROE determines the firm's cost of capital (equation 7). While the results of Proposition 1 are simple and easy to understand, the assumption of perfect information, however, is not very realistic. For example, the median annual ROE variance from 1962 to 2010 for a firm on Compustat with 10 years of data is approximately 0.026 with a median persistence parameter of 0.38. This would imply a median stock return volatility of about 16 percent per year according to equation (6). However, the realized median annualized stock return volatility of that same period is actually close to 55 percent, a value far in excess of that implied by the perfect information model.

In a world of perfect information, investors are given all information about each of the inputs required to forecast ROE and subsequently price assets. However, in reality, investors receive information from firms through periodic financial reports and other forms of disclosure. Investors then face the problem of extracting key pieces of information from accounting reports and financial disclosures to make estimates about the firm's profit-generating process. The remainder of this section describes how the quality of information provided to investors affects stock returns when information is imperfect.

2.3 Stock Returns Under Incomplete Information

2.3.1 Investors' Beliefs and the Information Structure

In this section I relax the assumption that the long-run profitability of the firm, μ, is observable to investors. In this scenario, investors are uncertain about the future profitability of the firm and so smoothing income using accruals or other forms of disclosure can help investors learn about the long-term profitability of firms as information is provided. For example, firms report their current period cash flows and simultaneously provide additional information through accruals, thereby smoothing income across time. The smoothed signal to investors helps them to make more precise estimates about the true level of long-run profitability. To capture this concept, investors are assumed to draw information from two sources: the reported ROE value, roe_t, and an additional signal, y_t, disclosed by the firm. Both observations contain the

[16] Specifically, cost of capital is a determined by the covariance of ROE with the marginal rate of consumption for a representative agent in the economy.

true long-term mean, μ, plus noise. Specifically, the disclosed information is assumed to take the standard fundamentals-plus-noise form:

$$y_{t+1} = \mu + \sigma_d w_{t+1}, \tag{9}$$

where $w_{t+1} \sim N(0,1)$, which is assumed to be independent of $\varepsilon_{S,t+1}$ and $\varepsilon_{I,t+1}$. The parameter σ_d represents the level of noise in the disclosure.

2.3.2 Investors' beliefs about ROE

Let $x_t = E_t[\mu]$ denote investors' conditional beliefs about long-run ROE at time t.[17] At time t investors have information that includes all past realizations of ROE and disclosures provided by the firm. The following lemma provides the evolution of those beliefs about firm ROE over time.

Lemma 1. *Conditional on information known at time t, investors' beliefs about long-run ROE evolve according to the following equation:*

$$x_{t+1} = x_t + \sigma_{I,t}\bar{\varepsilon}_{I,t+1} + \sigma_{d,t}\bar{w}_{t+1}, \tag{10}$$

where

$$\sigma_{I,t} = \frac{v_t(1-\omega)}{\sigma_I\sqrt{1+h_I v_t}}, \tag{11}$$

$$\sigma_{d,t} = \frac{v_t}{\sigma_d\sqrt{(1+h_I v_t)(1+v_t(h_d+h_I))}}, \tag{12}$$

$$\text{and } v_t = \frac{1}{h_0 + t h_x}. \tag{13}$$

Here $h_0 = \frac{1}{v_0}$, v_0 is the conditional variance of x_0. $h_x = h_I + h_d$ represents information precision or accounting quality, where $h_I = (\frac{1-\omega}{\sigma_I})^2$ and $h_d = (\frac{1}{\sigma_d})^2$ represent the precision of ROE and the additional disclosures respectively.

Lemma 1, equation (10), is a close discrete time analog of the Pástor and Veronesi (2003) result. However, unlike Pástor and Veronesi (2003), who assume that investors use only reported ROE as a source of

[17]For simplicity, I write the conditional expectation operator $E_t[\cdot]$ in place of the more formal measure theory notation $E[\cdot|\mathscr{F}_t]$, where $\mathscr{F}_t$ represents investors' filtration or information set. My notation should be regarded as a shorthand equivalent of writing the formal notation.

information, equation (10) shows that investors update their beliefs about long-term profitability using two sources of information: the realized ROE process itself, $\bar{\varepsilon}_{I,t+1}$, and the information from the additional disclosures, $\bar{w}_{t+1}$. Positive values for $\bar{\varepsilon}_{I,t+1}$ or $\bar{w}_{t+1}$ represent a positive shock to expectations, which causes upward revisions in investors' beliefs about future profitability. Negative shocks cause downward revisions. Intuitively, the volatility terms $\sigma_{I,t}$ and $\sigma_{d,t}$ decrease in the precision parameters h_I and h_d. This means that more precise information lowers the dispersion of investors beliefs. Similarly, the age of the firm, t, also lowers uncertainty about future profitability and in the limit ($t \to \infty$) all uncertainty about the firm's long-run profitability is resolved.

An important implication of Lemma 1 is that changes in investor's beliefs about long-run profitability are driven completely by idiosyncratic information. The systematic shock, $\bar{\varepsilon}_{S,t+1}$, has no effect on the dynamics of investor's beliefs about the long-run profitability of the firm. The results of Lemma 1 conform with the findings of Pástor and Veronesi (2003) and Johnson (2004) in that investor learning is idiosyncratic. This result does not imply that aggregate (or macro) factors do not affect firm valuations or realizations of firm ROE; they do. However, it does imply that the uncertainty about (firm specific) long-run profitability is entirely firm specific.

This result may seem odd given that firm ROE contains a systematic component. Nevertheless, the intuition for the result is straightforward. Investors are assumed to observe the current state of the economy by observing the discount factor $\frac{M_{t+1}}{M_t}$. This allows investors to identify the systematic component of noise when making inferences about the firm, leaving only firm specific noise as the only source of noise which contaminates investors' ability to learn. Hence, the updating of beliefs about firm specific long-run profitability is based only on idiosyncratic information.

Given the idiosyncratic nature of firm level learning, what then are the implications of AQ on stock returns? An important implication is that low AQ firms are much more volatile, as is formally shown in the next proposition.

Proposition 2. *Given the dynamics of ROE in equation (3) and Lemma 1, then under imperfect information stock returns have the following properties:*

(a) Innovations in firm stock returns are driven by shocks from realized ROE and shocks from incomplete

information about long-run profitability:

$$R_{t+1}-1 \quad = \underbrace{E_t[R_{t+1}-1]}_{\text{Expected Return}} + \quad \underbrace{\theta_1(roe_{t+1}-E_t[roe_{t+1}])}_{\text{Shocks from ROE}} + \underbrace{\theta_2(x_{t+1}-E_t[x_{t+1}])}_{\text{Shocks from long-run ROE}}. \tag{14}$$

(b) Stock return variance, σ_t^2, is composed of a ROE and a long-run ROE component,

$$\sigma_t^2 \quad = \quad \underbrace{\theta_1^2(\sigma_S^2+\sigma_I^2)}_{\text{Variance from ROE}} + \quad \underbrace{\theta_2^2(\frac{v_t}{k_1^2}-v_{t+1})}_{\text{Variance from long-run ROE}} \quad . \tag{15}$$

(c) Stock risk premiums, π_t, are given by

$$\pi_t \quad = \quad -cov_t(m_{t+1}, r_{t+1}) \tag{16}$$

$$\quad = \quad \theta_1\sigma_S\sigma_m, \tag{17}$$

where $\theta_1 = \frac{1}{1-\omega k_1}$ and $\theta_2 = k_1\frac{(1-\omega)}{(1-k_1)(1-k_1\omega)}$. v_t is the conditional variance of x_t and is given by $v_t = \frac{1}{h_0+th_x}$, where $h_0 = \frac{1}{v_0}$. $h_x = h_I + h_d$ represents information precision or accounting quality, where $h_I = (\frac{1-\omega}{\sigma_I})^2$ and $h_d = (\frac{1}{\sigma_d})^2$ represent the precision of ROE and the additional disclosures respectively.

Proposition 2 shows a distinct contrast to stock return behavior when investors have perfect information. Most notable is the new term that affects the shocks to stock returns and the variance of those stock returns. The behavior of stock returns is dramatically affected by incomplete information. The loading on shocks to expectations about long-run ROE, θ_2, is much higher than the loading on shocks to ROE, θ_1. Specifically, $\theta_2 = k_1\frac{1-w}{1-k_1}\theta_1 \approx 0.97\frac{1-\omega}{1-0.97}\theta_1$. Assuming that the average level of persistence in ROE ranges from 0.2 to 0.8, a 1% shock to expectations about long-run ROE impacts stock returns around 6 to 27 times more than a 1% shock from ROE. This sensitivity to long-run ROE has a powerful effect on firm volatility. Comparing the variance of stock returns in Proposition 2 to that in Proposition 1 shows that stock return variance is higher when investors do not observe long-run ROE and that AQ (or information precision), h_x, is a key variable that affects stock return volatility. Higher levels of information precision lowers stock return variance by decreasing the uncertainty in investors' beliefs about long-run ROE. However, despite the impact that AQ has on shocks to stock returns, the effect only serves to drive up average realized idiosyncratic stock return volatility. It does not increase the cost of capital. Comparing risk premiums from Propositions 1 and 2 shows that they are identical even when investors have imperfect information. These concepts are summarized in the following corollary.

Corollary 1. *As firm accounting quality increases: a) firm stock return volatility decreases, and b) there is no effect on firm cost of capital.*

Even though AQ affects stock return volatility, there is no effect on cost of capital. Examining the stock risk premiums in both Propositions 1 and 2, we see they are identical even when investors are uncertain about the firm's future. From (14), shocks to firm returns come from shocks to firm ROE and shocks to expectations about future ROE. However, since the shocks to future ROE are completely idiosyncratic (from Lemma 1 equation (10)), these shocks have no effect on the expected covariance between the systematic factors and firm stock returns, so varying firm AQ produces no variation in cost of capital.

Figure 1 shows the predicted effects of AQ on stock-return volatility for a typical firm in the Compustat annual database. The median persistence parameter for Compustat firms with at least ten years of ROE data is around $\omega = 0.38$. In the plot, I allow this to take three values $\omega = (0.3, 0.4, 0.5)$. The median ROE total variance is 0.026. Firm age is set at, $t = 13$, which is the median age of a firm with the required estimation period, and the initial variance v_0, is set to 0.05. Information precision, or accounting quality (AQ), h_x, is allowed to vary between 20 and 60. An AQ of approximately 42 is required to match the median annualized volatility for a typical firm in the sample with a typical persistence parameter and ROE variance.

Figure 1 clearly illustrates AQ's role in affecting stock return volatility. The relation between information precision and stock return volatility is negative and monotonic; a theoretical result that has recently been documented empirically by Rajgopal and Venkatachalam (2010).

The critical role that AQ plays in determining stock return volatility suggests that AQ effects are ubiquitous, affecting everything from portfolio allocation decisions to the value of executive compensation contracts to the value of traded option contracts. What remains is to determine *how* AQ affects these important decisions and values. For example, since AQ affects volatility, it will almost surely affect the value of an equity option, but it is not clear *how* it will affect the subsequent return of that option. If AQ impacts option returns in the same manner as it does stock returns, then we would learn very little by studying option returns. However, if AQ impacts option returns differently than stock returns, studying these difference may hold new important information about investors' expectations of the risks associated with AQ. The link between AQ and the value of options and their expected returns is discussed in the next section.

3 Accounting Quality and Derivative Pricing

This section of the paper explores the theoretical relation between the quality of the information provided to investors and the effects that information has on the pricing and the expected returns of derivative contracts. I first derive the price of a European call option contract assuming that investors have imperfect information and discuss the impact of AQ on the equilibrium price. AQ's effects on expected option returns are then outlined and the differences between AQ's impact on option and stock returns is discussed. Following this, I show that if AQ affects the price of a call option, it also affects the prices and expected returns of virtually all other non-linear claims written on a firm's equity.

3.1 Accounting Quality and the Price of an Option

This section derives the price of a European call option. The price of a put contract can be found by invoking put-call parity and so the result is suppressed for brevity.

Let C_t be the time t price of a European call option written on a stock, S_t, that expires at time $t+1$ with strike price K. Then, as with pricing stocks, the price of the call option is determined by its expected discounted payoff:

$$C_t = E_t[\frac{M_{t+1}}{M_t}\max(S_{t+1}-K,0)]. \tag{18}$$

This method of pricing is completely consistent with how equity was priced in the previous section and all of the assumptions are identical. The following proposition provides the result of a call option given the assumed information structure outlined in the previous section.

Proposition 3. *Given the return dynamics of (14), the price of a European Call option, C_t, written on a stock, S_t that expires at time $t+1$ with a strike price of X is given by*

$$C_t = e^{-r_f}(F_t N(q_1) - XN(q_2)), \tag{19}$$

where,

$$
\begin{aligned}
F_t &= e^{\frac{1}{k_1}[r_f+s_t-(1-k_1)d_t-K]+\frac{1}{2}V_t[r_{t+1}](\frac{1}{k_1^2}-\frac{1}{k_1})}, && (20)\\
q_1 &= \frac{\log(\frac{F_t}{X})+\frac{1}{2}\sigma_o^2}{\sigma_o}, && (21)\\
q_2 &= q_1-\sigma_o, && (22)\\
\sigma_o^2 &= \frac{1}{k_1^2}V_t[r_{t+1}], && (23)\\
V_t[r_{t+1}] &= \underbrace{\theta_1^2(\sigma_S^2+\sigma_I^2)}_{\textit{Variance from ROE}} + \underbrace{\theta_2^2(\frac{v_t}{k_1^2}-v_{t+1})}_{\textit{Variance from long-run ROE}}. && (24)
\end{aligned}
$$

$N(\cdot)$ is a cumulative normal density function, r_f, is the risk-free rate, s_t is the log-stock price, and d_t is log-dividends paid by the firm. K and k_1 are constants with values of approximately 0.135 *and* 0.97 *respectively. $V_t[r_{t+1}]$ is the conditional variance of firm stock returns. $\theta_2 = k_1\frac{1-\omega}{1-k_1}\theta_1$, where $\theta_1 = \frac{1}{1-\omega k_1}$. v_t, is the conditional variance of x_t and is given by $v_t = \frac{1}{h_0+th_x}$ where $h_0 = \frac{1}{v_0}$. $h_x = h_I + h_d$ represents information precision or accounting quality, where $h_I = (\frac{1-\omega}{\sigma_I})^2$ and $h_d = (\frac{1}{\sigma_d})^2$ represent the precision of ROE and the additional disclosures respectively.*

Proposition 3 offers a relatively simple closed form solution linking AQ to option valuation. The option pricing model takes a similar, but slightly more complicated, form to that of the Black and Scholes (1973) model. Like the Black-Scholes model, higher stock return volatility increases the value of the option contract. The results in Proposition 2 show that AQ affects stock return volatility and, hence, the price of the call option. Specifically, option contracts written on low AQ will have a higher price because of higher expected variance. Unlike with stock returns, this effect actually feeds through into the option's expected return.

3.2 Accounting Quality and Expected Option Returns

This section presents one of the main findings of the paper, namely, that expected option returns are affected by AQ even if expected stock returns are not. This result can be traced to the expression for the expected return on a option contract, originally derived by Black and Scholes (1973). Black and Scholes show that the expected risk premium for holding an option contract can be expressed as the expected risk premium for holding the underlying stock, multiplied by the leverage gained by investing using the option contract. Specifically, the expression for the net expected option return, $E_t[\frac{O_{t+1}}{O_t}-1]$, where O_t represents either a call option or a put option, can be written as:

$$E_t[\frac{O_{t+1}}{O_t}-1] = r_f+\lambda_t(E_t[R_{t+1}-1]-r_f) \quad (25)$$

$$= r_f+\lambda_t\pi_t. \quad (26)$$

Equation (26) shows that option risk premiums, $E_t[\frac{O_{t+1}}{O_t}-1]-r_f$, are composed of two firm specific variables: the expected risk premium for holding the underlying stock, π_t, and the option's leverage, λ_t. The leverage of the option is the product of the option's delta, Δ_t, which is a measure of the expected change in the option value relative to a change in the underlying stock price, and the stock price to option price ratio, $\frac{S_t}{O_t}$, and is written as $\lambda_t=\Delta_t\frac{S_t}{O_t}$.

The latter result appears quite intuitive as options are functions of the underlying stock price. However, λ_t has properties that are worth investigating and that yield interesting insights into the relation between AQ and option pricing. First, λ_t takes a strictly positive (negative) value for call (put) options and provides a higher (lower) expected return for the call (put) than for the underlying equity. This is a function of the option being a levered play on equity, a result proven in general by Coval and Shumway (2001). More importantly, option leverage, λ_t, changes with underlying stock return volatility. Specifically, call option leverage decreases with volatility while put option leverage increases with volatility. The latter property implies that while idiosyncratic volatility does not affect expected equity returns, it can be of substantial importance in the pricing of contingent claims. In particular, expected call (put) option returns will be lower (higher) for firms with lower AQ if AQ manifests as idiosyncratic risk. In other words, lower AQ has the effect of driving down call option leverage, λ_t, without affecting expected stock returns.

Figure 2 shows the effects of AQ on option leverage for an at-the-money call option expiring in 50 days (the average expiry time for the options used in this study) as predicted by the model. The parameters are based on a representative firm in Compustat. The figure clearly depicts a monotonically increasing relation between AQ and option leverage. Since higher AQ increases option leverage without affecting expected stock returns, the net effect is for higher AQ to increase expected call option returns. These results are summarized in the following corollary.[18]

Corollary 2. *If accounting quality manifests in the form of idiosyncratic risk, then, as firm accounting*

[18] The results for a put option are the exact opposite to that of a call option.

quality increases: a) call (put) option leverage increases (decreases), and b) expected call (put) option returns also increase (decrease).

Corollary 2 provides an empirically testable hypothesis. If AQ manifests in the form of idiosyncratic risk then there will be little or no association with expected stock returns, but the relation between expected call option returns and AQ will be positive. On the other hand, if AQ manifests in the form of systematic risk, then AQ will be negatively associated with expected stock returns and with call option returns. Formal tests of this hypotheses are conducted in the empirical section of this paper further below.

3.3 Accounting Quality and the Pricing of Other Equity Derivative Products

The seminal work of Carr and Madan (1998), Bakshi and Madan (2000), and Bakshi et al. (2003) shows that virtually all non-linear claims written on a firm's equity can be spanned (or replicated) with positions in bonds and call options, meaning that call options can be used as basic building blocks for other derivative assets. This spanning result together with the result that AQ affects the value of call options implies in turn that AQ affects virtually all non-linear claims on the firm's equity. This finding is formalized in the following corollary:

Corollary 3. *Accounting quality affects the price of virtually all non-linear claims written on a firm's equity.*

Corollary 3 is a direct result of Bakshi and Madan (2000) and Carr and Madan (1998). These papers show that the price, P_t, for any twice differentiable payoff function, call it $H(S_{t+1})$, is given by:

$$P_t = H(0)e^{-r_f} + S_t H_S(0) + \int_0^\infty H_{SS}(X)C_t(X)dX. \tag{27}$$

Here, $H_S(0)$ represents the partial derivative of H with respect to S_t evaluated at 0, and $H_{SS}(X)$ is the second derivative of H with respect to stock price evaluated at X. The last term says that the price of any twice differentiable contract depends on the infinite sum of call options (weighted by H_{SS}). Since a call option, C_t, is a function of AQ (by equation (19)), then AQ affects the price of any claim, P_t, where the term $\int_0^\infty H_{SS}(X)C_t(X)dX$ is not equal to zero. Importantly, this effect is present even if AQ does not affect a firm's cost of capital.

Corollary 3 has broad implications for accounting research and derivative markets. It suggests that since accounting information affects the volatility of stock returns, accounting information will ripple throughout the derivatives markets and affect virtually all non-linear claims. Specifically, a more general expression of equation (25) shows that the expected return for holding any arbitrary claim, P_t, has the form[19]

$$E_t[\frac{P_{t+1}}{P_t} - 1] - r_f = \frac{\partial P_t}{\partial S_t}\frac{S_t}{P_t}\pi_t.$$

Here, $E_t[\frac{P_{t+1}}{P_t} - 1]$ is the expected return for holding the derivative contract and, like with options, it is determined by the leverage of the derivative $\frac{\partial P_t}{\partial S_t}\frac{S_t}{P_t}$ multiplied by the firm's risk premium. Since AQ affects P_t, it will affect the expected return on that derivative as well. This is stated in the following corollary.

Corollary 4. *Accounting quality affects the expected returns of virtually all non-linear claims written on a firm's equity.*

The paper of Duffie and Lando (2001) shows a link between imperfect accounting information and credit derivatives. Corollary 4 links imperfect accounting information to equity based derivatives. Given the growing number of derivative products that are now used in capital markets, this link between accounting information and these products offers a new setting to study the impact of AQ on many different assets, in addition to equities.

4 Empirical Tests

This section tests some of the theoretical predictions of the model presented in the previous sections. The first critical prediction of the model is that firms with lower AQ should have higher expected stock return volatility and, hence, higher option prices. Second, the model predicts that the leverage of a call (put) option decreases (increases) as AQ decreases. The third prediction is that *even if* variation in AQ does not affect expected stock returns, it will affect expected option returns because they are the product of leverage and expected stock returns. These predictions can be written formally as follows:

H1: Accounting Quality (AQ) and option prices are inversely related.

H2: Accounting Quality (AQ) and call (put) option leverage are directly (inversely) related.

H3: Accounting Quality (AQ) and expected stock returns are unrelated whereas Accounting Quality (AQ) and expected call (put) option returns are directly (inversely) related.

[19] The Black and Scholes (1973) expected return equation for an option contract, their equation (17), holds for any contract written on the stock.

4.1 Accounting Quality Measures

Given that AQ is unobservable and difficult to measure, I employ four different proxies: two accrual quality proxies, a discretionary smoothing proxy, and a proxy derived from the value relevance of ROE. They are described in detail below.

4.1.1 Accrual Quality Measures

The first two sets of AQ proxies are based on two accrual quality measures that are widely used in accounting research.[20] The rationale for using accrual quality as a proxy for AQ comes from the fact that accruals are largely derived from expectations about future cash flows. If accruals are unreliable, or contaminated by high levels of measurement error, then this lowers the overall quality of information reported in firm earnings, which subsequently makes forecasting future firm profitability more difficult.

The first accrual quality proxy, DD, is based on the Dechow and Dichev (2002) measure modified by Francis et al. (2005). The DD measure is based on the idea that accruals map into past, present, and future cash flows. Firms with greater errors in this mapping process are considered to have lower quality earnings and thus lower AQ. The modified Dechow and Dichev (2002) model is estimated as follows:

$$TCA_{i,t} = \gamma_0 + \gamma_1 CFO_{i,t-1} + \gamma_2 CFO_{i,t} + \gamma_3 CFO_{i,t+1} + \gamma_4 \Delta REV_{i,t} + \gamma_5 PPE_{i,t} + w_{i,t}, \tag{28}$$

where TCA represents total current accruals and is calculated as $TCA = \Delta CA + \Delta DL - \Delta CL - \Delta CE$. Where CA is current assets, DL is debt in liabilities, CL, is current liabilities, and CE is cash and short-term investments. CFO is calculated as income before extraordinary items less total accruals, where total accruals are equal to TCA less depreciation and amortization. REV is firm revenue and PPE is property plant and equipment. All variables are deflated by average total assets. Equation (28) is estimated each year, for each of the Fama and French (1997) 48 industry classifications for which there are at least 20 firms. The AQ proxy is the five year rolling standard deviation of the residual $w_{i,t}$. Firms with higher standard deviations are considered to have lower AQ.

The second proxy, AV, follows from Tucker and Zarowin (2006) and Rajgopal and Venkatachalam (2010) and is based on the modified cross-sectional Jones (1991) model. Like the DD proxy for AQ, the

[20] The use of accrual quality measures as a proxy for AQ, or overall information quality is common. See for example Biddle et al. (2009); Ng (2011); and Rajgopal and Venkatachalam (2010).

AV proxy uses the variance of discretionary accruals as an estimate of AQ. Specifically, the AV measure is calculated as follows:

$$TA_{i,t} = \beta_0 + \beta_1 \frac{1}{AveAssets_{i,t}} + \beta_2 \Delta REV_{i,t} + \beta_3 PPE_{i,t} + \beta_4 ROA_{i,t} + u_{i,t}, \tag{29}$$

where TA is total accruals, calculated as TCA less depreciation and amortization. ROA is return on assets, calculated as income before extraordinary items over average total assets. ROA is included because Kothari et al. (2005) find that the Jones model is sensitive to firm performance. All other variables are previously defined. Following Tucker and Zarowin (2006), equation (29) is estimated each year for each two digit SIC code with more than 10 firms. The AQ proxy is the five year rolling standard deviation of the residual $u_{i,t}$. Firms with higher standard deviations are considered to have lower AQ.

4.1.2 Smoothing Measure

One of the primary theoretical predictions of the model is that uncertainty about long-run profitability has a powerful effect on stock return volatility. Since investors face the problem of extracting information about future profitability from noisy signals, the smoother the signal, the more precise will be their estimates about future firm profitability which then lowers stock return volatility. To operationalize this concept, the third measure of AQ is based on income smoothing. The measure of smoothing follows from Tucker and Zarowin (2006) and Dou et al. (2012) and is estimated as the negative correlation between discretionary accruals and per-discretionary income, where discretionary accruals are represented by the residual, $u_{i,t}$, in equation (29) and per-discretionary income (PDI), as defined by Tucker and Zarowin (2006), is income before extraordinary items less discretionary accruals. The AQ proxy is the five year rolling negative correlation between PDI and discretionary income. Firms with higher levels of smoothing are considered to have higher levels of AQ.[21]

[21] Whether the use of income smoothing garbles or makes reported income more informative is an unresolved issue in the accounting literature. For example, Jayaraman (2008) finds that income smoothing contributes, on average, to the garbling of information, while Tucker and Zarowin (2006) find that smoother income tends to make income more informative about future stock returns. Graham et al. (2005) found that of the executives they surveyed, over 90 percent of them indicated that they preferred smoothed income. However, both Barth et al. (2008) and Lang et al. (2006) use income smoothing as a measure of earnings management.

4.1.3 Value Relevance Measure

The final AQ proxy, ValRel, follows directly from the results of Proposition 2 equations (14) and (15). These results suggest that firm stock returns are driven by shocks to ROE and shocks to expectations about long-run profitability. More specifically, firms with lower levels of AQ will have a higher level of stock return variation which is unexplained by variation in ROE. Put differently, firms with lower levels of AQ will have ROE that is less relevant in explaining the equity value of the firm over time. To estimate this, realized stock returns are regressed on shocks to ROE as follows:

$$r_{i,t+1} = a + b(roe_{i,t+1} - E_t[roe_{i,t+1}]) + z_{i,t+1}, \tag{30}$$

where $r_{i,t+1}$ represents the log-return for firm i and $(roe_{i,t+1} - E_t[roe_{i,t+1}])$ is the ROE shock, $z_{i,t+1}$ represents shocks to returns not explained by firm ROE. To calculate shocks from ROE and $z_{i,t+1}$, a two step approach, similar to that used by Ogneva (2012), is employed. In the first step, ROE expectations are derived based on the simple AR(1) dynamics assumed in the paper.[22] Each year the ROE model is estimated cross-sectionally and the persistence parameter is retained and used to generate an expected ROE for the following year. The difference between realized ROE and the expected ROE is taken as the ROE shock.

In the second step, monthly stock returns are regressed on contemporaneous ROE shocks by each two digit SIC code. The rolling 36 month standard deviation of the residual from these monthly regressions represents the AQ proxy; firms with higher standard deviations are considered to have lower AQ.

4.2 The Data

To test the implications of AQ on option contracts, I follow Cao and Han (2012) and use monthly option and stock data provided by the IVY DB OptionMetrics database from January1996 to December 2010, and intersect this sample with the CRSP and the annual Compustat databases. Firm fundamentals are taken from Compustat and are assumed to be public knowledge 4 months after the firm's fiscal year end. Analyst data comes from the IBES unadjusted summary database.

At the end of each month, I collect call and put options that have the shortest maturity among those options with more than one month to expiration. To remove potentially erroneous option prices, I apply

[22] Alternative models which included ROE, firm size, book-to-market, and lagged returns were are also considered when deriving ROE expectations. The results were similar regardless of the model used.

numerous filters to the data. First, following Cao and Han (2012), to insure that the sample consists of options with relatively homogeneous "moneyness" (the ratio of strike price to stock price), options with strike price to stock price ratios of greater than 1.2 or less than 0.8 are excluded from the sample. Further, following Goyal and Saretto (2009), all options that expire on non-standard trading days, have zero open interest, and that violate arbitrage bounds are dropped from the sample. Options with ask prices below bid prices are also excluded. All options are required to have a measure of implied volatility and delta to be included in the sample. Options that are the closest to at-the-money (defined as the ratio of strike price to stock price) are used in the analysis. After merging the option returns data with Compustat and CRSP, and requiring that firms have a fiscal year end price greater than $1 and a book value of greater than zero, a sample of 238,538 firm month call option returns and 201,591 firm month put option returns are obtained for use in the analysis. Option leverage is calculated as the option's delta multiplied by the stock to option price ratio where the option's delta and price are obtained from the OptionMetrics raw option price file. Stock prices come from the OptionMetrics security price file. All independent variables in the analysis are windsorized at the 1 and 99 percentiles. To ensure the results are free from look-ahead bias, all variables are measured prior to any returns analysis.[23]

Table 1 Panels A and B provide summary statistics for the options used in the sample. The average monthly call option earns a 4.6 percent monthly return, whereas buying and holding the option until maturity (Until Expiry Call Return) results in a return of around 6.77 percent per month. Consistent with put options earning negative expected returns, average put returns lose 8.1 percent per month and 12.7 per month if the options are held until expiry. Implied volatilities for both calls and puts are similar with average values around 47%. The average leverage for a call option in the sample is around 9.7 and the average leverage for a put is around -8.7. Both the mean and median of moneyness are very close to one for both calls and puts, suggesting that the options are extremely close to at-the-money. The open interest to stock volume ratio shows that call options have about one-third higher option activity than put options.

Table 1, Panels C and D provide summary statistics for the AQ measures and other firm characteristics. The median firm in the sample is 12 years old and has 9 analysts following it. On average, the firms in the sample tend to be bigger and have lower book-to-market ratios than a sample consisting of firms without active option contracts. Thus, the results are unlikely to be driven by small firms or firms with very low analyst coverage.

[23] The *DD* measure is lagged by one year.

Table 1, Panel D presents Pearson (above the diagonal) and Spearman (below the diagonal) correlations for variables with available call option return data. The DD, AV, and ValRel measures are logged and multiplied by negative one so that higher values imply higher AQ. As can be observed from the table, all of the AQ measures are highly correlated with one another. They are negatively correlated with implied volatility, suggesting that the proxies for AQ are affecting expected volatility in the predicted direction. The AQ proxies also tend to be positively correlated with call option leverage, book-to-market, firm size, ROE and asset leverage. The correlations between AQ and call option returns as well as stock returns are also positive, but the magnitude of the correlations are relatively modest.

4.3 Option Leverage and Implied Volatility

This section tests H1 and H2; that options written on firms with lower AQ will have higher option prices (measured as the implied volatility of the contract), and option leverage will be lower for calls and higher for puts. Table 2 Panels A and B present the mean monthly option leverage and implied volatilities sorted on the various AQ proxies using call and put options, respectively. As predicted, the results show that expected volatility is monotonically decreasing with each of the AQ proxies, they also indicate that the magnitude in which the AQ proxies appear to affect firm volatility is large. Looking across both Panels A and B in Table 2, firms in the highest AQ deciles have annualized expected volatilities that range between 16 to 27 lower than firms in the lowest AQ deciles. The value relevance proxy, ValRel, appears to have the greatest impact on expected volatility, whereas the smoothing proxy, Smooth, appears to have the lowest impact.

Similarly, Table 3 Panels A and B show that the leverage implied by call options increases monotonically with AQ, while the implied leverage in put options monotonically decreases with AQ. Moving from the lowest AQ decile to the highest AQ decile shows that AQ's impact on option leverage is large. High-low spreads for call option leverage ranges from around 3.12 for the Smooth proxy to 5.38 for the DD proxy. The magnitude of high-low spreads are similar for put options, they range from -3.01 for the Smooth proxy to -4.97 for the DD proxy. Taken together, the results in Tables 2 and 3 provide compelling evidence in favor of H1 and H2 and suggest that AQ is likely to have a significant impact on expected option returns.

To test H1 and H2 formally, monthly Fama-MacBeth regressions of implied volatility and option leverage on AQ and control variables are estimated. The mean cross-sectional coefficients and Fama-MacBeth t-statistics are presented in Tables 4 and 5. As control variables, standard firm characteristics including the book-to-market ratio, firm size, ROE, and asset leverage are included in the regression. To control for stock return momentum effects, both the lagged (t-1) monthly stock return, and the lagged twelve month buy and hold stock return (with month t-1 stock return removed) are included in the regression.

As a control for historical volatility, the variable VolatilityControl is included in the regressions. VolatilityControl contains total historical stock return volatility which is not generated by the AQ proxy; specifically, $VolatilityControl = HistoricalVolatility - \alpha * AQ$, where α is estimated cross-sectionally each month before the multivariate regression is run.[24] This variable is used instead of total volatility because AQ is predicted to affect option prices *through* volatility, thus it would be inappropriate to use total firm volatility as the control variable since this would absorb the actual effect that AQ has on option contracts. To control for option specific characteristics, the variables Moneyness and OS Ratio are included in the regressions. Moneyness controls for any difference in the moneyness of the option contract and is measured as the strike price over the stock price. The OS Ratio is a control for liquidity, measured using the option's open interest to stock volume ratio.

The results in Table 4 suggest that the results in Table 2 hold true when controlling for many firm characteristics. Implied volatilities from both calls and puts are significantly impacted by each AQ measure, suggesting that AQ plays an important role in setting expectations about future firm risk. Table 4 also highlights that firm fundamentals are also important determinants of expected volatility. Firms with higher market values, book-to-market ratios, ROE, and asset leverage all tend to have lower expected volatilities. Consistent with prior research (Christensen and Prabhala, 1998) the control for historical volatility, VolatilityControl, is a strong positive predictor of expected future volatility. Both of the momentum control variables are negatively associated with expected volatility, as in the Moneyness control variable. The option to stock ratio, OS Ratio, is positively associated with implied volatility.

Table 5 also highlights AQ's effects on option leverage after controlling for firm characteristics. Call option leverage is positively associated with AQ and put option leverage is negatively associated with AQ. The results of both Tables 4 and 5 provide compelling evidence in favor of H1 and H2.

Next, I examine whether these effects flow through and affect option returns.

[24] Since the calculation of VolatilityControl involves a two step procedure of the type discussed in Newey and McFadden (1994), this approach may understate the standard errors of *AQ* in the second step regression. To insure that the standard errors were not understated, the two step approach was estimated simultaneously using GMM as discussed in Newey and McFadden (1994). The results using the GMM regressions were virtually identical to those reported in this paper, suggesting that the two step procedure is not overstating the significance of the reported results.

4.4 Option Returns Analysis

To test the effects of AQ on stock and option returns, I follow the large empirical asset pricing literature (Ang et al., 2006, 2009; Armstrong et al., 2011; Cochrane, 2001; Core et al., 2008; Duarte and Young, 2009; Easley et al., 2002; Kim and Qi, 2010; McInnis, 2010) and conduct monthly Fama-MacBeth regressions of realized returns on proxies for AQ to determine if AQ is priced in the cross-section. An association between option returns but not stock returns would offer evidence that AQ has an effect on option returns, even if it does not affect stock returns. To test this, I regress option and stock returns on AQ proxies plus control for other determinants of option and stock returns.

As controls in stock return regressions, I include all the non-option-related control variables used in the prior multivariate analysis. In the option return regressions, I include all controls that are used in the stock return regressions, as well as option-specific controls from the prior analysis.

Table 6 Panels A and B show that AQ has a significant effect on option returns. Call option returns are highly affected by AQ; each of the AQ proxies show a significant positive association with future call option returns. The results for puts are somewhat weaker than observed in call returns, however, all AQ proxies except Smooth are significantly (negatively) associated with future put option returns. The tables also show that standard variables that predict stock returns also predict call option returns. Both the book-to-market ratio and ROE are positively associated with future call returns, whereas market value and lagged stock returns are negatively related to call returns. Firms with higher historical volatility (VolatilityControl), higher OS Ratio's and lower Moneyness earn lower call option returns. Overall, the multivariate tests provide persuasive evidence that AQ has an important effect on future option returns.

Table 6 Panel C presents the results of regressing stock returns on AQ. To ensure consistency with the option return sample, only firm stock returns that have call option returns on the same date are used. The stock returns analysis in Panel C stands in stark contrast to Panels A and B. Unlike the strong association between option returns and AQ, there is no evidence of AQ having an effect on future stock returns in the sample. The overall results from the option and stock returns analysis provides compelling evidence in favor of H3, suggesting that AQ affects option returns even if there is no effect on stock returns.

4.4.1 Hold Until Expiry Option Returns

The previous section showed a strong relation between one-month option returns and AQ proxies. However, one month options may have significant transaction costs as the strategy requires buying and then selling the option each month. One way to mitigate transaction costs is to hold the option until it expires. The option then expires worthless or expires in-the-money, which removes the cost of unwinding the position at the end of the month. I now reproduce the option return analysis from the last section using hold-until-expiry option returns.

Table 7 reproduces the multivariate option return tests in the previous section using hold-until-expiry options. The results are very similar to the monthly option returns, but the association between Smooth and call option returns has been attenuated. However, all other AQ proxies show a strong association with future call and put option returns, suggesting that frequent buying and selling of options is not driving the results.

4.4.2 Portfolio Sorts

As an attempt to gauge the economic significance of AQ on option returns, Table 8 provides portfolio sorts based on monthly option returns. The results largely corroborate the multivariate tests in Tables 6 and 7. There is a clear positive (negative) and significant association with future call (put) option returns. Long-short investment strategies based on all measures of AQ produce statistically significant and economically meaningful returns (with the exception of Smooth when using call options) ranging from around 4 to 5 percent for call strategies and 1 to 7 percent for put strategies.

To ensure that results for stock returns also hold at the portfolio level, Table 8, panel C provides the portfolio returns analysis. The results indicate that, within the sample, no association between the AQ proxies and stock returns can be found.

4.5 Robustness Tests

4.5.1 Innate and Discretionary Accrual Quality

Following Francis et al. (2005), I decompose the DD measure used in the previous analysis into both discretionary and innate accrual quality. I find that both innate and discretionary accrual quality is associated with call and put option returns, however, no association between stock returns and innate or discretionary accrual quality could be found.

4.5.2 Low-priced stocks and Financial Firms

All tests were also run controlling for both low-priced stocks (Kim and Qi, 2010) and removing financial firms. All regression results were qualitatively similar to those reported in the paper.

4.6 Summary of Empirical Results

The results of the empirical tests can be summarized as follows: 1) AQ measures are highly associated with expected risk implicit in option contracts (measured using implied volatility). 2) AQ affects both call and put option leverage. High AQ firms have high call option leverage and low put option leverage. 3) AQ has a significant association with future option returns, observed in both call and put options, and the results hold with the inclusion of a large number of control variables. Using this same sample, no effects were detectable in equity returns data. 4) An investment strategy that buys calls (put) on high AQ firms and sells calls (puts) on low AQ firms generates large positive (negative) monthly returns. However, when this same strategy is applied to stocks the monthly equity returns are indistinguishable from zero.

The significant results observed in call and put option returns confirms the theoretical model derived in Sections 2 and 3. In large economies, AQ will have an effect on option returns even if there is no effect on stock returns. This is a byproduct of the fact that AQ affects the uncertainty, which is then impounded into option leverage and flows through into the option's expected returns.

5 Conclusion

This study investigates accounting quality's impact on option contract prices and returns both theoretically and empirically. The paper presents a framework for valuing stocks, options and other derivatives when firms' long-run profitability is unobservable to investors. Instead, investors use noisy information disclosed by the firm over time to dynamically learn about this value. The paper shows that the quality of information disclosed to investors has important implications for the pricing of many assets in a large economy, even if that information does not affect firms' cost of capital. The paper's central theoretical contribution is in showing that, even if AQ does not affect cost of equity capital, it still has an important impact on the price and expected returns of option contracts and virtually all non-linear equity claims in an economy.

Empirically, the model predicts that if AQ manifests as idiosyncratic (or unpriced) risk then firms with more precise disclosures will have: 1) lower stock return volatility, 2) lower call option leverage and higher put option leverage, 3) no cost of capital effect, but 4) expected option returns will be affected. Empirical support for each of these predictions is found. Using actual option data, firms with lower AQ are shown to have higher option prices, lower (higher) call (put) option leverage, and lower (higher) realized call (put) option returns. In all cases, accounting quality is shown to have a significant impact on option contracts, even when there is no detectable stock return effect.

While the paper offers insight into the effects of AQ on equities and contracts written on the equities, the paper cannot answer the question "Why do firms disclose information of varying quality?". Nor can the paper offer insight into the possible joint effects of AQ on equity and debt costs. These questions are important and offer potentially interesting areas of future research.

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A Proof of Proposition 1

I start with the standard no arbitrage condition for deriving the value of a stock $S_t = E_t[\frac{M_{t+1}}{M_t}(S_{t+1} + D_{t+1})]$. This expression can equivalently be written in terms of gross stock returns, $1 = E_t[\frac{M_{t+1}}{M_t} R_{t+1}]$, where the gross return is $R_{t+1} = \frac{S_{t+1}+D_{t+1}}{S_t}$. Letting $m_{t+1} = \ln(\frac{M_{t+1}}{M_t})$ and $r_{t+1} = \ln(R_{t+1})$ the no-arbitrage condition can be written in logs:

$$1 \quad = \quad E_t[\exp(m_{t+1} + r_{t+1})]. \tag{A.1}$$

Following Bansal and Yaron (2004), I conjecture that the market-to-book ratio is of log-linear form,

$$mb_t = \alpha_0 + \alpha_1 \mu + \alpha_2 roe_t - \alpha_3 \sigma_m, \tag{A.2}$$

where the α's are constants. Using the Vuolteenaho (2002) equation and the ROE dynamics in (3) log-returns can be written as:

$$\begin{aligned} r_{t+1} &= -mb_t + k_1 mb_{t+1} + roe_{t+1} && \text{(A.3)} \\ &= -(\alpha_1 \mu + \alpha_2 roe_t + \alpha_3 \sigma_m) + k_1(\alpha_1 \mu + \alpha_2 roe_{t+1} + \alpha_3 \sigma_m) + roe_{t+1}. && \text{(A.4)} \end{aligned}$$

Since both m_{t+1} and roe_{t+1} are conditionally normally distributed variables. The no-arbitrage condition (A.1) becomes,

$$\begin{aligned} 1 &= E_t[\exp(m_{t+1} + r_{t+1})] \\ &= \exp(E_t[m_{t+1}] + E_t[r_{t+1}] + \frac{1}{2}V_t[m_{t+1}] + \frac{1}{2}V_t[r_{t+1}] + cov_t[m_{t+1}, r_{t+1}]). \end{aligned}$$

Taking logs of both sides and using the fact that $m_{t+1} = -r_f - \frac{\sigma_m^2}{2} - \sigma_m \varepsilon_{S,t+1}$ then expected log-returns are written as:

$$E_t[r_{t+1}] = r_f - \frac{1}{2}V_t[r_{t+1}] + cov_t[m_{t+1}, r_{t+1}]. \tag{A.5}$$

Following Bansal and Yaron (2004) and Campbell (1993) stock returns are written as, $R_{t+1} - 1 = r_{t+1} + \frac{1}{2}V_t[r_{t+1}]$, where the $\frac{1}{2}V_t[r_{t+1}]$ term is a variance correction term for working in logs.

Using (A.4) and given that $roe_{t+1} = \mu(1-\omega) + \omega roe_t + \sigma_S \varepsilon_{S,t+1} + \sigma_I \varepsilon_{I,t+1}$ one obtains the following expressions:

$$
\begin{aligned}
E_t[r_{t+1}] &= [(1+\omega) + k_1(\alpha_1 + \alpha_2(1-\omega)) - \alpha_1]\mu \\
&\quad +(\alpha_2 \omega k_1 + \omega - \alpha_2) roe_t \\
&\quad +(\alpha_3 k_1 - \alpha_3)\sigma_m. &&\text{(A.6)} \\
V_t[r_{t+1}] &= (1 + k_1\alpha_2)^2(\sigma_S^2 + \sigma_I^2). &&\text{(A.7)} \\
cov_t[m_{t+1}, r_{t+1}] &= (1 + k_1\alpha_2)\sigma_S \sigma_m. &&\text{(A.8)}
\end{aligned}
$$

Plugging (A.6), (A.7), and (A.8) into (A.5) and solving yields:

$$
\begin{aligned}
\alpha_0 &= \frac{1}{2}\frac{1}{1-k_1}[(\frac{1}{1-k_1\omega})^2(\sigma_I^2 + \sigma_S^2) - r_f], &&\text{(A.9)} \\
\alpha_1 &= \frac{1-\omega}{(1-k_1)(1-k_1\omega)}, &&\text{(A.10)} \\
\alpha_2 &= \frac{\omega}{1-k_1\omega}, &&\text{(A.11)} \\
\alpha_3 &= \frac{1}{(1-k_1)(1-k_1\omega)}. &&\text{(A.12)}
\end{aligned}
$$

Plugging these values back into (A.4) implies the following properties for stock returns:

$$
\begin{aligned}
R_{t+1} - 1 &= E_t[R_{t+1} - 1] + \frac{1}{1-k_1\omega}(roe_{t+1} - E_t[roe_{t+1}]), \\
E_t[R_{t+1} - 1] &= r_f + \frac{1}{1-k_1\omega}\sigma_S \sigma_m, \\
V_t[R_{t+1} - 1] &= (\frac{1}{1-k_1\omega})^2(\sigma_S^2 + \sigma_I^2).
\end{aligned}
$$

B Proof of Lemma 1

Lemma 1 is a direct application of recursive optimal extrapolation (see Chapter 13, Liptser and Shiryaev, 1977).

Investors make inferences because μ is not observable to them. Let $x_t = E[\mu|\mathscr{F}_t] = E_t[\mu]$ be the belief about long-run profitability. Investors receive three signals that can be used to filter (or extract) the current value of μ: the realization in ROE, the state of the economy through m_{t+1} and the disclosure generated by the firm y_{t+1}. These observed signals are used to make inferences about the current state and expected evolution of long-term profitability. In vector form, this can be written as:

$$\Theta_{t+1} \quad = \quad \begin{bmatrix} m_{t+1} \\ roe_{t+1} \\ y_{t+1} \end{bmatrix} = \mathscr{A}_1 \mu + \mathscr{A}_2 \Theta_t + B_1 \mathbf{z}_{t+1}, \tag{A.13}$$

where $\mathscr{A}_1 = \begin{bmatrix} 0 \\ 1-\omega \\ 1 \end{bmatrix}$ and $\mathscr{A}_2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ $B_1 = \begin{bmatrix} \sigma_m & 0 & 0 \\ \sigma_S & \sigma_I & 0 \\ 0 & 0 & \sigma_d \end{bmatrix}$ and $\mathbf{z}_{t+1} = (\varepsilon_{S,t+1}, \varepsilon_{I,t+1}, w_{t+1})^T$. The variance-covariance matrix $\Sigma_i \Sigma_i^T = B_1 B_1^T + \mathscr{A}_1^T v_t \mathscr{A}_1$ is,

$$B_1 B_1^T + \mathscr{A}_1^T v_t \mathscr{A}_1 = \begin{bmatrix} \sigma_m^2 & -\sigma_m \sigma_S & 0 \\ -\sigma_m \sigma_S & \sigma_S^2 + \sigma_I^2 + v_t (1-\omega)^2 & v_t (1-\omega)^2 \\ 0 & v_t & \sigma_d^2 + v_t (1-\omega)^2 \end{bmatrix}. \tag{A.14}$$

Using Cholesky decomposition, the volatility matrix is

$$\Sigma = \begin{bmatrix} \sigma_m & 0 & 0 \\ -\sigma_S & \sqrt{\sigma_I^2 + v_t(1-\omega)^2} & 0 \\ 0 & \frac{v_t(1-\omega)}{\sqrt{\sigma_I^2 + v_t(1-\omega)^2}} & \frac{\sqrt{v_t(\sigma_I^2 + \sigma_d^2 (1-\omega)^2) + \sigma_d^2 \sigma_I^2}}{\sqrt{\sigma_I^2 + v_t(1-\omega)^2}} \end{bmatrix}. \tag{A.15}$$

Then following Chapter 13 of Liptser and Shiryaev (1977), the evolution of investors beliefs is given by:

$$x_{t+1} = x_t + v_t \mathscr{A}_1^T (\Sigma^T)^{-1} \bar{\mathbf{z}}_{t+1} \tag{A.16}$$

$$v_{t+1} = v_t - v_t^2 \mathscr{A}_1^T (\Sigma\Sigma^T)^{-1} \mathscr{A}_1. \tag{A.17}$$

Where $\bar{\mathbf{z}}_{t+1}$ is a Gaussian distribution with respected to the investors' filtration $\mathscr{F}_t$. This implies that the dynamics for firm ROE under $\mathscr{F}_t$ are written as:

$$roe_{t+1} = (1-\omega)x_t + \omega roe_t + \sigma_S \bar{\varepsilon}_{S,t+1} + \sqrt{\sigma_I^2 + v_t(1-\omega)^2}\bar{\varepsilon}_{I,t+1} \tag{A.18}$$

$$\begin{aligned} x_{t+1} &= x_t + \frac{v_t}{\sqrt{\sigma_I^2 + v_t(1-\omega)^2}}[(1-\omega)\bar{\varepsilon}_{I,t+1} \\ &\quad + \frac{\sigma_I^2}{\sqrt{v_t(\sigma_I^2 + \sigma_d^2(1-\omega^2)) + \sigma_d^2\sigma_I^2}}\bar{w}_{t+1}]. \end{aligned} \tag{A.19}$$

With

$$v_{t+1} = v_t - v_t^2 \frac{(\sigma_d^2(1-\omega)^2 + \sigma_I^2)}{v_t(\sigma_I^2 + \sigma_d^2(1-\omega^2)) + \sigma_d^2\sigma_I^2} \tag{A.20}$$

$$= \frac{v_t \sigma_d^2 \sigma_I^2}{v_t(\sigma_I^2 + \sigma_d^2(1-\omega)^2) + \sigma_d^2\sigma_I^2} \tag{A.21}$$

$$= \frac{1}{\frac{1}{v_t} + h_I + h_d}. \tag{A.22}$$

Solving this recursively yields

$$v_t = \frac{1}{h_0 + t(h_I + h_d)}, \tag{A.23}$$

where $h_I = (\frac{1-\omega}{\sigma_I})^2$ and $h_d = (\frac{1}{\sigma_d})^2$.

C Derivations of Proposition 2

Again we conjecture that the market-to-book ratio takes a log-linear form:

$$mb_t = \alpha_0 + \alpha_1 x_t + \alpha_2 roe_t - \alpha_3 \sigma_m + f_t. \tag{A.24}$$

Here, the function f_t is a function of the time varying conditional variance about long-run profitability. Given the return decomposition $r_{t+1} = k_1 mb_{t+1} - mb_t + roe_{t+1}$ and since all shocks come from x_t and ROE then the shocks to returns are given by

$$\begin{aligned} r_{t+1} &= E_t[r_{t+1}] + k_1\alpha_1(x_{t+1} - E_t[x_{t+1}]) + (1 + k_1\alpha_2)(roe_{t+1} - E_t[roe_{t+1}]) && \text{(A.25)} \\ &= E_t[r_{t+1}] + \eta_1(x_{t+1} - E_t[x_{t+1}]) + \eta_2(roe_{t+1} - E_t[roe_{t+1}]). && \text{(A.26)} \end{aligned}$$

Taking conditional variances of both sides

$$\begin{aligned} V_t[r_{t+1}] &= \eta_1^2 V_t[x_{t+1}] + \eta_2^2 V_t[roe_{t+1}] + 2\eta_1\eta_2 cov_t(roe_{t+1}, x_{t+1}) && \text{(A.27)} \\ &= \eta_2^2(\sigma_S^2 + \sigma_I^2 + v_t(1-\omega)^2) + \eta_1^2 \frac{v_t^2\sigma_d^2\sigma_I^2}{v_t(\sigma_I^2 + \sigma_d^2(1-\omega)^2) + \sigma_d^2\sigma_I^2} \\ &\quad + 2\eta_1\eta_2 v_t(1-\omega). && \text{(A.28)} \end{aligned}$$

From the proof of Proposition 1, we have the coefficients, $\alpha_1 = \frac{(1-\omega)}{(1-k_1)}\frac{1}{1-\omega k_1}$ and $\alpha_2 = \frac{\omega}{1-\omega k_1}$. So, $\eta_1 = k_1\frac{1-\omega}{1-k_1}\eta_2$, where $\eta_2 = \frac{1}{1-\omega k_1}$, implying that $\eta_1 + (1-\omega)\eta_2 = \eta_1\frac{1}{k_1}$. Simplifying, one obtains

$$V_t[r_{t+1}] = \eta_2^2(\sigma_S^2 + \sigma_I)^2 + \eta_1^2(\frac{v_t}{k_1^2} - v_{t+1}). \tag{A.29}$$

Since the constants α_0 through α_3 are known. Then equations (A.4) and (A.5) imply that the remaining unknown, f_t, must satisfy the following relation to insure no-arbitrage,

$$k_1 f_{t+1} - f_t = -\frac{1}{2}\eta_1^2(\frac{v_t}{k_1^2} - v_{t+1}). \tag{A.30}$$

This equation can be iterated forward and solved

$$f_t = \frac{1}{2}\eta_1^2 \sum_{j=1}^{\infty} k_1^{j-1}(\frac{1}{k_1^2}v_{t+j-1} - v_{t+j}), \quad (A.31)$$

$$= \frac{1}{2}\eta_1^2(\frac{1}{k_1^2}v_t H([1,p(1)],[p(2)],k_1) - \frac{1}{\frac{1}{v_t}+(h_I+h_d)}H([1,p(2)],[p(3)],k_1). \quad (A.32)$$

Where $H([],[],k_1)$ is a hypergeometic function and $p(u) = \frac{1+v_t(h_I+h_d)(u-1)}{v_t(h_I+h_d)}$. Thus the market to book-ratio is given by

$$mb_t = \alpha_0 + \alpha_1 x_t + \alpha_2 roe_t - \alpha_3 \sigma_m + f_t, \quad (A.33)$$

where $f_t = \frac{1}{2}\eta_1^2(v_t H([1,p(1)],[p(2)],k_1) - \frac{1}{\frac{1}{v_t}+(h_I+h_d)}H([1,p(2)],[p(3)],k_1))$ and the $\alpha's$ are given in equations (A.9) through (A.12). Combining these results with (A.4) implies the following properties for stock returns:

$$R_{t+1} - 1 = E_t[R_{t+1}-1] + \frac{1}{1-k_1\omega}(roe_{t+1} - E_t[roe_{t+1}]) + k_1\frac{1-\omega}{(1-k_1)(1-k_1\omega)}(x_t - E_t[x_{t+1}]),$$

$$E_t[R_{t+1}-1] = r_f + \frac{1}{1-k_1\omega}\sigma_S\sigma_m,$$

$$V_t[R_{t+1}-1] = (\frac{1}{1-k_1\omega})^2(\sigma_S^2+\sigma_I^2) + (k_1\frac{1-\omega}{(1-k_1)(1-k_1\omega)})^2(x_t - E_t[x_{t+1}]).$$

D Proof of Proposition 3

To price options, it is convenient to work in a risk-neutral setting. The existence of m_t insures the existence of a risk-neutral measure (see Duffie 2001). From Proposition 2,

$$r_{t+1} = E_t[r_{t+1}] + \theta_1(roe_{t+1} - E_t[roe_{t+1}]) + \theta_2(x_{t+1} - E_t[x_{t+1}]). \quad (A.34)$$

Under the risk-neutral measure induced by the discount factor, returns can be written as,

$$r_{t+1} = r_f - \frac{1}{2}V_t^Q[r_{t+1}] + \theta_1(roe_{t+1} - E_t^Q[roe_{t+1}]) + \theta_2(x_{t+1} - E_t^Q[x_{t+1}]), \quad (A.35)$$

where superscript Q indicates that the operator is being evaluated under the risk-neutral measure. Since a (log) stock return is defined as,

$$r_{t+1} = s_{t+1}k_1 - s_t + (1-k_1)d_{t+1} + K. \tag{A.36}$$

Next period log stock prices are given by[25]

$$s_{t+1} = \frac{1}{k_1}[s_t + r_{t+1} - (1-k_1)d_{t+1} - K]. \tag{A.37}$$

Assuming that $d_{t+1} \approx d_t$ then the risk neutral distribution of log stock prices is normal with mean, $E_t^Q[s_{t+1}] = \frac{1}{k_1}[r_f - \frac{1}{2}V_t^Q[r_{t+1}] + s_t - (1-k_1)d_t - K]$ and variance $V_t^Q[s_{t+1}] = \frac{1}{k_1^2}V_t^Q[r_{t+1}]$. The price of a call option expiring at time $t+1$ with strike price X is given by,

$$C_t = E_t^Q[\exp(-r_f)\max((S_{t+1} - X), 0)]. \tag{A.38}$$

Taking direct expectations:

$$C_t = e^{-r_f}\int_{S_{t+1}>X}^{\infty}(S_{t+1} - X)f(S_{t+1})dS_{t+1} \tag{A.39}$$
$$= F_t e^{-r_f}N(q_1) - Xe^{-r_f}N(q_2). \tag{A.40}$$

Which gives the equation

$$C_t = \exp(-r_f)(F_t N(q_1) - XN(q_2)), \tag{A.41}$$

where

[25]Future stock prices can be derived from the return linearization used in Campbell and Shiller (1988a) and Vuolteenaho (2002), $r_{t+1} = \log(\frac{S_{t+1}+D_{t+1}}{S_t}) \approx s_{t+1}k_1 - s_t + (1-k_1)d_{t+1} + K$.

$$
\begin{aligned}
F_t &= e^{\frac{1}{k_1}[r_f+s_t-(1-k_1)d_t-K]+\frac{1}{2}V_t[r_{t+1}](\frac{1}{k_1^2}-\frac{1}{k_1})}, \\
q_1 &= \frac{\ln(\frac{F_t}{X})+\frac{1}{2}\frac{1}{k_1^2}V_t[r_{t+1}]}{\sqrt{\frac{1}{k_1^2}V_t[r_{t+1}]}}, \\
d_2 &= d_1-\sqrt{\frac{1}{k_1^2}V_t[r_{t+1}]}.
\end{aligned}
$$

D.1 Proof of equation (27)

Using the results of Bakshi and Madan (2000) and Carr and Madan (1998). Any twice differentiable payoff function, $H(S_{t+1})$, written on the underlying equity S_{t+1}, can be replicated (or spanned) with the following equation:

$$
H(S_{t+1}) = H(0)+S_{t+1}H_S(0)+\int_0^\infty H_{SS}(X)(S_{t+1}-X)^+dX.
$$

The price of $H(S_{t+1})$ is then given by,

$$
\begin{aligned}
E_t^Q[\exp(-r_f)H(S_{t+1})] &= E_t^Q[\exp(-r_f)(H(0)-S_{t+1}H_S(0))] && \text{(A.42)} \\
&\quad +\int_0^\infty H_{SS}(X)C_t(X)dX. && \text{(A.43)}
\end{aligned}
$$

Let the price of the claim be P_t, which is given by the expected discounted payoff,

$$
\begin{aligned}
P_t &= E_t[\frac{M_{t+1}}{M_t}H(S_{t+1})], && \text{(A.44)} \\
&= E_t[\frac{M_{t+1}}{M_t}(H(0)+S_{t+1}H_S(0)+\int_0^\infty H_{SS}(X)(S_{t+1}-X)^+dX)], && \text{(A.45)} \\
&= H(0)e^{-r_f}+F_tH_S(0)+\int_0^\infty H_{SS}(X)C_t(X)dX. && \text{(A.46)}
\end{aligned}
$$

It follows immediately from (A.41) that AQ has an affect on every (twice differentiable) claim on the firms equity.

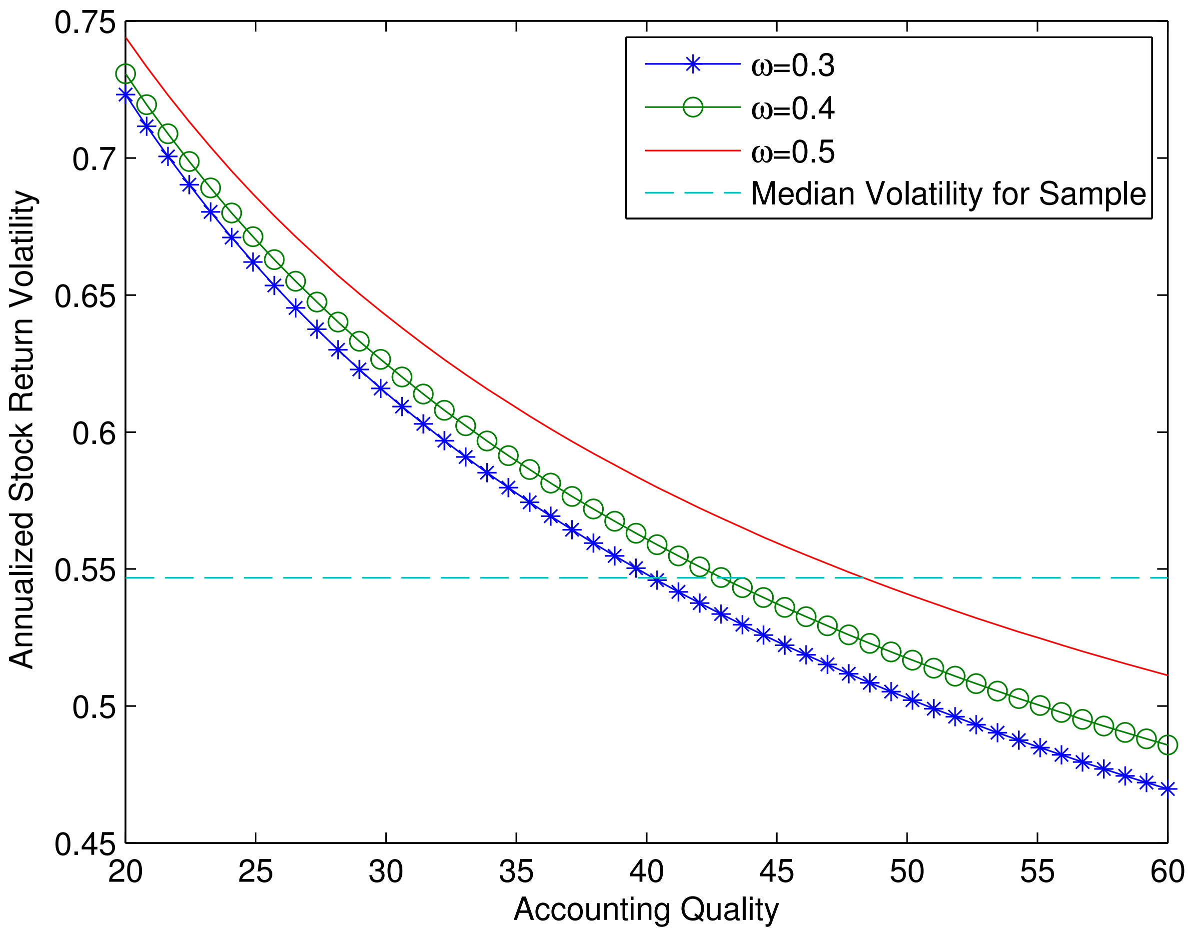

Figure 1: Stock Return Volatility Versus Accounting Quality

The figure plots annualized stock return volatility, measured as the square root of equation (15), against varying levels of accounting quality. The model parameters are: $\sigma_S^2 + \sigma_I^2 = 0.026$, $v_0 = 0.05$, $t = 13$, $k_1 = 0.97$.

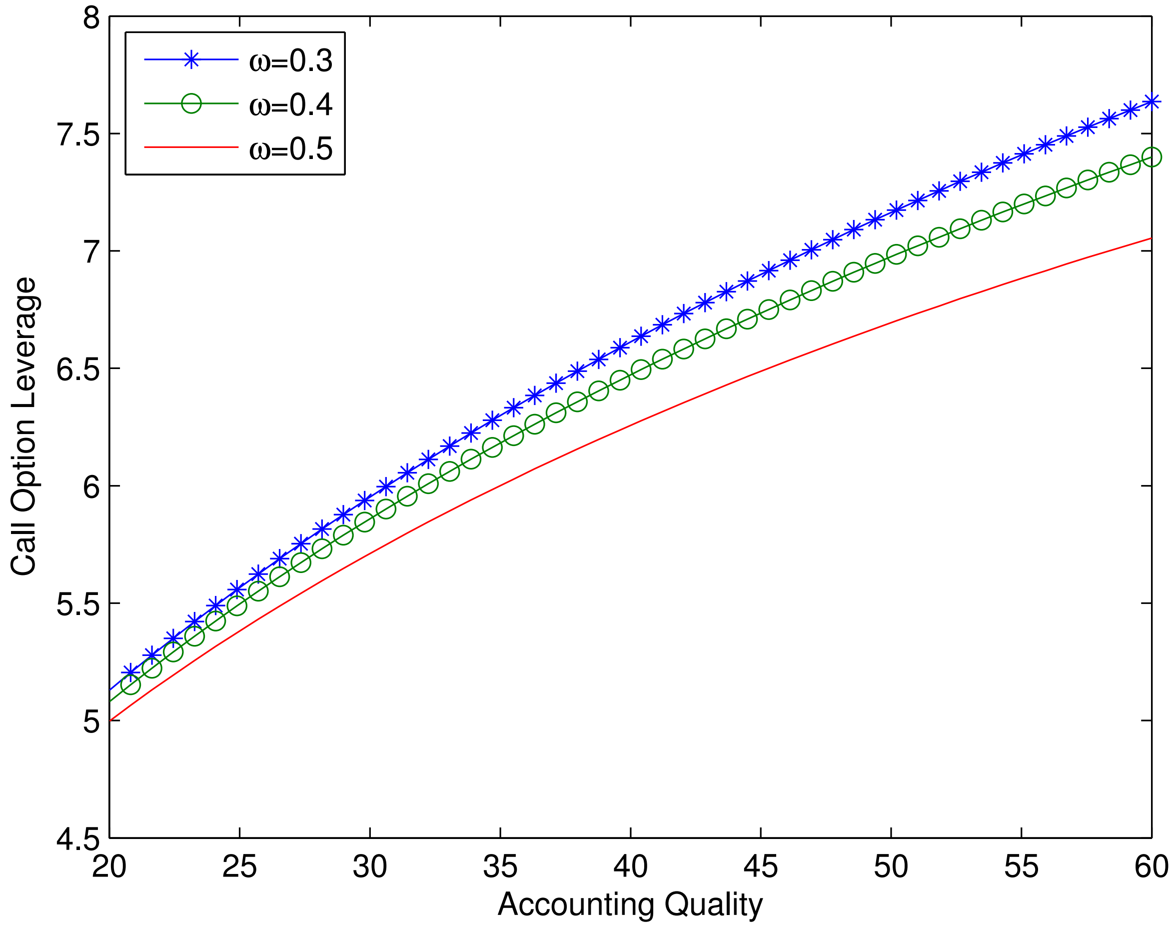

Figure 2: Call Option Leverage Versus Accounting Quality

The figure plots call option leverage according to (25), against varying levels of accounting quality. The options are assumed to be at the money and expire in 50 days. The model parameters are: $\sigma_S^2 + \sigma_I^2 = 0.026$, $v_0 = 0.05$, $t = 13$, $k_1 = 0.97$.

Table 1: Summary Statistics

This table presents summary statistics for variables used in the analysis.

Panels A and B provides summary data on the options used in the analysis. Monthly Call/Put Returns are the returns from buying a call or put at the end of one month and selling it at the end of the following month. Until Expiry Call/Put Return is the return from buying a call/put and holding it until expiry. Implied volatility is the implied volatility estimate provided by OptionMetrics. Option leverage is measured as $\Delta_t \frac{S_t}{O_t}$ where Δ_t is the delta of the option and $\frac{S_t}{O_t}$ is the stock to option ratio. Moneyness is the ratio of strike price to stock price and the OS Ratio is the option's open interest multiplied by 100 divided by stock volume.

Panel C provides sample summary data. DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Analyst following is the number of analysts providing one year ahead earnings forecasts as of three months after the firm's prior fiscal year end. AGE is firm age. Ln(BE/ME) is the book-to-market ratio at the firms fiscal year end calculated using Compustat data. Ln(ME) is the log of market value of equity at the firm's fiscal year end. ROE is the log of one plus income before extraordinary items over the prior years equity book value multiplied by one hundred. AssetLeverage is asset leverage which is calculated as long-term debt over total assets. Stock Return represents the monthly stock returns, Stock Return(t,t-1) is lagged monthly stock return, and Stock Return(t-1,t-12) is lagged one year cumulative return less the lagged one month return.

Panel D provides the time-series mean correlations of variables used in the analysis. The correlations above the diagonal are Pearson correlations, while the correlations below the diagonal are Spearman correlations.

Panel A: Call Option Distribution of Variables (Sample Size = 238, 538 Firm Months)

Variable	Mean	Median	StDev	P25	P75
Monthly Call Return (%)	4.60	-35.64	126.85	-76.84	43.64
Until Expiry Call Return (%)	6.77	-92.59	180.63	-100	62.93
Option Leverage	9.68	8.60	5.06	6.29	11.76
Implied Volatility (%)	47.27	42.2	22.86	31.02	58.5
Moneyness	1.01	1.01	0.06	0.97	1.04
OS Ratio	0.09	0.02	0.22	0.01	0.07

Panel B: Put Option Distribution of Variables (Sample Size = 201, 591 Firm Months)

Variable	Mean	Median	StDev	P25	P75
Monthly Put Return (%)	-8.08	-43.9	108.98	-77.78	24.44
Until Expiry Put Return (%)	-12.72	-100.00	161.11	-100.00	27.03
Option Leverage	-8.70	-7.73	4.79	-10.87	-5.38
Implied Volatility (%)	47.85	42.69	22.94	31.58	58.99
Moneyness	0.99	0.99	0.06	0.96	1.03
OS Ratio	0.05	0.01	0.13	0.00	0.05

Panel C: Firm Characteristic Summary Statistics

Variable					
	Mean	Median	StDev	P25	P75
DD(%)	4.65	3.62	3.66	2.20	5.88
AV(%)	8.32	6.00	7.93	3.70	9.81
Smooth	0.70	0.87	0.40	0.60	0.96
ValRel(%)	29.01	20.02	28.56	10.04	37.67
Following	10.97	9.00	7.38	5.00	15.00
AGE	20.70	14.00	16.28	8.00	33.00
Ln(BE/ME)	-0.99	-0.92	0.76	-1.44	-0.46
Ln(ME)	7.49	7.34	1.55	6.36	8.49
ROE	9.99	13.34	32.53	4.61	20.98
AssetLeverage	16.55	12.57	16.52	0.67	27.7
Stock Return (%)	1.07	0.82	14.63	-6.08	7.71
Stock Return(t,t-1) (%)	1.84	1.20	14.63	-5.90	8.58
Stock Return(t-1,t-12) (%)	22.31	9.50	84.10	-15.73	38.7

Panel D: Firm Characteristic Correlation Table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) DD		0.61	0.10	0.20	-0.37	0.35	0.01	0.01	0.22	0.31	0.05	0.00	-0.04	0.25
(2) AV	0.60		-0.26	0.21	-0.37	0.35	0.01	0.01	0.16	0.29	0.05	0.00	-0.04	0.20
(3) Smooth	0.11	-0.22		0.10	-0.26	0.21	0.01	0.00	0.10	0.16	0.15	-0.01	-0.02	0.10
(4) ValRel	0.20	0.21	0.11		-0.37	0.31	0.01	0.01	0.09	0.28	0.12	-0.02	-0.05	0.07
(5) Implied Volatility	-0.39	-0.39	-0.28	-0.38		-0.77	-0.05	-0.02	-0.15	-0.54	-0.26	-0.07	0.04	-0.16
(6) Option Leverage	0.36	0.36	0.25	0.35	-0.93		0.05	0.02	0.13	0.45	0.17	0.03	-0.03	0.14
(7) Option Return	0.03	0.03	0.02	0.02	-0.06	0.04		0.78	0.02	-0.01	0.01	-0.01	0.00	0.01
(8) Stock Return	0.02	0.02	0.01	0.02	-0.03	0.05	0.92		0.03	-0.01	0.00	-0.01	0.01	0.00
(9) Ln(BE/ME)	0.20	0.14	0.10	0.09	-0.14	0.14	0.04	0.02		-0.12	-0.11	0.03	-0.07	0.17
(10) Ln(ME)	0.33	0.30	0.19	0.29	-0.59	0.53	0.00	0.01	-0.11		0.23	-0.05	-0.11	0.10
(11) ROE	0.03	0.02	0.14	0.11	-0.24	0.22	0.00	0.01	-0.34	0.29		-0.03	-0.02	-0.03
(12) Stock Return(t,t-1)	0.00	0.01	0.00	0.00	-0.08	0.05	-0.01	-0.02	0.03	-0.03	-0.01		-0.01	0.00
(13) Stock Return(t-1,t-12)	0.01	0.02	0.02	0.02	-0.09	0.08	0.01	0.02	-0.05	-0.02	0.04	-0.01		-0.02
(14) Asset Leverage	0.27	0.24	0.12	0.12	-0.25	0.23	0.02	0.01	0.25	0.20	-0.03	0.00	0.00	

Table 2: Implied Volatility Sorted on Accounting Quality Proxies

This table presents monthly implied volatilities estimated from traded option contracts sorted on accounting quality (AQ) proxies. DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Fama-MacBeth corrected t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Call Implied Volatility

	DD	AV	Smooth	ValRel
1 (Low AQ)	60.88	58.18	56.74	63.46
2	54.85	53.81	52.16	54.54
3	52.13	51.50	49.74	50.39
4	49.11	49.20	47.45	47.55
5	47.50	47.78	45.87	45.42
6	44.71	45.34	44.87	44.40
7	44.13	43.17	43.29	42.73
8	42.34	41.14	42.03	41.51
9	39.84	39.35	41.36	40.56
10 (Hi AQ)	36.69	34.47	40.45	37.36
1-10 (Hi-Low)	**-24.19*****	**-23.71*****	**-16.29*****	**-26.10*****
T-stat	**(-41.40)**	**(-32.01)**	**(-50.73)**	**(-42.78)**

Panel B: Put Implied Volatility

	DD	AV	Smooth	ValRel
1 (Low AQ)	61.83	59.29	57.29	64.88
2	55.58	54.48	52.67	55.61
3	52.89	52.41	50.44	51.12
4	49.93	49.94	48.20	48.30
5	47.88	48.70	46.72	46.32
6	45.30	45.88	45.67	45.10
7	44.90	43.75	44.17	43.31
8	42.96	41.76	42.79	42.48
9	40.72	39.84	42.22	41.36
10 (Hi AQ)	37.74	35.52	41.42	38.20
1-10 (Hi-Low)	**-24.09*****	**-23.77*****	**-15.87*****	**-26.69*****
T-stat	**(-41.93)**	**(-32.39)**	**(-48.72)**	**(-43.48)**

Table 3: Option Leverage

This Table presents monthly implied option leverage estimates from traded option contracts sorted on accounting quality (AQ) proxies. Option leverage, λ_t, is measured as $\Delta_t \frac{S_t}{O_t}$ where Δ_t is the delta of the option and $\frac{S_t}{O_t}$ is the stock to option price ratio. DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Fama-MacBeth corrected t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Call Leverage

	DD	AV	Smooth	ValRel
1 (Low AQ)	7.16	7.65	7.79	6.83
2	7.95	8.12	8.48	8.06
3	8.43	8.46	8.90	8.79
4	8.83	8.88	9.37	9.33
5	9.21	9.16	9.67	9.84
6	9.79	9.68	9.80	10.12
7	9.93	10.07	10.31	10.46
8	10.41	10.62	10.58	10.76
9	11.09	11.11	10.80	10.93
10 (Hi AQ)	12.54	12.87	10.91	11.85
1-10 (Hi-Low)	**5.38*****	**5.22*****	**3.12*****	**5.02*****
T-stat	**(46.46)**	**(42.44)**	**(35.38)**	**(42.46)**

Panel B: Put Leverage

	DD	AV	Smooth	ValRel
1 (Low AQ)	-6.20	-6.64	-6.80	-5.82
2	-6.95	-7.13	-7.54	-7.04
3	-7.49	-7.46	-7.92	-7.86
4	-7.82	-7.88	-8.37	-8.35
5	-8.30	-8.20	-8.69	-8.77
6	-8.86	-8.73	-8.81	-9.07
7	-8.99	-9.13	-9.26	-9.44
8	-9.35	-9.65	-9.52	-9.67
9	-10.05	-10.12	-9.70	-9.83
10 (Hi AQ)	-11.17	-11.47	-9.81	-10.71
1-10 (Hi-Low)	**-4.97*****	**-4.84*****	**-3.01*****	**-4.89*****
T-stat	**(-42.51)**	**(-41.03)**	**(-33.47)**	**(-39.28)**

Table 4: Implied Volatility Regressions

This table presents the results of regressing implied (annualized) stock return volatility on accounting quality (AQ). DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Ln(BE/ME) is the book-to-market ratio at the firms fiscal year end calculated using Compustat. Ln(ME) is the log of market value of equity at the firm's fiscal year end. ROE is the log of one plus income before extraordinary items over the prior years equity book value multiplied by one hundred. AssetLeverage is asset leverage which is calculated as long-term debt over total assets. Stock Return(t,t-1) is lagged monthly stock return, and Stock Return(t-1,t-12) is lagged one year cumulative return less the lagged one month return. VolatilityControl represents historical volatility less the AQ measure. Moneyness is the ratio of strike price to stock price and the OS Ratio is the option's open interest multiplied by 100 divided by the stock volume. t-statistics are based on Fama-MacBeth standard errors with a Newey-West correction. t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Implied Call Option Volatility

Dep. Var:	Call Implied Volatility			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**-2.70*****	**-1.41*****	**-1.66*****	**-2.50*****
	(-17.1)	**(-12.2)**	**(-23.8)**	**(-17.2)**
Ln(BE/ME)	-2.40***	-2.44***	-2.55***	-2.60***
	(-10.7)	(-12.6)	(-12.0)	(-10.4)
Ln(ME)	-3.28***	-3.22***	-3.36***	-3.25***
	(-20.9)	(-23.6)	(-21.0)	(-17.8)
ROE	-0.081***	-0.081***	-0.076***	-0.083***
	(-23.1)	(-24.3)	(-23.2)	(-21.2)
AssetLeverage	-0.031***	-0.031***	-0.036***	-0.033***
	(-6.60)	(-6.20)	(-7.53)	(-6.96)
Stock Return(t,t-1)	-0.16***	-0.16***	-0.16***	-0.17***
	(-17.8)	(-17.6)	(-17.7)	(-18.8)
Stock Return(t-1,t-12)	-0.01**	-0.010**	-0.010**	-0.011***
	(-2.19)	(-2.34)	(-2.24)	(-2.86)
VolatilityControl	10.1***	9.86***	10.0***	10.3***
	(17.0)	(17.4)	(16.7)	(18.0)
Moneyness	-12.4***	-12.7***	-12.8***	-12.7***
	(-9.99)	(-9.79)	(-10.0)	(-10.1)
OS Ratio	4.04***	4.16***	4.24***	3.75***
	(7.07)	(7.15)	(7.33)	(7.22)
N	185,389	174,427	174,427	225,936
Adj-R^2	66.6%	66.9%	66.7%	67.8%

Panel B: Implied Put Option Volatility

Dep. Var:	Put Implied Volatility			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**-2.65*** **	**-1.40*** **	**-1.62*** **	**-2.49*** **
	(-16.0)	**(-12.1)**	**(-22.2)**	**(-17.6)**
Ln(BE/ME)	-2.48***	-2.50***	-2.62***	-2.64***
	(-11.4)	(-13.0)	(-12.4)	(-10.3)
Ln(ME)	-3.24***	-3.18***	-3.33***	-3.18***
	(-20.9)	(-23.2)	(-20.8)	(-17.6)
ROE	-8.28***	-8.34***	-7.76***	-8.31***
	(-21.1)	(-22.4)	(-21.7)	(-19.8)
AssetLeverage	-0.021***	-0.021***	-0.027***	-0.023***
	(-4.49)	(-4.09)	(-5.55)	(-5.61)
Stock Return(t,t-1)	-12.1***	-11.7***	-11.8***	-13.1***
	(-13.0)	(-12.8)	(-12.9)	(-14.1)
Stock Return(t-1,t-12)	-0.58	-0.77*	-0.71	-0.89**
	(-1.46)	(-1.75)	(-1.63)	(-2.35)
VolatilityControl	10.0***	9.83***	9.99***	10.4***
	(15.8)	(16.1)	(15.5)	(16.6)
Moneyness	-14.5***	-14.9***	-14.8***	-14.8***
	(-9.38)	(-9.67)	(-9.64)	(-9.45)
OS Ratio	8.50***	8.83***	9.17***	8.50***
	(12.8)	(13.2)	(13.7)	(12.0)
N	157,830	149,026	149,026	191,441
Adj-R^2	66.8%	67.0%	66.8%	68.1%

Table 5: Option Leverage Regressions

This table presents the results of regressing option leverage on accounting quality (AQ). Option leverage, λ_t, is measured as $\Delta_t \frac{S_t}{O_t}$ where Δ_t is the delta of the option and $\frac{S_t}{O_t}$ is the stock to option ration.DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Ln(BE/ME) is the book-to-market ratio at the firms fiscal year end calculated using Compustat. Ln(ME) is the log of market value of equity at the firm's fiscal year end. ROE is the log of one plus income before extraordinary items over the prior years equity book value multiplied by one hundred. AssetLeverage is asset leverage which is calculated as long-term debt over total assets. Stock Return(t,t-1) is lagged monthly stock return, and Stock Return(t-1,t-12) is lagged one year cumulative return less the lagged one month return. VolatilityControl represents historical volatility less the AQ measure. Moneyness is the ratio of strike price to stock price and the OS Ratio is the option's open interest multiplied by 100 divided by the stock volume. t-statistics are based on Fama-MacBeth corrected standard errors. t-statistics are based on Fama-MacBeth standard errors with a Newey-West correction. t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Call Option Leverage

Dep. Var:	Call Option Leverage			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**0.70*****	**0.35*****	**0.40*****	**0.55*****
	(21.2)	**(19.0)**	**(12.3)**	**(20.6)**
Ln(BE/ME)	0.39***	0.43***	0.48***	0.49***
	(9.45)	(10.6)	(11.5)	(11.1)
Ln(ME)	0.70***	0.71***	0.76***	0.72***
	(14.6)	(13.8)	(15.2)	(14.5)
ROE	0.0078***	0.0081***	0.0066***	0.0065***
	(9.41)	(10.6)	(9.94)	(9.26)
AssetLeverage	0.0092***	0.011***	0.013***	0.0074***
	(9.70)	(10.3)	(13.1)	(8.65)
Stock Return(t,t-1)	0.031***	0.031***	0.031***	0.031***
	(12.3)	(12.5)	(13.1)	(12.2)
Stock Return(t-1,t-12)	0.0022***	0.0024***	0.0023***	0.0025***
	(4.19)	(4.14)	(4.05)	(4.62)
VolatilityControl	-2.24***	-2.27***	-2.32***	-2.31***
	(-31.7)	(-29.5)	(-33.4)	(-28.1)
Moneyness	26.0***	26.9***	26.9***	26.7***
	(15.2)	(15.9)	(16.0)	(14.4)
OS Ratio	-0.22*	-0.23*	-0.27**	-0.33***
	(-1.72)	(-1.66)	(-1.97)	(-2.71)
N	185,389	174,427	174,427	225,936
Adj-R^2	59.1%	59.3%	58.7%	58.7%

Panel B: Put Option Leverage

Dep. Var:	Put Option Leverage			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**-0.64*** **	**-0.32*** **	**-0.37*** **	**-0.52*** **
	(-20.4)	**(-19.2)**	**(-12.3)**	**(-19.6)**
Ln(BE/ME)	-0.33***	-0.35***	-0.39***	-0.41***
	(-7.17)	(-7.70)	(-8.39)	(-8.15)
Ln(ME)	-0.67***	-0.67***	-0.72***	-0.68***
	(-12.5)	(-11.9)	(-12.7)	(-12.2)
ROE	-0.75***	-0.79***	-0.65***	-0.63***
	(-8.94)	(-9.88)	(-9.15)	(-8.70)
AssetLeverage	-0.0076***	-0.0087***	-0.010***	-0.0057***
	(-8.99)	(-9.55)	(-11.9)	(-9.23)
Stock Return(t,t-1)	-2.60***	-2.63***	-2.64***	-2.63***
	(-9.76)	(-9.83)	(-10.0)	(-9.46)
Stock Return(t-1,t-12)	-0.15***	-0.17***	-0.16***	-0.19***
	(-3.03)	(-3.14)	(-2.96)	(-3.76)
VolatilityControl	2.17***	2.19***	2.23***	2.23***
	(30.5)	(29.1)	(33.0)	(28.3)
Moneyness	20.1***	20.7***	20.7***	20.5***
	(14.6)	(14.8)	(14.9)	(14.1)
OS Ratio	1.10***	1.11***	1.19***	1.20***
	(9.10)	(9.01)	(10.3)	(9.32)
N	157,830	149,026	149,026	191,441
Adj-R^2	60.8%	60.9%	60.3%	61.1%

Table 6: Option Return Regressions

This table presents the results of monthly option returns regressed on accounting quality (AQ). DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Ln(BE/ME) is the book-to-market ratio at the firms fiscal year end calculated using Compustat. Ln(ME) is the log of market value of equity at the firm's fiscal year end. ROE is the log of one plus income before extraordinary items over the prior years equity book value multiplied by one hundred. AssetLeverage is asset leverage which is calculated as long-term debt over total assets. Stock Return(t,t-1) is lagged monthly stock return, and Stock Return(t-1,t-12) is lagged one year cumulative return less the lagged one month return. VolatilityControl represents historical volatility less the AQ measure. Moneyness is the ratio of strike price to stock price and the OS Ratio is the option's open interest multiplied by 100 divided by the stock volume. t-statistics are based on Fama-MacBeth standard errors with a Newey-West correction. t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Call Option Returns

Dep. Var:	Call Option Returns			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**1.09*** **	**0.59*** **	**0.58** **	**0.99*** **
	(3.35)	**(3.32)**	**(2.13)**	**(3.87)**
Ln(BE/ME)	2.75***	2.69***	2.75***	2.18**
	(2.80)	(2.74)	(2.77)	(2.14)
Ln(ME)	-1.98***	-2.02***	-1.95***	-2.16***
	(-3.40)	(-3.52)	(-3.37)	(-3.87)
ROE	0.028*	0.032**	0.032**	0.025
	(1.81)	(2.04)	(2.10)	(1.50)
AssetLeverage	-0.012	-0.0096	-0.0080	-0.021
	(-0.35)	(-0.27)	(-0.22)	(-0.64)
Stock Return(t,t-1)	-0.12**	-0.11*	-0.11*	-0.12**
	(-2.12)	(-1.87)	(-1.91)	(-2.18)
Stock Return(t-1,t-12)	-0.0089	-0.021	-0.021	-0.0077
	(-0.45)	(-0.98)	(-0.98)	(-0.40)
VolatilityControl	-4.73***	-4.81***	-4.86***	-4.94***
	(-5.32)	(-5.33)	(-5.36)	(-5.54)
Moneyness	100***	102***	102***	97.7***
	(6.79)	(6.78)	(6.81)	(6.85)
OS Ratio	-12.5***	-11.7***	-11.5***	-12.8***
	(-4.48)	(-4.10)	(-4.07)	(-4.99)
N	185,389	174,427	174,427	225,936
Adj-R^2	4.70%	4.80%	4.80%	5.00%

Panel B: Put Returns

Dep. Var:	Put Option Returns			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**-0.73****	**-0.52*****	**0.07**	**-0.52****
	(-2.29)	**(-2.67)**	**(0.28)**	**(-2.30)**
Ln(BE/ME)	-0.16	0.059	-0.35	-0.60
	(-0.20)	(0.070)	(-0.42)	(-0.70)
Ln(ME)	-1.20**	-1.03**	-1.30***	-1.22**
	(-2.44)	(-2.11)	(-2.64)	(-2.53)
ROE	1.03	0.95	1.08	1.36
	(0.77)	(0.71)	(0.81)	(1.00)
AssetLeverage	0.048*	0.045	0.035	0.058**
	(1.78)	(1.65)	(1.24)	(2.16)
Stock Return(t,t-1)	4.25	4.88	5.10	3.51
	(0.92)	(1.05)	(1.10)	(0.72)
Stock Return(t-1,t-12)	-1.24	-0.80	-0.86	-1.54
	(-0.95)	(-0.57)	(-0.61)	(-1.17)
VolatilityControl	-0.19	-0.26	0.081	0.41
	(-0.25)	(-0.33)	(0.099)	(0.54)
Moneyness	-32.5**	-28.3*	-28.0*	-29.5**
	(-2.10)	(-1.80)	(-1.78)	(-2.04)
OS Ratio	0.44	0.18	0.57	0.15
	(0.13)	(0.052)	(0.17)	(0.049)
N	157,830	149,026	149,026	191,441
Adj-R^2	4.60%	4.70%	4.70%	4.80%

Panel C: Stock Returns

Dep. Var:	Stock Returns			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**0.087**	**0.050**	**0.002**	**0.055**
	(1.58)	**(1.61)**	**(0.049)**	**(1.29)**
Ln(BE/ME)	0.17	0.15	0.17	0.15
	(1.33)	(1.17)	(1.40)	(1.08)
Ln(ME)	-0.21***	-0.21***	-0.19**	-0.21***
	(-2.78)	(-2.89)	(-2.54)	(-2.90)
ROE	0.0015	0.0016	0.0018	0.00079
	(0.55)	(0.62)	(0.70)	(0.26)
AssetLeverage	-0.0081*	-0.0071*	-0.0065	-0.0085**
	(-1.96)	(-1.74)	(-1.58)	(-2.18)
Stock Return(t,t-1)	-0.022***	-0.021***	-0.021***	-0.019**
	(-2.83)	(-2.63)	(-2.68)	(-2.51)
Stock Return(t-1,t-12)	-0.0014	-0.0028	-0.0027	-0.00095
	(-0.50)	(-0.98)	(-0.97)	(-0.35)
VolatilityControl	-0.17	-0.16	-0.19	-0.22
	(-1.05)	(-0.98)	(-1.11)	(-1.35)
N	185,389	174,427	174,427	225,936
Adj-R^2	7.90%	8.10%	8.10%	8.30%

Table 7: Hold Until Expiry Option Return Regressions

This table presents the results of hold until expiry option returns regressed on accounting quality (AQ). DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Ln(BE/ME) is the book-to-market ratio at the firms fiscal year end calculated using Compustat. Ln(ME) is the log of market value of equity at the firm's fiscal year end. ROE is the log of one plus income before extraordinary items over the prior years equity book value multiplied by one hundred. AssetLeverage is asset leverage which is calculated as long-term debt over total assets. Stock Return(t,t-1) is lagged monthly stock return, and Stock Return(t-1,t-12) is lagged one year cumulative return less the lagged one month return. VolatilityControl represents historical volatility less the AQ measure. Moneyness is the ratio of strike price to stock price and the OS Ratio is the option's open interest multiplied by 100 divided by the stock volume. t-statistics are based on Fama-MacBeth standard errors with a Newey-West correction. t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Call Option Returns

Dep. Var:	Call Option Returns			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**1.15****	**0.50***	**0.56**	**0.68***
	(2.30)	**(1.89)**	**(1.33)**	**(1.73)**
Ln(BE/ME)	4.80***	4.60***	4.59***	3.73**
	(3.09)	(3.03)	(3.01)	(2.21)
Ln(ME)	-0.78	-0.78	-0.80	-0.90
	(-0.79)	(-0.80)	(-0.80)	(-0.95)
ROE	0.025	0.027	0.029	0.025
	(0.93)	(1.05)	(1.16)	(0.80)
AssetLeverage	-0.033	-0.024	-0.025	-0.033
	(-0.56)	(-0.40)	(-0.42)	(-0.60)
Stock Return(t,t-1)	-0.20**	-0.19*	-0.19*	-0.20**
	(-2.11)	(-1.88)	(-1.93)	(-2.14)
Stock Return(t-1,t-12)	-0.0041	-0.025	-0.025	-0.0054
	(-0.12)	(-0.69)	(-0.68)	(-0.16)
VolatilityControl	-5.47***	-5.74***	-5.73***	-5.69***
	(-4.20)	(-4.37)	(-4.30)	(-4.43)
Moneyness	79.5***	79.9***	79.6***	76.5***
	(3.34)	(3.29)	(3.30)	(3.23)
OS Ratio	-16.6***	-15.7***	-15.4***	-15.1***
	(-4.28)	(-4.00)	(-3.92)	(-4.08)
N	185,389	174,427	174,427	225,936
Adj-R^2	4.20%	4.20%	4.30%	4.40%

Panel B: Put Returns

Dep. Var:	Put Option Returns			
	Accounting Quality Measures			
	DD	AV	Smooth	ValRel
AQ	**-2.06*** **	**-1.03*** **	**-0.30**	**-1.02*** **
	(-4.39)	**(-3.64)**	**(-0.82)**	**(-3.00)**
Ln(BE/ME)	-0.11	-0.098	-0.73	-1.28
	(-0.079)	(-0.072)	(-0.54)	(-0.91)
Ln(ME)	-1.27*	-1.22	-1.65**	-1.34*
	(-1.68)	(-1.63)	(-2.16)	(-1.79)
ROE	1.42	0.52	0.94	2.49
	(0.63)	(0.23)	(0.42)	(1.08)
AssetLeverage	0.12**	0.11**	0.095**	0.13***
	(2.56)	(2.38)	(2.00)	(2.90)
Stock Return(t,t-1)	5.82	6.19	6.72	3.72
	(0.88)	(0.93)	(1.02)	(0.58)
Stock Return(t-1,t-12)	0.083	0.60	0.59	-0.56
	(0.042)	(0.29)	(0.29)	(-0.28)
VolatilityControl	1.09	0.82	1.43	1.90
	(0.91)	(0.69)	(1.18)	(1.54)
Moneyness	2.34	6.74	7.12	4.92
	(0.074)	(0.22)	(0.23)	(0.16)
OS Ratio	-4.29	-5.48	-4.45	-5.54
	(-0.97)	(-1.24)	(-1.00)	(-1.33)
N	157,830	149,026	149,026	191,441
Adj-R^2	4.30%	4.40%	4.30%	4.40%

Table 8: Option Return Portfolios

This table presents monthly portfolio option returns sorted on accounting quality (AQ) proxies. DD represents accrual quality estimated using the Dechow Dichev model as in Francis et al. (2005). AV represents accrual quality measured using the rolling five year standard deviation of discretionary accruals calculated using the modified Jones model. Smooth is measured as the five year rolling correlation between discretionary accruals and per-managed income multiplied by negative one following Tucker and Zarowin (2006). ValRel is the rolling thirty six month standard deviation of the residual from regressing stock returns contemporaneous ROE shocks. Fama MacBeth-corrected t-statistics are in parentheses and significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Panel A: Call Option Returns

	DD	AV	Smooth	ValRel
1 (Low AQ)	2.48	2.79	2.28	1.14
2	3.28	2.06	4.76	4.01
3	4.78	5.82	6.71	4.43
4	6.69	3.50	5.95	4.91
5	3.96	7.60	4.25	5.96
6	5.39	6.89	5.52	3.57
7	6.01	5.28	5.47	6.27
8	4.73	4.78	4.57	7.83
9	6.13	5.91	6.04	4.75
10 (Hi AQ)	7.37	7.39	6.47	5.83
1-10 (Hi-Low)	**4.89***	**4.61***	**4.19***	**4.69***
T-stat	**(1.79)**	**(1.66)**	**(1.95)**	**(1.90)**

Panel B: Put Option Returns

	DD	AV	Smooth	ValRel
1 (Low AQ)	-5.67	-5.11	-8.70	-5.92
2	-5.76	-7.07	-8.08	-6.20
3	-6.77	-6.83	-8.79	-8.13
4	-8.44	-9.04	-9.58	-9.37
5	-8.32	-9.46	-9.56	-9.79
6	-10.23	-9.29	-9.09	-10.38
7	-10.66	-10.65	-9.49	-10.22
8	-10.28	-11.62	-9.39	-9.18
9	-12.22	-10.87	-9.91	-10.55
10 (Hi AQ)	-10.71	-12.45	-9.78	-12.08
1-10 (Hi-Low)	**-5.04****	**-7.34*****	**-1.08**	**-6.16*****
T-stat	**(-2.18)**	**(-2.90)**	**(-0.65)**	**(-2.83)**

Panel C: Stock Returns

	DD	AV	Smooth	ValRel
1 (Low AQ)	0.99	0.93	1.15	0.95
2	1.03	1.04	1.20	1.20
3	1.29	1.34	1.34	1.19
4	1.41	1.17	1.34	1.36
5	1.10	1.45	1.13	1.27
6	1.31	1.30	1.33	1.06
7	1.37	1.32	1.29	1.18
8	1.15	1.20	1.10	1.32
9	1.30	1.22	1.17	1.15
10 (Hi AQ)	1.20	1.28	1.19	1.25
1-10 (Hi-Low)	**0.20**	**0.35**	**0.05**	**0.30**
T-stat	**(0.44)**	**(0.71)**	**(0.14)**	**(0.65)**