Shareholder wealth and firm risk

Hyun-Han Shin and René M. Stulz*

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* Respectively, Assistant Professor of Finance at the School of Management, State University of New York at Buffalo, and Everett D. Reese Chair of Banking and Monetary Economics at the Ohio State University, and Research Associate, National Bureau of Economic Research. We are grateful for useful comments from Harry DeAngelo, Gene Fama, Andrew Karolyi, Ehud Ronn, participants at seminars at Emory, INSEAD, the Ohio State University, the University of Zurich, and at the Fourth Maryland Finance Research Symposium.

Abstract

The evidence presented here is inconsistent with variants of corporate finance theory which hold that the option properties of growth opportunities or asset substitution incentives are first-order determinants of equity values, but it is supportive of risk management and capital structure theories that emphasize the costs of cash flow volatility. Specifically, controlling for known determinants of changes in shareholder wealth, we find that the change in shareholder wealth over one year is inversely related to the change in expected equity volatility over the same year in cross-section regressions. This relation holds consistently through time for all but the largest firms and is economically significant. It is stronger for firms with weaker financial health. When we decompose volatility into beta risk and idiosyncratic risk, we find that shareholder wealth is positively related to beta changes, so that our evidence cannot be explained by a beta effect. Nor can the evidence be explained by the impact of returns on volatility predicted by the leverage effect studied in the option pricing literature.

1. Introduction.

The value of a firm's equity is equal to the expected equity cash flows discounted at the expected rate of return investors require for cash flows of comparable risk. Consequently, an increase in cash flow volatility can affect shareholder wealth by changing either the discount rate or expected cash flows. The asset pricing literature has established that investors do not discount more volatile cash flows at a higher rate if the exposure of cash flows to priced risk factors is kept constant. However, corporate finance theory has predictions about the impact of changes in cash flow volatility on expected cash flows that have not been studied empirically. This paper investigates these predictions through an examination of the relation between shareholder wealth and changes in equity volatility.

One strand of the corporate finance literature suggests that an increase in firm cash flow volatility has a positive impact on shareholder wealth. Since Merton (1974), modern finance theory views equity as an option on firm value. In Merton (1974), an increase in firm cash flow volatility that leaves expected firm cash flows unchanged increases equity value as well as equity volatility, thereby leading to a positive relation between equity volatility and shareholder wealth. In Jensen and Meckling (1976), equity holders have incentives to increase firm cash flow volatility, and hence equity volatility, even though they may decrease firm value when doing so. The literature on real options emphasizes the option properties of growth opportunities. With these properties, increases in the volatility of the cash flows the firm would receive from new investments make growth options more valuable and increase equity volatility. Consequently, there should be a positive relation between equity volatility and value for firms with valuable growth opportunities.

The literature on capital structure and risk management policies offers theories showing that increases in firm cash flow volatility have a detrimental effect on shareholder wealth that can be of first-order importance.[1] These theories point out that greater firm cash flow volatility hurts shareholders since, for given leverage, it reduces the present value of the firm's tax shields from debt and increases the present value of costs of financial distress. A recent literature extends the contingent claims approach to pricing equity to take into account the endogeneity of the firm's capital structure. After reviewing this literature, Leland (1999) shows that shareholders may find it optimal to reduce firm volatility, and hence equity volatility, to preserve the tax benefits of debt despite the existence of the agency costs of debt emphasized by Jensen and Meckling (1976). With these theories, an increase in cash flow volatility that increases equity volatility affects shareholders adversely by reducing their expected cash flows, so that there is a negative relation between changes in equity volatility and shareholder wealth.

Since the corporate finance literature finds that an increase in equity volatility can be associated with both positive and negative changes in shareholder wealth, empirical research is required to determine the nature of the relation between shareholder wealth and changes in equity volatility. Surprisingly, there is no direct empirical evidence that we know of on whether shareholder wealth increases or decreases with expected equity volatility taking into account known determinants of changes in shareholder wealth. We find that there is a significant negative relation between equity returns in a year and the contemporaneous change in equity volatility. This relation is economically important since a one standard deviation increase in equity volatility reduces shareholder wealth by about 16.3%. A number of tests show that this relation holds up with alternate regression specifications, proxies for changes in expected volatility, and sample selection criteria.

After showing that the relation we uncover is robust, we investigate how it varies across firms. The real options argument suggests that an increase in equity volatility should not be associated with a decrease in shareholder wealth or, at least, should be associated with a smaller

[1] Harris and Raviv (1991) review the capital structure literature. Smith and Stulz (1985) and Froot, Scharfstein, and Stein (1993), among others, analyze implications of cash flow volatility on firm value.

decrease in shareholder wealth, for firms with high growth opportunities. We find no evidence that firms with high growth opportunities benefit from an increase in equity volatility. However, we find some evidence that an increase in equity volatility has less of an adverse impact on firms with better growth opportunities. According to the agency costs of debt theory, shareholders should benefit most from increases in volatility for highly levered firms. Instead, we find that shareholder wealth decreases more with an increase in equity volatility for firms with high leverage, low interest coverage, low investment, and low cash flow as one would expect with the capital structure and risk management theories that emphasize costs of financial distress. We find that the decrease in shareholder wealth associated with an increase in equity volatility is inversely related to firm size and insignificant for the largest firms. This result is consistent with the theories that emphasize costs of financial distress in that larger firms generally have better access to capital markets and benefit from economies of scale in risk management.

Our empirical evidence relates to several empirical literatures. First, there is evidence that cash flow and equity volatility has real effects on firms. In particular, Leahy and Whited (1996) show that an increase in equity volatility decreases investment, and Minton and Schrand (1999) demonstrate that there is a negative contemporaneous relation between cash flow volatility and investment. Second, there is a large literature that examines the determinants and implications of risk management practices. This literature finds support for risk management theories that emphasize costs of financial distress. Perhaps more directly related to this paper, Allayannis and Weston (2001) show that firms with foreign exchange exposure that use foreign exchange derivatives have higher value.[2]

Following Black (1976) and Christie (1982), a number of papers have examined how changes in equity value affect equity volatility (for instance, Schwert (1989), Cheung and Ng (1992), Duffee (1995), Bekaert and Wu (2000), Figlewski and Wang (2000)). The starting point for these

[2] Note also that Tufano (1998) and Guay (1999) document that risk management affects the distribution of stock returns.

papers is the option-pricing model of equity. With that model, if firm volatility and the face value of debt are constant, a decrease in firm value increases leverage and therefore increases the volatility of equity when equity is a call option on firm value. Hence, rather than being explained by the effect of changes in volatility on equity value, our results could come from the impact on volatility of changes in firm value. The impact on volatility of changes in firm value is generally called the leverage effect. We show that if the leverage effect were to explain our results, we would have to find a much stronger impact of volatility changes on firms with low leverage than firms with high leverage. We can always reject this hypothesis.

The paper proceeds as follows. In Section 2, we describe the data we use and our volatility measures. In Section 3, we show that there is a robust negative relation between shareholder wealth and changes in volatility. We investigate the determinants of that relation in Section 4 and address the issue of whether changes in firm value can explain our results in Section 5. We conclude in Section 6.

2. The sample and the risk measures.

In this paper, we want to understand how and why increases in expected equity volatility affect shareholder wealth taking into account other determinants of shareholder wealth. It is therefore important for us to be able to measure changes in firm characteristics that could explain changes in shareholder wealth and to identify firm characteristics that could explain the impact of a change in equity volatility on shareholder wealth. For this reason, we measure the change in shareholder wealth by the one-year return on equity. We start with all firms available on the COMPUSTAT database for which stock returns are available from CRSP during the period from 1962 to 1999. Each year, we drop 1% of the observations in each tail of each independent variable used in the regressions we report and require that sample firms have at least one million dollars of assets in year t-1 if they enter the sample in year t. Assets are measured in 1998 dollars.

If a firm is in the sample in year t, we also require that it have the same fiscal year-end in year t and t+1.

The corporate finance literature referred to in the introduction argues that expected cash flows to equity depend on firm cash flow volatility expected to hold over the time period for which expected cash flows are computed. We could therefore attempt to study the relation between changes in expected firm cash flow volatility and shareholder wealth directly rather than focus on the relation between changes in equity volatility and shareholder wealth. Forecasting yearly cash flow volatility at the firm level using time-series cash flow data would be an impossible task except possibly for a handful of firms. However, expected equity volatility generally increases with expected firm cash flow volatility, so that we can use changes in expected equity volatility to proxy for changes in expected firm cash flow volatility. Since we observe equity returns daily, we can estimate equity volatility for firms without a long reporting history. We therefore use changes in expected equity volatility as a proxy for changes in expected cash flow volatility.[3] As we will see, our results cannot be explained by our use of a proxy instead of actual changes in expected cash flow volatility.

Equity volatility could change even though cash flow volatility does not. First, the leverage effect discussed in the introduction is such that a decrease in shareholder wealth increases equity volatility keeping firm cash flow volatility constant. As discussed in the introduction, we explore the implications of the leverage effect in Section 5 and conclude that it cannot explain our results. Second, in a Modigliani and Miller world, fully anticipated leverage increases that leave firm cash flow volatility unchanged increase the volatility of equity without changing shareholder

[3] Because of data limitations, we cannot use the volatility of firm value as a proxy for the volatility of firm cash flows. We do not have the market value of debt for our sample. Consequently, we would have to approximate changes in firm value by changes in the value of equity plus changes in the book value of debt. Within a fiscal year, changes in our measure of firm value would be perfectly correlated with changes in the market value of equity. Assuming risk-free debt, the volatility of firm value would be the volatility of equity times the ratio of the market value of equity to the sum of the book value of debt plus the market value of equity. With this approach, our estimate of the volatility of firm value would be an increasing function of shareholder wealth even if the true volatility of the firm were constant. Therefore, we cannot use this estimate of the volatility of firm value to explain changes in shareholder wealth.

wealth. In this case, we would find no relation between changes in expected volatility and shareholder wealth. Third, an increase in the volatility of the firm's equity risk premium would increase the volatility of equity even though cash flow volatility might be unchanged. This risk premium effect would be the same for all firms that have the same exposure to priced risk factors. To take this effect into account, it is therefore important for us to control for exposure to common risk factors across firms. A final difficulty with equity volatility is that an increase in market volatility theoretically leads to an increase in the risk premium on the market, thereby increasing expected returns but affecting contemporaneous returns adversely.[4] Again, controlling for exposure to priced sources of risk should account for this effect if it is economically important.

Several approaches could be contemplated to measure expected equity volatility. One approach would be to use a time-series model. Since we require a forecast of the one-year volatility, estimating such a model would limit sharply the number of firms in our sample. A second approach would be to use implied volatilities. However, we want our study to use a broad cross-section of firms rather than only firms that have traded options. We use a third approach, which takes maximum advantage of the high frequency with which stock prices are observed. We do not observe the market's expectation of the firm's risk for year t+1, but we can use the realized volatility in year t+1 estimated from daily returns as our proxy for expected volatility for year t+1. With rational expectations, our proxy for the market's expectation is the market's expectation plus a random error. This error biases the slope of the regression coefficient towards zero when the only independent variable is the risk measure. As a result, we might fail to find a significant relation between changes in risk and changes in firm value because of the errors-in-variables problem.

We estimate the yearly standard deviation of a stock's return using daily returns following Schwert (1989) for the fiscal year period (not for the calendar period). We use the fiscal year

4 See Merton (1980) for the risk premium effect and Campbell and Hentschel (1992) for a discussion of the contemporaneous effect. As reviewed in Bekaert and Wu (2000), evidence on the relation between the risk

period because in many of our regressions we control for the contemporaneous change in earnings. However, our results hold if we restrict the sample to firms with fiscal years that coincide with the calendar year. The estimator of the variance of the yearly return is the sum of the squared daily log returns after subtracting the average daily log return in the fiscal year:

$$\hat{s}_{tj}^{2} = \sum_{i=1}^{N_t} (r_{itj} - \bar{r}_{tj})^2$$

where there are N_t daily log returns, r_{itj}, in fiscal year t for firm j. There are two important concerns with using daily returns. The first concern is that serial correlation in daily returns might affect our results. The use of volatilities estimated using weekly returns does not change the conclusions of this paper. The second concern has to do with missing returns. It is not clear that missing returns create a bias in estimates of changes in volatility. Nevertheless, to avoid having our results affected by missing returns, we require a firm to have returns for 95% of the days on which markets are open for us to compute volatility. We also used less restrictive samples. In particular, we used a sample where we require a firm to have at least 100 daily returns in years for which we compute volatility (it is important to note that the firm has to exist for the whole year). The results for this less restrictive sample are qualitatively similar to those obtained for the more restrictive sample.

Throughout the paper, we use variables that are useful to predict returns. In addition to accounting variables, we use the market value of firm equity to proxy for a size effect, market-to-book to proxy for value versus growth, industry dummy variables to proxy for industry effects, and the market model beta to capture a firm's exposure to the market. Beta plays two different roles in the analysis. First, in the cross-section, higher beta stocks are more exposed to market movements and therefore should have higher returns when the market has a positive return.

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premium on the market and market volatility is mixed.

Second, with the capital asset pricing model, the expected return of a stock increases with beta. To estimate beta, we use the market model:

$$r_{ij} = \boldsymbol{a}_j + \boldsymbol{b}_j r_{im} + \boldsymbol{e}_{ij}$$

where r_{ij} is the log return of firm j for day i and r_{im} is the log return of the CRSP value-weighted index for day i. We report results using ordinary-least-squares estimates of the market model. We also estimated Scholes-Williams $\boldsymbol{b}$'s, which led to similar results. With the capital asset pricing model, systematic risk is the product of b_j^2 and the variance of the market return, while unsystematic risk is the variance of $\boldsymbol{e}_{ij}$.

3. The relation between shareholder wealth and changes in equity volatility.

Our first investigation of the relation between shareholder wealth and equity volatility changes proceeds as follows. For year t, we consider all firms for which we have data in year t-1, t, and t+1. We then compute the equity return of a firm for year t and the change in equity volatility from year t to year t+1. Table 1 shows the average equity return in excess of the one-year T-bill yield for the deciles of changes in equity volatility for our whole sample period. The average excess equity return falls monotonically as the change in equity volatility increases. The firms in the decile with the highest increase in equity volatility have a return that is significantly negative. The average return difference between the decile of firms with the lowest increase in volatility and the decile of firms with the highest increase in equity volatility is 35.7% with a t-statistic of 9.8. From 1964 to 1997, the return difference between the top and the bottom decile is negative every year.

Table 1 presents the key finding that we wish to explain: an increase in expected equity volatility is associated with a decrease in shareholder wealth. The obvious problem with the results of Table 1 is that we do not control for determinants of expected returns and that the change in volatility could proxy for the level or contemporaneous changes in firm characteristics. Consequently, we investigate in Table 2 the relation between equity returns and changes in equity volatility in regressions that take into account the impact on shareholder wealth of firm characteristics. To do this, we estimate the return/volatility from yearly cross-section regressions. When the stock market has a positive return, we would expect high beta stocks to earn more than low beta stocks. For a given correlation between a stock and the market, beta is positively related to volatility. Not using beta as an explanatory variable could lead us to conclude that high volatility stocks have higher returns than low volatility stocks simply because volatility proxies for beta. In all the regressions of Table 2, we therefore use beta estimated in year t as an independent variable in regressions in year t as a way to capture differences in returns across stocks that can be explained simply by market movements. We estimated our regressions without controlling for beta in this way and the conclusions of the paper are unaffected.

Table 2 shows estimates of the slope for changes in equity volatility for the whole sample and for two subperiods using four sets of control variables and for a subsample that excludes financial firms and utilities. Regression (1) shows estimates of the relation between equity returns and changes in equity volatility that control only for beta. For the whole sample and both subperiods, we find that there is a negative relation between equity returns and changes in equity volatility. The Fama-McBeth t-statistic on the change in volatility is –7.09 for the whole sample and exceeds 4.9 in absolute value for each of the subsamples. In regression (2), we also control for industry by industry dummy variables determined by the firm's two-digit SIC code, the log of the firm's age, and the log of the firm's assets. The firm’s age is the number of years for which the firm is recorded in COMPUSTAT files. The firm’s assets are measured in 1998 dollars using the Consumers Price Index as a deflator. The results are similar to those in regression (1). In regression (3), we add the contemporaneous change in earnings to regression (2). We find similar results, but the absolute value of the coefficient on volatility and its t-statistic fall slightly. In the following, the tables report results that use the control variables of regression (3), but we will discuss results using other sets of control variables. To understand the economic significance of the coefficient on the change in volatility in Table 3, it is useful to note that the standard deviation of the volatility change is 0.32. Consequently, a one standard deviation increase in the volatility change decreases shareholder wealth by 16.3%. In regression (4), we repeat regression (3), but without utilities and financial firms. Financial firms are firms with an SIC between 6000 and 6999. Utilities are firms with an SIC between 4900 and 4999. Our results are not affected.

In regression (5), we use as control variables in addition to beta the variables used in Fama and French (1998). In their paper, they choose these control variables to soak up all the variation in Tobin's q. We use changes in these variables. We therefore have changes from t-1 to t and from t to t+1 of total assets, R&D, earnings, interest payments, dividends, as well as the change from t to t+1 of firm market value. All variables are normalized by total assets in year t. The discussion in the introduction implies that corporate finance theories predict that some of these variables will be affected by changes in volatility. For instance, a shock in volatility in year t could increase the cost of capital of the firm, thereby reducing investment during year t+1. Consequently, using the variables as control variables biases the results against finding an impact of volatility on returns and we should expect that using these variables would weaken our results. However, the benefit of these regressions is that they show that our result holds even if a whole kitchen sink of variables is used to try to explain changes in shareholder wealth. Using these control variables weakens the return/volatility relation but it is always significant nevertheless.

In Table 2, we show that the equity return is negatively related to the change in equity volatility. Such a result is consistent with equity volatility being costly for shareholders, but it could also be a statistical artifact. In particular, an important concern about the results in Table 2 is that the relation we estimate could be explained by skewness in the distribution of simple returns. This concern follows from Duffee (1995). Simple returns are bounded below by –1 but are not bounded above. Consequently, large absolute value returns at t will be positive returns, thereby leading to a situation where a high volatility at t is associated with a high return at t.

Keeping volatility at t+1 constant, this argument implies that there should be a negative relation between equity returns and volatility changes because there is a positive relation between volatility at t and returns at t. We address this problem in two different ways. First, we re-estimate the regressions of Table 2 with continuously compounded returns. There is no lower bound for continuously compounded returns. The first panel of Table 3 shows estimates of regression (3) of Table 2 for continuously compounded returns. Using continuously compounded returns reduces the size of the coefficient on the volatility change but increases its t-statistic. Now the t-statistic for the whole sample period exceeds 9 in absolute value. Though we report the results using simple returns in the paper, we estimated all our regressions using continuously compounded returns also. In general, using continuously compounded returns seems to strengthen the results, but a few of the results are sensitive to the returns we use and we discuss this where appropriate.

A second way to address the skewness problem follows Duffee (1995) and separates the change in volatility into two variables, volatility at t and volatility at t+1. Volatility at t+1 is not associated with returns at t, so that it is not affected by skewness of returns at t. Therefore, if our results are spurious because of skewness, we should find that there is a much weaker or even no relation between volatility at t+1 and returns at t. It is clear from the second panel of Table 3 that this is not the case. We find a significant positive coefficient for volatility at t and a significant negative coefficient for volatility at t+1 in all the regressions not only for the regressions reported in Table 3 but also for the other specifications of Table 2. In the second subsample period, volatility at t+1 never has a t-statistic below 5 in absolute value for the regression specifications reported in Table 2. In contrast, volatility at t never has a t-statistic above 4. In regressions that we do not report in the table, we omit volatility at year t altogether. In one set of regressions, we use only volatility at t+1. Volatility at t+1 has a significant negative coefficient. In another set of regressions, we compute the volatility change from t-1 to t+1. The coefficient on this change is –0.197 with a t-statistic of –4.32.

We report in the table tests of two other possible explanations for our results. With any asset pricing model where beta earns a risk premium, an increase in beta for given expected cash flows should decrease shareholder wealth because it means that expected cash flows are discounted at a higher rate. Hence, it could be that our result has no implications for the relation between equity volatility and shareholder wealth, but is simply due to the fact that an increase in beta leads to a higher discount rate for a firm's expected cash flows. A simple way to check this explanation for our results is to split the change in equity volatility into one piece due to the change in beta and another piece due to the change in idiosyncratic risk in the market model regression. Rather than using the estimate of equity volatility constructed from equation (1), we estimate the market model for each firm during year t. With the market model regression, beta squared times the variance of the market return is the firm's risk due to its beta. In Panel 3 of Table 3, we see that an increase in systematic risk actually increases shareholder wealth. Hence, this effect goes in the opposite direction of what we would need to find for a change in beta to explain our results. Admittedly, beta is measured with error. However, this is not an important issue here, since increases in beta risk cannot explain our results.

The final robustness check reported in the table tests whether the impact of an increase in equity volatility is symmetric, namely whether increases and decreases in equity volatility have the same effect on equity returns in absolute value. For this check, we split changes in volatility between increases and decreases in volatility. If the relation between equity returns and changes in volatility were symmetric, we would expect the coefficient on increases in volatility to be the same as the coefficient on decreases in volatility. We see in Panel 4 of Table 3 that we cannot reject that the relation between changes in volatility and equity returns is symmetric for all our regressions. In regressions not reported in the table, we find weak evidence of asymmetry with the Fama and French control variables, but not for the second half of the sample. Interestingly, the evidence that the relation is symmetric seems to depend somewhat on whether the returns are simple or continuously compounded. With continuously compounded returns, increases in volatility seem to have more of an impact than decreases in volatility, except with the Fama and French control variables. This seems consistent with skewness playing some role in the return/volatility relation, since using continuously-compounded returns makes the distribution of returns more symmetric and gives less weight in regressions to the largest positive returns.

The results we report in the tables do not include market-to-book, the logarithm of the market value of equity, and leverage as explanatory variables. We prefer omitting them because they depend on expectations of future volatility. Nonetheless, we estimated regressions with these additional control variables as well. The conclusions we reach with these additional control variables are the same as those we reach with the regressions reported in the tables in this section. Finally, to further explore the robustness of the results, we estimated our regressions on two different samples. First, as discussed in the previous section, we estimated our regressions using only firms with fiscal years coinciding with calendar years. Second, we omitted all stocks with prices below $2 to make sure that our results were not due to low price stocks. Our results are stronger for these two samples.

4. The determinants of the relation between equity returns and changes in expected equity volatility.

The bottom line from all the regressions in Section 3 is that there is a negative relation between equity returns and changes in volatility from t to t+1. This negative relation is not explained by skewness or by changes in systematic risk. It is consistent with the hypothesis that an increase in expected volatility affects shareholders adversely. In this section, we investigate whether the return/volatility relation differs across firm types. For this analysis, we report in Table 4 regressions using beta, assets, firm age, industry dummies, and the change in earnings as control variables, but we estimated our regressions for other specifications not reported in the table and discuss those when appropriate. In all cases, we define a firm's type based on characteristics observed at the end of year t-1, which is before we compute returns or volatility.

Consider the impact of an unexpected increase in equity volatility on a levered firm. In Merton's (1974) model, the value of equity is positively related to volatility and equity is more sensitive to volatility as leverage increases. With that model, we would therefore expect shareholders to benefit more from increases in volatility as leverage increases. In contrast, in a static tradeoff model of capital structure, an increase in volatility leads to a higher probability of distress for the existing capital structure. Eventually, one would expect that the firm would change its capital structure to reflect the new volatility. Since volatility has increased, the firm will choose to have less debt, so that the present value of the tax benefits of debt will fall. Hence, in the static tradeoff capital structure model, an increase in volatility has an adverse effect on firm value. Financial distress is less likely for firms with either low leverage or high interest coverage. One would expect the relation between returns and volatility to be weaker for such firms.

In Panels 1 and 2 of Table 4, we show estimates of our regressions for sample splits according to leverage and interest coverage. In each case, we split the sample into three groups (the bottom 30%, the middle 40%, and the top 30% of the distribution of a firm characteristic) formed using a firm characteristic observed at the end of year t-1. Leverage is measured as liabilities to the market value of total assets and interest coverage is measured as earnings before interest, depreciation, and taxes over interest paid. We find clear evidence that the return/volatility relation is steeper for firms with higher leverage and firms with lower interest coverage. However, the return/volatility relation is significant even for firms with low leverage or high interest coverage. We estimated no regression where high leverage firms have a significantly less negative return/volatility relation than low leverage firms. Therefore, we found no support for the view that volatility shocks are first-order determinants of equity values because of the option property of equity.

We turn next to an examination of how a firm's financial health affects the return/volatility relation. Firms in poor financial health might benefit from gambling for redemption. In this case, an increase in volatility would increase shareholder wealth. Alternatively, firms in poor financial health that experience an increase in volatility might find their expected costs of financial distress increase, perhaps because it becomes harder for them to raise funds, to maintain customer relationships, and keep key employees. The evidence is consistent with the latter view. We first split the sample firms in each year based on cash flow to total assets and then estimate the return/volatility relation the next year. We find that the slope of the relation is significantly more negative for firms with low cash flow. The difference in the slope between high and low cash flow firms is significant across all the specifications that we investigated. Firms that are financially constrained invest less. This leads us to split the sample according to investment to total assets. Again, we find that firms that invest less are firms with a significantly more negative return/volatility relation.

Small firms find it harder to access capital markets since they are less likely to have publicly traded debt. Their risk management activities are typically limited because they do not benefit from the economies of scale inherent to risk management.[5] Splitting the sample into three size classes based on the value of the firm's equity, we find that the return/volatility relation does not hold for the largest firms. A concern with this result is that it may simply be due to the fact that volatility is more volatile for small firms than for large firms. Our size split includes as large firms all firms that have greater equity value than the 70th percentile of the NYSE firms and as small firms all firms with lower equity value than the 30th percentile of the NYSE firms. The standard deviation of the volatility change is 0.098 for larger firms and 0.44 for small firms. We investigated for large firms whether the impact of an increase in volatility is more negative for firms with lower interest coverage. The coefficient on the volatility change is significantly lower

[5] See, for instance, Nance, Smith, and Smithson (1993).

for large firms with lower interest coverage than for large firms with higher interest coverage. Surprisingly, large firms with high interest coverage significantly benefit from an increase in volatility. It may well be that this result is similar to the result of Comment and Jarrell (1994) that firms that focus during a year increase their shareholders' wealth since one would expect a reduction in diversification to lead to an increase in equity volatility.

The real options model predicts that the return/volatility relation should be less negative for firms with better growth opportunities. We use the ratio of the market value of the firm to its book value as a proxy for growth opportunities. The market value of the firm is estimated as the value of assets minus the book value of equity plus the market value of equity. The ratio proxies for Tobin's q. Admittedly, firms with the lowest Tobin's q are firms that not only do not have valuable growth opportunities but also presumably are weak financially. The t-statistic for the difference between the change in volatility coefficient of low q firms and of high q firms is –1.57. Even the firms with the best investment opportunities have a significant negative return/volatility relation. We investigated two other approaches to split the sample according to growth opportunities. First, we split the sample according to R&D expenditures. Since so many firms have only trivial R&D expenditures, we split the sample according to whether firms have non-trivial R&D expenditures. We define trivial R&D expenditures arbitrarily as expenditures of less than 1% of assets. We find that firms with non-trivial R&D expenditures have a less negative return/volatility relation. Second, we split the sample according to where a firm is traded. We find no significant difference in the return/volatility relation between NASDAQ and NYSE firms. We already discussed our sample split according to investment to book assets. Presumably, firms that invest more have better growth opportunities and we saw that these firms have a less steep return/volatility relation. This result can also be viewed as evidence that an increase in expected equity volatility has less of an adverse impact on firms with better growth opportunities.

We estimated regressions on subsamples using different control variables, using only firms that are not utilities or financial firms, and using continuously compounded returns. In all these regressions, the return/volatility relation is significant for all our regressions except when we choose a sample of large firms. One could argue, though, that significance ought to be judged more conservatively. The reason for this is that the slopes on the volatility change are not independent across years. For the main regression of table 2, the first-order autocorrelation of the slope on the volatility change is 0.35 and is significant. The higher order autocorrelations are insignificant. As Fama and French (1998) discuss in their paper, taking into account an autocorrelation of 0.5 would increase the standard errors by about 40%. This means that a conservative approach to evaluating t-statistics is to require a t-statistic to be at least 3 for significance if one would use 2 with no autocorrelation in the slopes. In Table 4, the coefficient on volatility changes has a t-statistic lower than 3 in absolute value only for large firms and high R&D firms. When we use continuously compounded returns for the regressions reported in the table, we also find that the coefficient is insignificant only for large firms and high R&D firms.

It is interesting to note that our conclusion that the return/volatility relation is strongest for firms with low cash flow and low interest coverage holds also if we use the change in volatility from t-1 to t+1. However, when we use the change in volatility from t-1 to t+1, the difference in the relation between size groups is not significant. We also re-estimated the regressions using only volatility at t+1. When we use only the volatility at t+1, the differences between the various subsamples are typically not significant. However, the return/volatility relation is significant for the firms that are financially weaker while it is not for the firms that are financially stronger. These results are perhaps not surprising since the theoretical arguments discussed in the introduction imply that an unexpected change in expected volatility should affect shareholder wealth. If we use only volatility at t+1, we have a poor proxy of the unexpected change in expected volatility.

The results presented in Table 4 allow the impact of the control variables to vary across subsamples. This raises the question of whether our results depend on this assumption. To investigate this issue, we re-estimated our regressions, but instead of splitting the sample into three groups each year, we used the groups to define interactive dummy variables. Consequently, we estimated the return relation for the three groups, but forced the control variables to have the same slopes for each group. Proceeding this way does not lead to changes in our conclusions. Finally, we re-estimated our regressions using the sample of firms where the fiscal year coincides with the calendar year and the sample of firms with stock prices exceeding $2 immediately before years in which they are in the sample. The results become stronger when we exclude firms with low stock prices; when we use only the firms with December fiscal years, there is no significant difference in the return/volatility relation when we split firms according to investment, Tobin's q, R&D, and where the firm's stock trades.

5. An examination of the reverse causation hypothesis

So far, we have shown a negative relation between changes in expected equity volatility and shareholder wealth. We have seen that this relation is stronger for firms with lower interest coverage and lower cash flow. This evidence is consistent with the arguments in the risk management and capital structure literatures that total risk affects firm value adversely. However, at this point, we have to consider carefully the possibility that the relation we have analyzed results from the fact that equity in a levered firm is an option on firm value. With the Black-Scholes formula, the volatility of the return of an option increases as the value of the underlying falls. Consequently, a decrease in firm value decreases the value of equity and increases the volatility of equity, thereby producing a negative relation between equity returns and the volatility of equity.

A number of papers estimate time-series regressions of the change in equity volatility on a firm's stock return. These papers find a negative coefficient on the firm's stock return, but not always. In particular, Cheung and Ng (1992) do not find a negative coefficient for large firms. Christie (1982) argues that the negative relation reflects the leverage effect. To show this, he estimates a regression where the relation between volatility changes and equity returns is determined by theory and finds support for the theory. Subsequently, authors using larger samples have not found as much support for the theoretical relation as Christie. Further, Duffee (1995) makes the point that the negative relation between the change in volatility and the firm's stock returns is mostly due to the strong positive relation between volatility and the contemporaneous stock return. He attributes this strong positive relation to the skewness in stock returns. More recently, Figlewski and Wang (2000) investigate the impact of equity returns on volatility for firms in the S&P100. They find that the impact of equity returns on volatility is not permanent and that leverage changes brought about by security issues do not have the impact predicted by the leverage effect literature.

Before assessing whether our results could be explained by the leverage effect, we have to find out what this effect implies for our regressions. Remember that Merton (1974) values equity as an option on firm value where the exercise price is equal to the face value of discount debt. With this model, an increase in firm value decreases the volatility of equity. As the ratio of the value of equity to the value of the firm increases, the volatility of equity falls as it converges asymptotically to the volatility of the firm. As Figure 1 shows, the impact of changes in the value of the firm on equity volatility weakens as equity increases in value. This means that if the only reason for equity volatility changes is changes in firm value, a 100 basis point change in equity volatility is the product of a much bigger change in firm value when firm value is high than when firm value is low. Consequently, for given face value of debt, the leverage effect implies a much larger coefficient on volatility for firms with low leverage than firms with high leverage. We estimated no regression where this was true. On the contrary, any significant evidence involving leverage or involving firm value leads us to reach the opposite conclusion, namely that the return/volatility relation is weaker for firms with low leverage and firms with high value relative to book assets. To the extent that the leverage effect is at work in our data, it therefore weakens our conclusions.

Stronger evidence can be provided that our results cannot be explained by the leverage effect. In Table 5, we first look at the return/volatility relation for firms that have almost no leverage. These firms have liabilities below 20% of firm value measured as the sum of liabilities plus the market value of firm equity. For these firms, we find a significant relation between returns and volatility but there is no evidence of a stronger relation for these firms than for other firms. There is more, however. We then split the firms in that sample into three groups based on interest coverage. We see that firms with low leverage but low interest coverage have a strong return/volatility relation but firms with high interest coverage have an insignificant relation. This result reaffirms the importance of interest coverage, and hence of the probability of financial distress, as a determinant of the return/volatility relation that we identified in the previous section. The leverage effect would predict that the return/volatility relation would be strong for the firms with high interest coverage and low leverage since these firms must be the least levered in our sample.

The results in Table 5 also show that our results cannot be explained by the fact that we use changes in expected equity volatility to proxy for changes in firm cash flow volatility. The reason for this is that the firms used in the regressions of Table 5 have almost no leverage. For such firms, equity volatility is very close to firm volatility. Yet, even for these firms, we find that there is a significant return/volatility relation.

6. Conclusion.

In this paper, we explored the relation between return and changes in expected equity volatility. Throughout the paper, we find that an increase in expected volatility is associated with a decrease in shareholder wealth. This decrease is stronger for firms that are financially weaker and have poorer growth opportunities. This evidence is consistent with corporate finance theories that emphasize the cost of total risk, but is inconsistent with theories that argue that the option properties of equity or growth opportunities are first-order effects. We saw that our evidence cannot be explained by the impact of changes in shareholder wealth on volatility, but this impact weakens our results. Further work should attempt to lessen this bias in our estimates, so that we can quantify the return/volatility relation more precisely. Also, an examination of the return/volatility relation for alternate estimators of the change in expected equity volatility and possibly for other proxies for cash flow volatility would enable us to understand the return/volatility relation better. However, the bottom line from our investigation is that we find evidence that changes in expected equity volatility affect shareholder wealth using a number of different regression specifications and the evidence is consistent with the theoretical corporate finance literature finding that increases in cash flow volatility are costly for shareholders.

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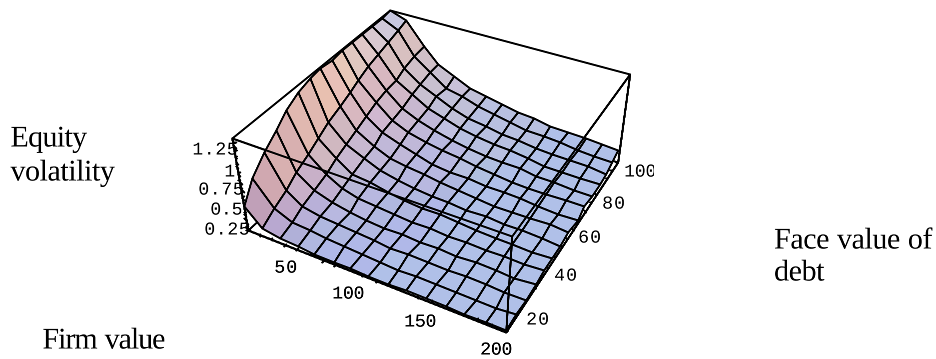
Figure 1. The leverage effect

The two panels assume an interest rate of 6%, discount debt with maturity in five years, a firm volatility of 25% p.a. Panel A shows how changes in firm value and face value of debt affect volatility. Panel B shows the ratio of the impact of a change in value of the firm on the return of equity to the impact of a change in value of the firm on volatility. This ratio tells us what the coefficient on the change in risk would have to be for the leverage effect to explain our results.

Panel A. Volatility, firm value, and face value of debt.



Panel B. Leverage effect.

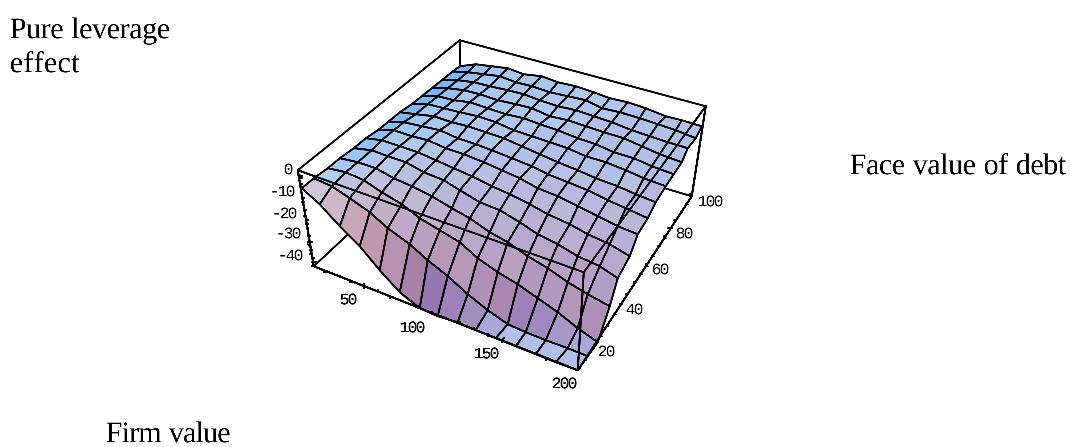


Table 1. The average equity return in excess of the one-year T-bill yield for the deciles of changes in equity volatility. The sample period is from 1964 to 1997. The sample consists of all firms in COMPUSTAT with the required data whose stock returns are available from CRSP and whose total assets are greater than 1 million dollars in 1998 dollars. Average equity return is for year t while changes in equity volatility are from year t to year t+1.

	Decile by changes in equity volatility										
Year	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	Dec. 10 - Dec. 1
1964	0.315	0.215	0.156	0.158	0.167	0.125	0.175	0.171	0.105	-0.042	-0.357
1965	0.665	0.167	0.151	0.173	0.137	0.185	0.162	0.371	0.389	0.306	-0.359
1966	0.308	0.146	-0.011	-0.071	-0.093	-0.106	-0.102	-0.084	-0.133	-0.132	-0.440
1967	1.524	0.986	0.763	0.567	0.395	0.314	0.218	0.333	0.520	0.464	-1.060
1968	0.758	0.499	0.290	0.275	0.154	0.175	0.174	0.203	0.291	0.373	-0.385
1969	-0.309	-0.223	-0.243	-0.218	-0.289	-0.275	-0.321	-0.344	-0.429	-0.397	-0.088
1970	-0.272	-0.230	-0.198	-0.152	-0.049	-0.056	0.002	0.011	-0.118	-0.281	-0.009
1971	0.269	0.210	0.303	0.151	0.157	0.108	0.116	0.133	0.228	0.077	-0.192
1972	0.080	0.038	0.068	0.059	0.082	0.040	0.007	-0.108	-0.142	-0.276	-0.356
1973	-0.400	-0.339	-0.259	-0.267	-0.227	-0.276	-0.297	-0.350	-0.377	-0.482	-0.082
1974	-0.291	-0.258	-0.281	-0.260	-0.275	-0.243	-0.261	-0.257	-0.308	-0.447	-0.156
1975	0.573	0.608	0.644	0.543	0.490	0.406	0.334	0.308	0.262	0.149	-0.424
1976	0.441	0.438	0.354	0.309	0.335	0.276	0.284	0.232	0.190	0.054	-0.387
1977	0.500	0.238	0.127	0.045	0.048	0.077	0.139	0.130	0.122	0.062	-0.438
1978	0.475	0.285	0.242	0.096	0.062	0.033	0.057	0.179	0.120	0.145	-0.330
1979	0.449	0.229	0.179	0.126	0.105	0.062	0.124	0.257	0.295	0.166	-0.283
1980	0.507	0.341	0.283	0.308	0.179	0.127	0.126	0.138	0.236	0.186	-0.321
1981	0.077	0.095	-0.012	0.041	0.000	-0.011	-0.041	-0.140	-0.162	-0.385	-0.463
1982	0.239	0.234	0.212	0.264	0.228	0.186	0.217	0.150	0.073	-0.089	-0.329
1983	0.937	0.550	0.486	0.359	0.339	0.250	0.267	0.279	0.235	0.092	-0.845
1984	-0.266	-0.146	-0.118	-0.047	-0.017	-0.031	-0.035	-0.160	-0.233	-0.414	-0.148
1985	0.094	0.209	0.256	0.244	0.246	0.231	0.259	0.185	0.075	-0.205	-0.299
1986	0.211	0.164	0.157	0.123	0.110	0.055	0.095	0.034	-0.020	-0.148	-0.359
1987	-0.064	-0.050	-0.086	-0.119	-0.098	-0.118	-0.116	-0.088	0.022	-0.203	-0.139
1988	-0.147	0.040	0.049	0.092	0.125	0.094	0.104	0.064	0.025	-0.250	-0.102
1989	0.105	0.236	0.178	0.189	0.135	0.145	0.120	0.020	-0.117	-0.252	-0.358
1990	-0.154	-0.076	-0.115	-0.081	-0.088	-0.142	-0.148	-0.187	-0.253	-0.431	-0.277
1991	0.847	0.659	0.513	0.394	0.283	0.285	0.359	0.317	0.329	0.209	-0.638
1992	0.379	0.225	0.217	0.180	0.169	0.148	0.132	0.146	0.050	-0.036	-0.415
1993	0.628	0.350	0.275	0.196	0.200	0.215	0.140	0.213	0.198	-0.073	-0.701
1994	-0.050	0.026	0.005	-0.016	-0.063	-0.039	-0.047	-0.017	-0.094	-0.321	-0.271
1995	0.509	0.298	0.226	0.224	0.219	0.249	0.256	0.325	0.399	0.094	-0.415
1996	0.259	0.186	0.164	0.171	0.180	0.148	0.153	0.155	0.120	-0.144	-0.404
1997	0.144	0.221	0.338	0.269	0.286	0.308	0.286	0.310	0.100	-0.164	-0.308
Average	0.275	0.193	0.156	0.127	0.107	0.087	0.086	0.086	0.059	-0.082	-0.357
t-stat	3.87	4.05	3.73	3.64	3.41	2.93	2.89	2.52	1.48	-1.92	-9.80

Table 2. Fama-McBeth regressions of yearly returns on changes in equity volatility and control variables. The sample period is from 1964 to 1997. Regression (1) controls only for beta. Regression (2) controls for beta, industry dummy variables determined by the firm's two-digit SIC code, the log of the firm's age, and the log of the firm's assets measured in 1998 dollars. Regression (3) uses control variables of regression (2) as well as changes in earnings from t-1 to t. Regression (4) repeats regression (3) for a sample without financial firms and utilities. Regression (5) uses the same control variables as Fama and French (1998) as well as beta.

		Equity volatility (t+1) - Equity volatility (t)	
		Mean	t(Mean)
(1)	Whole sample period	-0.633	-7.09
	Years between 64 and 80	-0.837	-5.91
	Years between 81 and 97	-0.430	-4.92
(2)	Whole sample period	-0.586	-7.61
	Years between 64 and 80	-0.763	-6.67
	Years between 81 and 97	-0.409	-4.73
(3)	Whole sample period	-0.509	-7.03
	Years between 64 and 80	-0.651	-5.89
	Years between 81 and 97	-0.366	-4.44
(4)	Whole sample period	-0.514	-7.19
	Years between 64 and 80	-0.658	-6.13
	Years between 81 and 97	-0.369	-4.44
(5)	Whole sample period	-0.459	-5.59
	Years between 64 and 80	-0.627	-4.68
	Years between 81 and 97	-0.290	-3.64

Table 3. Robustness tests. The sample period is from 1964 to 1997. Systematic risk is the product of the market model beta squared and the variance of the CRSP value-weighted index return. Unsystematic risk is the variance of market model residuals. The control variables in the regressions are beta, industry dummy variables determined by the firm's two-digit SIC code, the log of the firm's age, and the log of the firm's assets in 1998 dollars. Regressions are performed every year and the reported estimate is the average of the yearly coefficients, and the t-statistic is for the average coefficient. Continuously-compounded returns are the logarithm of (1+ yearly return).

Panel 1. Continuously-compounded returns.

	Equity volatility (t+1) - Equity volatility (t)	
Whole sample period	-0.378	-9.96
Years between 64 and 80	-0.471	-10.56
Years between 81 and 97	-0.285	-5.32

Panel 2. Regression of returns on current equity volatility, expected equity volatility and other variables.

	Equity volatility (t)		Equity volatility (t+1)		Difference in coefficients	
	Mean	t(Mean)	Mean	t(Mean)	Mean	t(Mean)
Whole sample period	0.425	3.39	-0.454	-9.12	0.879	5.79
Years between 64 and 80	0.594	2.80	-0.562	-8.12	1.157	5.15
Years between 81 and 97	0.256	2.00	-0.346	-5.50	0.602	3.21

Panel 3. Regression of returns on changes in systematic risk and changes in non-systematic risk.

	Systematic Risk (t+1) - Systematic Risk (t)		Non-Systematic Risk (t+1) - Non-Systematic Risk (t)	
	Mean	t(Mean)	Mean	t(Mean)
Whole sample period	5.991	6.42	-0.680	-6.60
Years between 64 and 80	5.831	4.40	-0.953	-5.73
Years between 81 and 97	6.150	4.55	-0.408	-4.87

Panel 4. Regression of returns on positive changes in equity volatility and negative changes in equity volatility.

	Positive (Equity volatility (t+1) - Equity volatility (t))		Negative (Equity volatility (t+1) - Equity volatility (t))		Difference in coefficients	
	Mean	t(Mean)	Mean	t(Mean)	Mean	t(Mean)
Whole sample period	-0.402	-6.30	-0.635	-3.93	0.233	1.23
Years between 64 and 80	-0.495	-4.26	-0.856	-3.19	0.361	1.05
Years between 81 and 97	-0.308	-6.56	-0.414	-2.41	0.106	0.63

Table 4. Fama-McBeth regressions by firm characteristics. The sample period is from 1964 to 1997. Control variables are beta, industry dummy variables determined by the firm's two-digit SIC code, the log of the firm's age, and the log of the firm's assets in 1998 dollars, and changes in earnings from t-1 to t.

	Equity volatility (t+1) - Equity volatility (t)	
	Mean	t(Mean)
Panel 1. Leverage (liabilities (t-1) / market value (t-1))		
Low leverage	-0.379	-5.92
Medium leverage	-0.448	-6.16
High leverage	-0.589	-6.64
Difference between low and high	0.210	1.92
Panel 2. Interest coverage (EBIDT (t-1) / Interest (t-1))		
Low interest coverage	-0.616	-6.51
Medium interest coverage	-0.418	-5.95
High interest coverage	-0.366	-5.05
Difference between low and high	-0.249	-2.09
Panel 3. Cash flow (EBIDT (t-1) / total assets (t-1))		
Low cash flow	-0.631	-6.90
Medium cash flow	-0.434	-5.26
High cash flow	-0.335	-4.90
Difference between low and high	-0.296	-2.60
Panel 4. Investments (capital expenditures (t-1) / total assets (t-1))		
Low investments	-0.663	-7.21
Medium investments	-0.410	-5.73
High investments	-0.429	-5.63
Difference between low and high	-0.234	-1.96
Panel 5. Size (market value of equity (t-1))		
Small firms	-0.592	-6.70
Medium firms	-0.337	-4.86
Large firms	0.008	0.09
Difference between small and large	-0.601	-4.78
Panel 6. Growth opportunities (market value (t-1) / book value (t-1))		
Low growth opportunities	-0.583	-6.54
Medium growth opportunities	-0.465	-5.55
High growth opportunities	-0.380	-4.06
Difference between low and high	-0.204	-1.57
Panel 7. Low R&D is R&D less than 1 % of total assets		
Low R&D	-0.525	-6.74
High R&D	-0.255	-2.24
Difference between low and high	-0.270	-1.95
Panel 8. Exchange listing at t		
NASDAQ	-0.424	-5.13
NYSE & AMEX	-0.548	-8.06
Difference	0.124	1.16

Table 5. Yearly cross-section regressions for low leverage firms. The sample period is from 1964 to 1997. Low leverage firms are firms whose total liabilities are less than 20 percent of market value of the firm's total assets. Interest coverage is the ratio of earnings before interest, depreciation and tax to interest expenses. Control variables are beta, industry dummy variables determined by the firm's two-digit SIC code, the log of the firm's age, and the log of the firm's assets in 1998 dollars, and changes in earnings from t-1 to t.

Panel 1. Firms with trivial liabilities

	Equity volatility (t+1) - Equity volatility (t)	
	Mean	t(Mean)
Liabilities < 10% of market total assets	-0.357	-3.07
Liabilities < 20% of market total assets	-0.402	-5.09

Panel 2. Regressions by interest coverage for low leverage firms

	Equity volatility (t+1) - Equity volatility (t)	
	Mean	t(Mean)
Low interest coverage	-0.539	-4.23
Medium interest coverage	-0.152	-1.21
High interest coverage	-0.023	-0.08
Difference between low and high	-0.516	-1.63