Accruals and the cross-section of expected stock and option returns

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Abstract

Interpreting accruals as investment, we use a basic model of optimal investment to study how accruals are related to the expected returns for holding equity and the expected returns to holding equity return volatility. In our setting, firms optimally invest to maximize shareholder value, which, intuitively, leads to firms investing more when discount rates are low. This allows us to make two predictions: 1) there is a negative relation between accruals and expected stock returns (equity risk premia) because firms invest when discount rates are low; and 2) there is a positive relation between accruals and the expected returns to trading in stock return variance embedded in option contracts (variance risk premia) because low discount rates imply low exposure to variance risk premia (which is negative), thus raising the returns to traded variance embedded in traded options for high accrual firms. These predictions are borne out in empirical tests and the results hold in a variety of empirical specifications. Collectively, these findings suggest that the documented negative relation between accruals and future stock returns may be far less anomalous than previously thought.

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1. Introduction

Extant research provides considerable evidence that accruals and investment negatively forecast stock returns. However, there is debate as to whether this empirical regularity reflects rational asset pricing or not. One stream of research argues that investors systematically misprice accruals and investment (e.g., Sloan, 1996; Xie, 2001; Barth and Hutton, 2004; Stambaugh and Yuan, 2017) due to errors in expectations about future profitability. In contrast, another stream of research argues that accruals reflect investment decisions and that the predictive power of accruals and investment for future stock returns reflect diminishing returns to investment (e.g., Dechow et al., 2008; Fairfield et al., 2003; Wu et al., 2010). This schism in the literature shows little sign of abating. Most recently, Stambaugh and Yuan (2017) examine the commonality across numerous anomalies and construct "mispricing factors" which feature accruals and investment as mispriced firm characteristics. On the other hand, Fama and French (2016) propose a five-factor expected return model which includes an investment factor and show that for most anomalies the new model dramatically shrinks the average returns left unexplained by the FF three-factor model. In short, extant work on the role of accruals and investment in asset pricing has yielded little fruit in disentangling between efficient and inefficient markets.

This paper advances the literature along two key dimensions. First, we show analytically that in a traditional asset pricing setting with rational expectations, accruals forecast returns to volatility-based trading strategies. Second, to test the predictions of our model we exploit a new market of traded assets, i.e. the equity options market, on which approximately $330 billion worth of equity options representing $9.6 trillion worth of underlying notional equity was traded in 2013 alone. Using data from this new market, we are able to extract investors' expectations of future volatility and find results consistent with our model. Overall, our findings provide new evidence on the relation between accruals and future asset prices, and suggest that the negative relation between accruals and future stock returns documented in prior literature may be far less anomalous than previously thought.

Following Wu et al. (2010), we interpret accruals as investment and extend their setting to a case where the distribution of payoffs to investment can fluctuate randomly through time. Using this stylized setting, we solve for equity values and expected stock returns within a complete and rationally functioning market that operates in partial equilibrium. In our model, a firm invests in order to maximize shareholder value and, as in Wu et al. (2010), this intuitively leads to firms investing less when discount rates are high. Because high discount rates imply high expected stock returns, investment is negatively related to expected stock returns. The key innovation that we provide is to show how investment is predicted to relate to the expected returns of other assets, and in particular, the relation between investment and the expected returns to trading in equity variance (variance risk premiums) in option contracts. Variance risk premiums represent the premium for holding an asset with a payoff equal to future realized variance. Thus the expected gross return on a variance contract is the expected future stock return variance divided by the price of the variance contract (roughly option implied variance). We show that low discount rates imply higher returns to trading in equity variance.

The intuition for this result is straight forward. Discount rates are determined by exposure to (systematic) risk, and risk in our model is proportional to variance. Higher discount rates mean higher exposure to variance which leads to higher exposure to variance risk. Because the premium for holding variance is negative (as documented by Carr and Wu, 2009 and many others), higher accruals investment implies lower exposure to variance risk and higher variance risk premiums. We use this result to offer new analytically driven evidence on the large body of research that has tried to explain the relation between accruals and asset returns.

While our analytical setting is able to provide closed form solutions for expected stock returns and expected returns on trading stock return variance, we additionally investigate how accruals relate more broadly to "option returns." In our empirical tests, we use the returns of three option-based "volatility" strategies that are designed to pay off if stock return volatility increases. Specifically, we use realized returns for both delta-hedged and strangle positions as well as realized returns on variance contracts as our proxies for expected returns to trading variance. Following Dechow et al. (2008); Arif and Lee (2014) we measure accruals using the change in net operating assets and also measure overall investment using total asset growth (e.g., Hou et al., 2014; Fama and French, 2016). Consistent with the model, we find that accruals positively forecast the returns of each of these option-based strategies and yield hedged monthly returns that range from 5 to 10 percent per month depending on the strategy. Our conclusions are unaffected by including a large set of additional controls such as book-to-market, profitability, past stock returns, and past idiosyncratic volatility.[1]

This paper makes several contributions to the literature. First, despite two decades of research studying the relation between accruals and future returns, there is a lack of consensus as to whether this relation reflects rational asset pricing or not. In light of the extant literature's failure to make headway by focusing almost exclusively on average future stock returns, we adopt a distinctly different approach. From a theoretical standpoint, we build a tractable model of optimal investment which predicts not only that investment is negatively associated with expected stock returns, but also makes the new prediction that investment positively forecasts expected returns to traded variance embedded in options. Using information from this new market, we are able to extract investors' expectations of future volatility and empirically test whether investment forecasts the difference between realized volatility and expected volatility using a variety of option-based trading strategies. To our knowledge, we are the first to introduce variance risk into investment-based asset pricing. Moreover, our results are consistent with rational markets in which investment plays an important role in the premium that investors

[1]Since prior research has focused extensively on the relation between accruals and future stock returns, our focus is on the returns to trading stock return variance. However to ensure that prior results also hold within our sample, we examine accruals and future stock returns. We find that accruals negatively forecast future three-month stock returns over the same period that we have sufficient data to estimate variance risk premia, 1996-2013, with a t-statistic of -2.52. This result is consistent with the first prediction of the model we provide and with prior research.

earn for bearing the risk associated with firms' investment decisions. Thus, the negative relation between accruals and future stock returns documented in prior literature may be far less anomalous than previously thought.

We also contribute to the literature studying variance risk premia and the factors associated with option returns. Carr and Wu (2009) document large cross-sectional variation in variance risk premia but do not formally identify potential factors that drive this cross-sectional variation. Thus, relatively little is known about the cross-sectional determinants of variance risk premia and in particular the role played by firm fundamentals in determining variance risk. We take a first step towards modeling the relation between accruals and expected returns on volatility trading strategies and find robust empirical evidence consistent with the prediction of our analytical model. Collectively, our results suggest that investment play an important role in variance risk premia.

This paper proceeds as follows. Section 2 describes our theoretical model, and Section 3 presents the key predictions of our model. Section 4 describes our data and empirical results. Section 5 concludes.

2. Model and Predictions

In this section we provide a stylized model of optimal investment similar to Lin and Zhang (2013); Wu et al. (2010) and use it to link investment to expected stock returns and the expected returns to trading stock return variance.

Current time is given by time t, and there are two future periods, $t+1$, and $t+2$. We assume that a representative firm has productive capital K_t and has the ability to invest I_t additional dollars. We assume the firm does not invest at time $t+1$ and that the project pays a net cash flow of $\pi_{t+2} = (K_t + I_t)(G_{t+2} - 1)$ at time $t+2$ where G_{t+2} represents the gross return on invested capital. Investors receive as a payoff, net cash flows plus invested capital, less costs of investment. The cash not invested by the firm can be invested in a risk-free bond, or it can be paid out to investors through a dividend. The firm's total assets at time t are $K_t + C_t$ where C_t represents cash on hand.

2.1. Equity Values

Because the firm does not pay a dividend at time $t+1$, its current equity value, P_t, is given by

$$P_t = E_t[\frac{\Lambda_{t+2}}{\Lambda_t} P_{t+2}], \tag{1}$$

$$= E_t[\frac{\Lambda_{t+2}}{\Lambda_t}((K_t + I_t) + \pi_{t+2} + (C_t - \psi_t - D_t) R_{f,t+2})]. \tag{2}$$

Here $\frac{\Lambda_{t+2}}{\Lambda_t}$ represents the discount factor that prices all assets in the economy and has an expected value $E_t[\frac{\Lambda_{t+2}}{\Lambda_t}] = R_{f,t+2}^{-1}$ which is the inverse of the risk-free rate from time t to $t+2$. ψ_t represents investment costs and D_t represents current dividends. Cash that is not invested or paid to investors grows at the risk-free rate $R_{f,t+2}$ from t to $t+2$. We make the common assumption that the firm has quadratic adjustment costs such that $\psi_t = I_t(1 + \frac{1}{2}\frac{I_t}{K_t})$. The first order condition that maximizes (1) yields an optimal investment rate, $\frac{I_t}{K_t}$, of

$$\frac{I_t}{K_t} = E_t[\frac{\Lambda_{t+2}}{\Lambda_t}(G_{t+2} - R_{f,t+2})]. \tag{3}$$

Following prior literature, we assume that $D_t = C_t - \psi_t$, where $D_t < 0$ means an equity injection and $D_t > 0$ means an equity payout. Using this and (3) yields an valuation of

$$P_t = K_t E_t[\frac{\Lambda_{t+2}}{\Lambda_t} G_{t+2}]^2. \tag{4}$$

Expected returns from time t to $t+2$ are then given by $E_t[R_{t+2}] = E_t[\frac{P_{t+2}}{P_t}]$, and can be written as

$$E_t[R_{t+2}] = \frac{E_t[G_{t+2}]}{E_t[\frac{\Lambda_{t+2}}{\Lambda_t} G_{t+2}]}. \tag{5}$$

Using the optimal investment policy (3), expected stock returns can be rewritten as a function of investment intensity, $1 + \frac{I_t}{K_t}$,

$$E_t[R_{t+2}] = \frac{E_t[G_{t+2}]}{1 + \frac{I_t}{K_t}}. \tag{6}$$

As in Wu et al. (2010), higher investment lowers expected stock returns because firms' will invest more when discount rates are low.

2.2. Equity Prices and Dynamics

In order to derive prices for variance, we need to impose more structure on G_{t+2} and $\frac{\Lambda_{t+2}}{\Lambda_t}$. We assume that the logarithm of the discount factor and return on investment evolve as follows

$$\log(\frac{\Lambda_{t+1}}{\Lambda_t}) = \lambda_{t+1} = -r_f - \frac{1}{2}(\sigma_g^2 + \sigma_v^2) - \sigma_g \epsilon_{t+1} + \sigma_v \xi_{t+1}, \tag{7}$$

$$\log(G_{t+1}) = g_{t+1} = g - \frac{1}{2}\sigma_t^2 + \sigma_t \epsilon_{t+1}, \tag{8}$$

$$\sigma_{t+1} = \sigma_t + \gamma \xi_{t+1}. \tag{9}$$

The discount factor discounts all assets at the risk-free rate, r_f, plus two sources of risk, ϵ_{t+1} and ξ_{t+1}, that price assets in the economy. We assume that they are Normally distributed, IID through time, and to avoid any mechanical statistical relationship in our results, that they are uncorrelated with one-another. The first source reduces the prices of all assets with payoffs that vary positively with ϵ_{t+1} and the second source raises the prices of assets with payoffs that vary positively with ξ_{t+1}. The discount factor is meant to capture the the intuition provided in Bansal and Yaron (2004) that there are several sources of priced risk in the economy without using their more complex discount factor directly. The assumption for G_t implies that expected gross returns on investment are given by $E_t[G_{t+2}] = e^{2g}$ but that the uncertainty around the return, σ_t, can fluctuate randomly through time with a "volatility of volatility" of γ. Our assumption for the dynamics of σ_t are the discrete time version of the SABR volatility model used in option pricing. Both represent a parsimonious set of stochastic processes that allow us to study how investment relates to asset prices. For simplicity we have assumed the the innovations in G_t are completely driven by common innovations and there is no idiosyncratic risk. All of the following results hold, they differ only by a constant correlation coefficient, if we relax this assumption and allow for the innovations in G_t to be only partially correlated with ϵ_{t+1} and ξ_{t+1}.

Armed with the above dynamics, we can solve for prices, stock returns and volatility in closed form. As outlined in the Appendix, log market value of equity is given by:

$$\log(P_t) \equiv p_t = k_t + a_t + 2(g - r_f - \sigma_g \sigma_t) - \sigma_g \gamma \sigma_v + \frac{1}{2}\sigma_g^2 \gamma^2, \tag{10}$$

where $k_t = \log(K_t)$ and $a_t = \log(1+\frac{I_t}{K_t})$ represents log investment intensity. Assuming that current capital plus investment represents book value of equity, then prices have a form similar to that of a residual income model: price is given by book value $(k_t + a_t)$ plus expected future profitability $(2g)$ less a discount for uncertainty $(2(r_f + \sigma_g \sigma_t) + \sigma_g \gamma \sigma_v - \frac{1}{2}\sigma_g^2 \gamma^2)$. Prices increase with book values and expected future profits and decline with risk.

Given (10), expected rates of return on equity, $\mu_{t,t+2}$, stock return variance, $\Sigma_{t,t+2}$, and expected stock return variance, $E_t[\Sigma_{t,t+2}]$, from t to $t+2$ follow immediately:

$$\mu_{t,t+2} = 2(r_f + \sigma_g \sigma_t) + \sigma_g \gamma \sigma_v - \frac{1}{2}\sigma_g^2 \gamma^2, \tag{11}$$

$$\Sigma_{t,t+2} = \sigma_t^2 + \sigma_g^2 \gamma^2 + \sigma_{t+1}^2, \tag{12}$$

$$E_t[\Sigma_{t,t+2}] = 2\sigma_t^2 + \gamma^2(\sigma_g^2 + 1). \tag{13}$$

From equation (6) it is easy to see that the risk premia of stock returns can be written as function of investment intensity

$$\alpha_t = \mu_{t,t+2} - 2r_f = 2(g - r_f) - a_t, \tag{14}$$

which clearly shows that expected stock returns are negatively related to investment within our setting. We next show how investment relates to the risk premia in stock return variance.

2.3. Variance Risk Premia

To examine investment's relation with the risk premium in stock return variance requires calculating the fair market price for a variance contract, v_t, which is a contract that pays realized stock return variance, $\Sigma_{t,t+2}$. The market price for such a contract must satisfy the standard asset pricing equation $v_t = E_t[\frac{\Lambda_{t+2}}{\Lambda_t}\Sigma_{t,t+2}]$ and as outlined in the appendix the solution for this contract is given by

$$v_t = R_{f,t+2}^{-1}(2\sigma_t^2 + (\sigma_g^2 + 1)\gamma^2 + 2\gamma\sigma_t\sigma_v + \gamma^2(\sigma_v^2 + 1)). \tag{15}$$

The so-called variance risk premium, α_t^v, is the difference between expected variance and the price of the variance contract and in our setting has a tractable form

$$\alpha_t^v = E_t[\Sigma_{t,t+2}] - R_{f,t+2}v_t = -2\gamma\sigma_t\sigma_v - \gamma^2(\sigma_v^2 + 1). \tag{16}$$

Prior studies have shown that the variance risk premium is negative (e.g., Carr and Wu, 2009; Bollerslev et al., 2009) equation (16) shows that the expected returns to holding variance are indeed negative for all $\sigma_t > \frac{\gamma(\sigma_v^2+1)}{2\sigma_v}$.

The key state variable in both expected stock returns and variance risk premiums is the current volatility of profitability, σ_t, and it is positively related to expected stock returns and negatively related to variance risk premiums, which allows us to connect investment to variance risk premia.

2.4. Linking Equity and Variance Risk Premiums

Using the equation for equity risk premia (11) and combining it with (16) allows us to write variance risk premia as a function of equity risk premia and investment

$$\alpha_t^v = -\gamma(\frac{(\sigma_v - \frac{1}{2}\sigma_g\gamma) + 2\gamma(\sigma_v^2 + 1)}{2} + \frac{\sigma_v}{\sigma_g}\alpha_t), \tag{17}$$

$$= \gamma\frac{\sigma_v}{\sigma_g}a_t - \frac{1}{2}\Theta, \tag{18}$$

where $\Theta = \gamma(\sigma_v - \frac{1}{2}\sigma_g\gamma + 2\gamma(\sigma_v^2 + 1) + \frac{\sigma_v}{\sigma_g}4(g - r_f))$. Thus the rate of investment, as defined as $a_t = \log(1 + \frac{I_t}{K_t})$, is negatively related to equity risk premiums and positively related to variance risk premiums. Our empirical investigation that follows, tests this prediction.

3. Data and Empirical Analyses

3.1. Data

We collect stock price information from The Center for Research in Security Prices (CRSP), financial statement data from Compustat quarterly files, and option data from OptionMetrics. Our sample includes all firms with fiscal year ends of March, June, September, and December from January 1996 to December 2013. We require firms to have positive book value, at least four quarters of historical accounting information, CRSP share code 10 or 11, beginning-of-month stock prices greater than \$5 and we exclude financial firms (SIC code 6XXX).

We match a firm's most recently reported quarterly financial information to the prices of options and variance contracts as follows.[2] At the end of each month, for each firm with sufficient data we calculate the value of a variance contract using OptionMetrics

[2] To ensure quarterly financial statement data is publicly available, we require at least four months to have passed from the most recent fiscal quarter end before the financial statement data enters the sample.

volatility surface files with 30-day expirations following the model-free approach outlined in the appendix, resulting in 216,797 firm-month variance returns. We estimate realized variance as the sum of squared daily log returns. We then calculate the variance return (R_{Var}) as the difference between the future realized variance minus the cost of purchasing the variance contract, scaled by the cost of purchasing the variance contract. The variance risk premium is calculated as the variance return minus the risk-free rate. For delta-hedged and strangle positions we closely follow Cao and Han (2013) and select one call and one put option that are closest to being at-the-money and have the shortest maturity among those with more than one month until expiry from OptionMetrics option price files. We exclude options where the underlying stock paid a dividend during the remaining life of the option; options with moneyness than 0.8 or greater than 1.2 are also excluded. Thus, the selected options are approximately at-the-money. These filters results in 133,625 firm-month observations for delta-hedged call returns and 109,869 firm-month observations for strangle returns. All variables are winsorized at the 1% level.

Our empirical tests employ an accrual-based measure of investment in operating assets (INV) as well as a measure of overall investment in total assets (AG). Specifically, our accrual measure is the quarterly change in net operating assets over quarter t scaled by net operating assets at the end of quarter $t-1$. We define net operating assets following Dechow et al. (2008) and Arif and Lee (2014) as total assets (Compustat AT) less cash and short-term investments (Compustat CHE) minus non-debt liabilities; where non-debt liabilities equals total liabilities (Compustat LT) plus minority interest (MIB) less debt (Compustat DLTT plus Compustat DLC).[3] Book-to-market (BM) is measured as book value (Compustat CEQQ) scaled by market capitalization, while return on equity (ROE) is measured as income before extraordinary items (Compustat IBQ) scaled by book value.

We follow Bakshi and Kapadia (2003) to calculate delta-hedged option gains. Specifically, the total delta-hedged gain for each call option from time t to $t+\tau$, $x_{t,t+\tau}$, is calcu-

[3]Following Arif and Lee (2014), we add minority interest (MIB) to total liabilities (LT) in the calculation of non-debt liabilities to retain consistency with Dechow et al (2008) given that the definition of total liabilities in the Compustat Xpressfeed database excludes minority interest, while the definition of total liabilities in the Compustat Legacy database includes minority interest.

lated as: $x_{t,t+\tau} = \max(S_{t+\tau} - K, 0) - C_t - \sum_{n=0}^{N-1} \Delta_{t_n}(S_{t_{n+1}} - S_{t_n}) - \sum_{n=0}^{N-1} \frac{a_n r_n}{N}(C_{t_n} - \Delta_{t_n} S_{t_n})$ where $t_0 = t$, $t_N = t + \tau$ is the maturity date, Δ_{t_n} is the option delta at t_n, $r_{t_n}$is the annualized risk-free rate on date t_n, and $a_n$is the number of calendar days between t_n and t_{n+1}. The delta-hedged put option gain is similar, except the put option price and delta replaces the call option price and delta. In our empirical tests we measure delta-hedged call option returns (R_{DH}) as the delta-hedged call option gain scaled by the implied volatility of the call on date t. Strangle returns (R_{ST}) are defined as the average of the delta-hedged call scaled by the implied volatility of the call and the delta-hedged put scaled by the implied volatility of the put on date t.

Table 1 provides descriptive statistics for key variables used in the analysis. Consistent with prior literature (e.g., Bakshi and Kapadia, 2003; Cao and Han, 2013), average delta-hedged call option and strangle returns are negative. Similarly, the average variance risk premium (VRP) is negative, consistent with the price of a 30 day ahead variance contract $v_{t,t+1}$ being greater than future realized 30 day variance on average (Lyle and Naughton, 2016). Moreover, the economic magnitude of this premium is large, with the excess return on a 30 day variance contract averaging -16.98 percent. Mean asset growth is 0.043 and the mean change in net operating assets is 0.074, indicating that firms invest on average. The mean book-to-market ratio is 0.44 and mean ROE is 1.2 percent. Average log market cap (size) is 14.15, consistent with firms in our sample being large.

Panel B displays the univariate correlations between the variables of interest. Consistent with intuition, the returns to delta-hedged calls, strangles and variance contracts are positively correlated. In addition, these returns are positively correlated with both asset growth and investment, providing initial evidence in support of the main prediction of our model. Option and variance returns are also positively associated with size and book-to-market. Consistent with prior research, larger firms and growth firms tend to invest more, while high book to market firms have lower ROE.

3.2. Investment and future returns to holding equity volatility

Equation 18 predicts that investment is positively related to future returns to holding equity volatility. This relation can be expressed in terms of a traditional risk premium as:

$$E_t[R^v_{t,t+1} - R_f] = \frac{E_t[\Sigma_{t,t+2}]}{v_t} - R_f = \frac{\phi_0}{v_t} + \phi_1 \frac{INV_t}{v_t}. \quad (19)$$

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This leads to the following empirical specification:

$$R^v_{t,t+1} - R_f = a_0 + a_1 \frac{1}{v_t} + a_2 \frac{INV_t}{v_t} + \xi_{t+1}. \quad (20)$$

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We test this prediction empirically using all three measures of the returns to holding equity volatility (i.e. returns to holding variance contracts, R_{VAR}, delta-hedged calls, R_{DH}, and strangles, R_{ST}) and two measures of investment (asset growth, AG, and change in net operating assets, INV).[4]

Table 2 presents the results of monthly Fama-Macbeth regressions over the 215 months in our sample, where future returns to holding equity volatility are regressed on either asset growth or the change in net operating assets controlling for standard characteristics. We include controls for historical idiosyncratic volatility, $IVOL$, (Cao and Han, 2013), book-to-market, BM, and return on equity, ROE, (Lyle and Naughton, 2016) and firm size, ME, as initial controls to ensure that the results present are not driven by inclusion of certain control variables. In Table 3 we also control for past stock returns over the prior month, year, and three years to ensure that well known stock predictors are not

[4]Specifically, our tests with delta-hedged call options set $R^v_{t,t+1}$equal to the delta-hedged call gain scaled by the call option's implied volatility (v_t). Our tests with delta-hedged strangles set $R^v_{t,t+1}$equal to the average of the delta-hedged call scaled by the implied volatility of the call and the delta-hedged put scaled by the implied volatility of the put on date t, where v_t equals the average of the call and put implied volatility. Our tests with variance contracts set $R^v_{t,t+1}$ equal to the variance return, i.e. the difference between the future realized variance minus the cost of purchasing the variance contract, scaled by the cost of purchasing the variance contract (v_t).

driving our results. Across all specifications, investment is a robust positive predictor of strategies that are long realized volatility. More specifically, we find that both asset growth and change in net operating assets significantly predict returns to call options, strangles and variance contracts.

We note that the predictive power of investment for returns to trading equity volatility survive a battery of robustness checks. In untabulated results, we test whether our findings are sensitive to the holding period by repeating our analysis with 60 calendar day ahead variance returns and we find similar results to those tabulated. Tests using S&P 500 firms also yield similar results to those tabulated. Furthermore, adding additional firm-level controls such as lagged realized variance, lagged systematic volatility, jump risk, Fama French five-factor betas, and VIX beta does little to change the predictive power of investment for future option-based returns.

Table 4 reports the equal-weighted average future returns of delta-hedged calls, strangles and variance contracts ranked by the underlying firm's investment in the most recent quarter. Consistent with the predictions of our theoretical model and with the Fama Macbeth regressions presented in Table 3, the portfolio sorts indicate that the returns to holding equity volatility of firms with high past investment significantly exceed the returns to holding the equity volatility of firms with low past investment, with hedged monthly returns ranging from 5 to 10 percent per month depending on the strategy.

4. Conclusion

In this paper, we use a basic model of optimal investment to study how accruals are related to both expected stock returns and expected returns to holding equity return volatility. In our model, low discount rates imply low exposure to variance risk premia (which is negative), thus raising the returns to traded variance and delta-hedged options for high accrual firms. In our empirical tests, we employ both the change in net operating asset accruals as well as total asset growth as measures of investment and measure the returns to holding equity volatility using the delta-hedged returns of call options, strangles and variance contract returns. Consistent with the predictions of our model, we find robust evidence that accruals positively forecast the returns to holding equity return volatility.

We contribute to the literature on accruals and investment as well as the literature studying the cross-sectional determinants of expected equity volatility. While a large literature documents a link between firm investment and expected stock returns (e.g., Sloan, 1996; Dechow et al., 2008; Wu et al., 2010; Fama and French, 2016), there is debate as to whether this emprical finding reflects rational asset pricing or not. We show that the relation between investment and the distribution of future asset prices - both in terms of expected returns and expected volatility returns - can be reconciled within a model of optimal investment, and provide empirical evidence consistent the predictions of our model. In other words, the negative relation between accruals and future stock returns documented in prior literature may be far less anomalous than previously thought.

We also contribute to the literature on the cross-sectional determinants of expected equity volatility returns. Carr and Wu (2009) find significant cross-sectional variation in variance risk premia, and highlight that little is known about the factors that drive this variation. We take a first step towards understanding the relation between investment and the distribution of future asset prices, and provide robust evidence that accruals plays a role in expected volatility returns as well as a theoretical framework linking investment to expected returns to holding equity volatility.

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A. Derivations

A.1. Valuations

Starting with $P_t = E_t[\frac{\Lambda_{t+2}}{\Lambda_t}((K_t + I_t) + \pi_{t+2} + (C_t - \psi_t - D_t)R_{f,t+2})]$ the first order condition is

$$E_t[\frac{\Lambda_{t+2}}{\Lambda_t}(G_{t+2} - (1 + \frac{I_t}{K_t})R_{f,t+2})] = 0. \tag{A.1}$$

This implies $1 + \frac{I_t}{K_t} = E_t[\frac{\Lambda_{t+2}}{\Lambda_t}G_{t+2}]$. Now assuming that $D_t = C_t - \psi_t$ gives a value of $P_t = (K_t + I_t)E_t[\frac{\Lambda_{t+2}}{\Lambda_t}G_{t+2}]$, which using the optimal investment rule gives a price of $P_t = K_t E_t[\frac{\Lambda_{t+2}}{\Lambda_t}G_{t+2}]^2$. Assuming that investment is booked, then the market-to-book ratio is given by $\frac{P_t}{K_t+I_t} = E_t[\frac{\Lambda_{t+2}}{\Lambda_t}G_{t+2}]$. Using the dynamics:

$$\begin{aligned}
\log(\frac{\Lambda_{t+1}}{\Lambda_t}) &= \lambda_{t+1} = -r_f - \frac{1}{2}(\sigma_g^2 + \sigma_v^2) - \sigma_g\epsilon_{t+1} + \sigma_v\xi_{t+1}, \\
\log(G_{t+1}) &= g_{t+1} = g - \frac{1}{2}\sigma_t^2 + \sigma_t\epsilon_{t+1}, \\
\sigma_{t+1} &= \sigma_t + \gamma\xi_{t+1},
\end{aligned}$$

we have $E_t[\frac{\Lambda_{t+2}}{\Lambda_t}G_{t+2}] = E_t[\frac{\Lambda_{t+1}}{\Lambda_t}e^{g_{t+1}}E_{t+1}[\frac{\Lambda_{t+2}}{\Lambda_{t+1}}e^{g_{t+2}}]]$ and $E_{t+1}[\frac{\Lambda_{t+2}}{\Lambda_{t+1}}e^{g_{t+2}}] = e^{g-r_f-\sigma_g\sigma_{t+1}}$. Using the fact that all innovation terms are normal implies

$$E_t[\frac{\Lambda_{t+2}}{\Lambda_t}G_{t+2}] = e^{2(g-r_f-\sigma_g\sigma_t)-\sigma_g\gamma\sigma_v+\frac{1}{2}\sigma_g^2\gamma^2}. \tag{A.2}$$

Thus the log value is given by

$$p_t = k_t + a_t + 2(g - r_f - \sigma_g\sigma_t) - \sigma_g\gamma\sigma_v + \frac{1}{2}\sigma_g^2\gamma^2. \tag{A.3}$$

A.2. Stock Returns

Given our assumed dynamics, we solve for prices at each point in time, which allows us to determine the dynamics of prices and their volatilities. The price at time $t+1$ is

$$P_{t+1} = (K_t + I_t)e^{g_{t+1}+g-r_f-\sigma_g\sigma_{t+1}} \tag{A.4}$$

Which implies that the return, r_{t+1}, from t to $t+1$ is

$$p_{t+1} - p_t = r_f + \sigma_g\sigma_t - \frac{1}{2}\sigma_t^2 + \sigma_t\epsilon_{t+1} - \sigma_g\xi_{t+1}. \tag{A.5}$$

Terminal prices are $P_{t+2} = (K_t + I_t)e^{g_{t+1}+g_{t+2}}$ which implies that the return from $t+1$ to $t+2$ is

$$p_{t+2} - p_{t+1} = r_f - \frac{1}{2}\sigma_{t+1}^2 + \sigma_g\sigma_t + \sigma_g\gamma\xi_{t+1} + \sigma_{t+1}\epsilon_{t+2}. \tag{A.6}$$

A.2.1. Equity Risk Premia

The equity risk premia from t to $t+2$ is given by

$$\alpha_t = \log(E_t[\frac{P_{t+2}}{P_t}]R_{f,t+2}^{-1}) = 2g - 2r_f - 2(g - r_f - \sigma_g\sigma_t) + \sigma_g\gamma\sigma_v - \frac{1}{2}\sigma_g^2\gamma^2, \tag{A.7}$$

$$= \sigma_g\sigma_t + \sigma_g\gamma\sigma_v - \frac{1}{2}\sigma_g^2\gamma. \tag{A.8}$$

A.2.2. Equity Variance

The cumulative variance on equity is given by

$$\Sigma_{t,t+2} = E_t[r_{t+1} - E_t[r_{t+1}]]^2 + E_{t+1}[r_{t+2} - E_{t+1}[r_{t+2}]]^2, \tag{A.9}$$

$$= \sigma_t^2 + \sigma_g^2\gamma^2 + \sigma_{t+1}^2. \tag{A.10}$$

Which implies that expected variance is $E_t[\Sigma_{t,t+2}] = 2\sigma_t^2 + \gamma^2(\sigma_g^2 + 1)$.

A.2.3. Variance Risk Premia

Using the pricing rule,$v_t = E_t[\frac{\Lambda_{t+2}}{\Lambda_t}\Sigma_{t,t+2}]$ we have

$$v_t = R_{f,t+2}^{-2}(2\sigma_t^2 + \sigma_g^2\gamma^2) + E_t[\frac{\Lambda_{t+2}}{\Lambda_t}(2\gamma\sigma_t\xi_{t+1} + \gamma^2\xi_{t+1}^2)], \quad \text{(A.11)}$$

$$= R_{f,t+2}^{-2}(2\sigma_t^2 + \sigma_g^2\gamma^2 + 2\gamma\sigma_t\sigma_v + \gamma^2(\sigma_v^2 + 1)). \quad \text{(A.12)}$$

A.3. The Price of a Variance Contract

We apply the model free equation provided by Bakshi and Madan (2000) where any twice differentiable function $F(S)$ can be expressed as:

$$F(S) = F(\bar{S}) + (S - \bar{S})F_S(\bar{S}) \quad \text{(A.13)}$$

$$+ \int_{\bar{S}}^{\infty} F_{SS}(K)(S-K)^+ dK + \int_0^{\bar{S}} F_{SS}(K)(K-S)^+ dK, \quad \text{(A.14)}$$

where $\bar{S}$ is an arbitrary real constant.

Let $F(S) = \log(P_{t+\tau}) = p_{t+\tau}$, then where

$$p_{t+\tau} = \log(\bar{S}) + \frac{(P_{t+\tau} - \bar{S})}{\bar{S}} - \int_{\bar{S}}^{\infty} \frac{(P_{t+\tau} - K)^+ dK}{K^2} - \int_0^{\bar{S}} \frac{(K - P_{t+\tau})^+ dK}{K^2}. \quad \text{(A.15)}$$

The value of a log contract is thus

$$f_{t,t+\tau} = E^Q[e^{-r_{t+\tau}} p_{t+\tau}] = e^{-r_{t+\tau}} \log(F_{t+\tau})$$

$$- \int_{F_{t+\tau}}^{\infty} \frac{C(K, t+\tau)dK}{K^2} - \int_0^{F_{t+\tau}} \frac{P(K, t+\tau)dK}{K^2}. \quad \text{(A.16)}$$

where $F_{t,t+\tau}$ is a forward contract on the equity, while $C(K, t+\tau)$ and $P(K, t+\tau)$ represent call and put contracts respectively. This implies that the price of variance can be given by,

$$v_{t,t+\tau} = 2(e^{-r_f(t+\tau)}(p_t + r_f(t+\tau)) - e^{-r_{t+\tau}} \log(F_{t+\tau})$$
$$+ \int_{F_{t+\tau}}^{\infty} \frac{C(K,t+\tau)dK}{K^2} + \int_{0}^{F_{t+\tau}} \frac{P(K,t+\tau)dK}{K^2}). \tag{A.17}$$

We approximate this equation using OptionMetrics' volatility surface files along with their estimate of the forward contract, $F_{t+\tau}$.

B. Tables

Table 1: Descriptive Statistics

Table 1 reports summary statistics of key variables used in the analysis and other common firm-level characteristics. R_{DH} is the delta-hedged call option gain scaled by the implied volatility of the call, R_{ST} is the average of the delta-hedged call and put gain scaled by the average implied volatility of the call and put option, and R_{Var} is the difference between the future realized variance minus the cost of purchasing the variance contract, scaled by the cost of purchasing the variance contract. $BM_t = \frac{B_t}{M_t}$ is the book-to-market ratio. $ROE = \frac{x_t}{B_t}$ is the quarterly return on book equity. $ME_t = log(M_t)$ is the log of market capitalization. $AG = \log(\frac{TA_t}{TA_{t-1}})$ is asset growth. $INV = \frac{\Delta NOA_t}{NOA_{t-1}}$ is the change in net operating assets scaled by lagged net operating assets.

(a) Panel A: Summary Statistics

	Mean	Std Dev	P10	P25	P50	P75	P90
R_{DH}	-18.50	182.59	-187.26	-94.56	-30.51	35.75	147.13
R_{ST}	-9.10	180.28	-172.10	-86.30	-25.09	43.91	159.74
R_{Var}	-16.98	71.45	-77.55	-61.72	-37.06	0.83	60.81
AG	0.043	0.135	-0.051	-0.011	0.020	0.059	0.129
INV	0.074	0.498	-0.112	-0.027	0.018	0.086	0.246
ME	14.147	1.376	12.518	13.148	13.968	14.982	16.031
BM	0.435	0.320	0.120	0.213	0.360	0.573	0.833
ROE	0.012	0.111	-0.066	0.001	0.027	0.049	0.081

(b) Panel B: Correlation Table

R_{DH}		0.97	0.05	0.02	0.02	0.05	0.02	0.00
R_{ST}	0.96		0.04	0.03	0.02	0.03	0.00	0.01
R_{VAR}	0.09	0.08		0.08	0.03	0.28	0.06	0.02
AG	0.02	0.02	0.13		0.33	0.23	-0.08	0.00
INV	0.02	0.02	0.07	0.36		0.12	0.00	-0.03
ME	0.10	0.07	0.32	0.14	0.10		0.31	-0.19
BM	0.09	0.06	0.09	-0.15	-0.07	0.33		-0.11
ROE	-0.04	-0.02	0.08	0.37	0.18	0.00	-0.24	

Table 2: Cross-Sectional Regressions

Table 2 reports mean coefficients and t-statistics based on the Fama and MacBeth (1973) approach (with a Newey-West correction) of one-period-ahead returns on delta hedged calls, R_{DH}, strangles, R_{ST}, and variance contracts, R_{VAR}. $AG = \log(\frac{TA_t}{TA_{t-1}})$ is asset growth. $INV = \frac{\Delta NOA_t}{NOA_{t-1}}$ is the change in net operating assets scaled by lagged net operating assets. $BM_t = \frac{B_t}{M_t}$ is the book-to-market ratio. $ROE = \frac{x_t}{B_t}$ is the quarterly return on book equity. $ME_t = log(M_t)$ is the log of market capitalization. $IVOL$ is idiosyncratic volatility over month $t-1$. The deflator in each regression, v_t, is the implied volatility of the corresponding call, strangle or variance contract. *, **, and *** denote two-tailed statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) R_{DH}	(2) R_{ST}	(3) R_{VAR}	(4) R_{DH}	(5) R_{ST}	(6) R_{VAR}
AG	8.243***	8.924***	0.341***			
	(2.972)	(4.404)	(6.298)			
INV				3.446***	2.202***	0.083***
				(3.420)	(2.629)	(6.372)
ME	-2.685***	-1.476*	-0.023***	-2.637***	-1.411*	-0.023***
	(-6.224)	(-1.965)	(-4.822)	(-6.010)	(-1.873)	(-4.742)
BM	-0.297	0.013	-0.061***	-0.323	-0.066	-0.062***
	(-0.400)	(0.024)	(-6.220)	(-0.431)	(-0.120)	(-6.230)
ROE	-2.337	6.857***	-0.003***	-3.253	7.263***	-0.003***
	(-0.800)	(3.156)	(-4.290)	(-1.141)	(3.325)	(-4.238)
$IVOL$	3.751***	17.288	0.935***	3.733***	18.315	0.945***
	(10.029)	(0.590)	(14.116)	(9.937)	(0.614)	(13.842)
v_t^{-1}	34.121***	17.093	0.077**	33.174***	16.062	0.077**
	(3.420)	(1.212)	(1.990)	(3.252)	(1.134)	(1.980)
R^2	0.01	0.00	0.01	0.01	0.00	0.01
# Obs.	133,625	109,869	216,797	133,625	109,869	216,797

Table 3: Cross-Sectional Regressions

Table 3 reports mean coefficients and t-statistics based on the Fama and MacBeth (1973) approach (with a Newey-West correction) of one-period-ahead returns on delta hedged calls, R_{DH}, strangles, R_{ST}, and variance contracts, R_{VAR}. $AG = \log(\frac{TA_t}{TA_{t-1}})$ is asset growth. $INV = \frac{\Delta NOA_t}{NOA_{t-1}}$ is the change in net operating assets scaled by lagged net operating assets. $BM_t = \frac{B_t}{M_t}$ is the book-to-market ratio. $ROE = \frac{x_t}{B_t}$ is the quarterly return on book equity. $ME_t = log(M_t)$ is the log of market capitalization. $IVOL$ is idiosyncratic volatility over month $t-1$. The deflator in each regression, v_t, is the implied volatility of the corresponding call, strangle or variance contract. *, **, and *** denote two-tailed statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) R_{DH}	(2) R_{ST}	(3) R_{VAR}	(4) R_{DH}	(5) R_{ST}	(6) R_{VAR}
AG	6.744***	8.140***	0.234***			
	(2.700)	(4.286)	(5.601)			
INV				3.542***	2.371***	0.058***
				(3.564)	(2.776)	(5.227)
$R(t-1,t)$	1.348	7.868***	-0.734***	1.423	7.780***	-0.736***
	(0.377)	(3.033)	(-4.437)	(0.397)	(3.000)	(-4.442)
$R(t-12,t-2)$	1.947*	2.306***	0.093***	2.201*	2.627***	0.099***
	(1.743)	(3.055)	(4.178)	(1.943)	(3.487)	(4.362)
$R(t-36,t-13)$	-0.025	-0.407	0.048***	0.004	-0.272	0.050***
	(-0.043)	(-0.869)	(6.961)	(0.007)	(-0.551)	(7.066)
ME	-3.006***	-1.984***	-0.020***	-2.81	-1.931***	-0.020***
	(-7.318)	(-2.780)	(-4.267)	(-5.2)***	(-2.708)	(-4.258)
BM	0.303	0.662	-0.035***	1.03	0.719	-0.034***
	(0.537)	(1.320)	(-4.614)	(0.62)	(1.449)	(-4.424)
ROE	-3.242	5.110**	-0.003***	-5.40	5.273***	-0.003***
	(-1.151)	(2.568)	(-4.365)	(-1.67)*	(2.617)	(-4.260)
$IVOL$	3.386***	-23.936	0.898***	3.794	-23.846	0.903***
	(8.921)	(-0.792)	(13.429)	(6.42)***	(-0.772)	(13.251)
v_t^{-1}	45.550***	26.768**	0.042	3.542***	2.371***	0.044
	(5.839)	(2.099)	(1.092)	(3.564)	(2.776)	(1.140)
R^2	0.068	0.046	0.084	0.068	0.046	0.084
# Obs.	133,625	109,869	216,797	133,625	109,869	216,797

Table 4: Portfolio Sorts

Table 4 reports equal-weighted portfolio returns based on univariate sorts on investment in net operating assets and asset growth. R_{DH} is the delta-hedged call option gain scaled by the implied volatility of the call, R_{ST} is the average of the delta-hedged call and put gain scaled by the average implied volatility of the call and put option, and R_{Var} is the difference between the future realized variance minus the cost of purchasing the variance contract, scaled by the cost of purchasing the variance contract. $AG = \log(\frac{TA_t}{TA_{t-1}})$ is asset growth. $INV = \frac{\Delta NOA_t}{NOA_{t-1}}$ is the change in net operating assets scaled by lagged net operating assets. *, **, and *** denote two-tailed statistical significance at the 10%, 5%, and 1% levels, respectively. Significance levels are based on standard errors corrected for heteroskedasticity.

	AG			INV		
	R_{DH}	R_{ST}	R_{VAR}	R_{DH}	R_{ST}	R_{VAR}
1 (Low)	-19.53	-10.13	-17.92	-18.9	-8.65	-14.45
2	-22.76	-13.29	-23.95	-23.06	-11.56	-22.37
3	-20.7	-9.18	-19.18	-21.1	-9.55	-21.2
4	-16.6	-4.62	-11.89	-17.8	-6.78	-14.22
5 (High)	-14.47	-2.64	-7.81	-13.29	-3.31	-8.45
High-Low	5.06	7.49	10.11	5.61	5.34	6.00
t-stat	(2.01)**	(3.16)***	(5.15)***	(2.72)***	(2.68)***	(4.81)***