Stock Return Volatility and Capital Structure Decisions*

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Abstract

We comprehensively examine the effects of stock return volatility on firms' financial and investment decisions. Consistent with theories of investment with financing frictions, firms with high volatility actively reduce their leverage, cut investment, increase cash holding, cut non-cash current assets such as inventories and account receivables, and cut dividend. The effects of volatility are stronger for firms with higher leverage and for firms with low cash holdings. Further decomposition of the volatility measure reveal that firms respond respond differently to expected volatility and volatility surprises, as well as to systematic and idiosyncratic volatility shocks. Finally, stock return volatility also significantly predicts future leverage adjustment and future investment.

JEL Classification: G32, G17.

Keywords: Stock Return Volatility, Leverage Ratio, Investment, Financial Constraint, Surprise Shocks, Uncertainty.

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1 Introduction

How are firms affected by economic uncertainty? A rapidly growing body of research has been studying the effects of uncertainty shocks on corporate investment and financing from the micro and macro level. In the presence of financial frictions, the effects of economic uncertainty on investment cannot be understood in isolation of firms' financial decisions, and vice versa. In this paper, we empirically examine the channels through which uncertainty shocks affect firms' financial and investment decisions in a joint framework.

Our analysis focuses on the basic budget equation for firms:

$$\underbrace{I_t + \Delta CH_t + \Delta CA_t + DIV_t}_{uses} = \underbrace{FCF_t + \Delta E_t + \Delta D_t}_{sources}.$$

This equation can also be interpreted as a statement of the uses and sources of cash inside a firm. The left-hand side of the equation states that the firm can use its cash (or generate cash if the sign of a term is negative) to make investment (I), increase cash holding (ΔCH), increase other current assets (ΔCA), or pay dividend (DIV). The right-hand side of the equation states that the firm can generate cash (or lose cash if the sign of a term is negative) through free cash flows (FCF), and by issuing equity (ΔE) or debt (ΔD).

In the presence of financing frictions, corporate decisions on investment, cash savings, payout, and external financing all become highly inter-connected. If a firm wants to increase its financial slack when facing a higher level of economic uncertainty, it could simultaneously cut investment, increase cash holding, reduce payout, and adjust its external debt or equity financing. Recent developments in dynamic models of investment with financing constraints have provided new predictions on such multifaceted responses firms can have for uncertainty shocks. Examining these responses in a joint framework can help us better distinguish the channels through which uncertainty shocks affect firm decisions. For example, they can help us distinguish between the financial friction channel and the classic real option channel for how uncertainty affects investment.

We show that firms with high volatility actively reduce their leverage, improve internal liquidity, and increase debt maturity. We capture the leverage effect by focusing on the active adjustments firms make to change their book (and market) leverage. Specifically, high volatility firms appear to be issuing equity and reducing debt, even though the effects of these actions on leverage are largely offset by other factors. This finding is consistent with the prediction of the trade-off theory, which shows that it could be optimal for firms with high volatility to reduce leverage in order to reduce the risks of financial distress. Alternatively, it could be the limited supply of short-term debt that forces firms facing higher uncertainty to delever. On the uses of cash side, we show that firms with high volatility tend to reduce investment, increase cash holding, reduce non-cash current assets, and cut dividends.

When decomposing volatility into lagged volatility and changes in volatility, we show that the adjustments on long-term debt, equity, and cash holding primarily respond to lagged volatility, while investment and other financial adjustments respond significantly to both lagged volatility and contemporaneous volatility shocks. When decomposing volatility into expected volatility and volatility surprises, we show that the surprise component in volatility plays the main role in determining the effect of uncertainty on investment. The latter finding echoes Abel and Eberly (1994) in that uncertainty is less influential when it is largely predictable. Moreover, systematic volatility shocks have larger effects on investment and financing decisions than idiosyncratic volatility shocks. Finally, we show that the effects of volatility shocks on firms' investment and financing decisions are stronger when firms are more financially constrained, as proxied by high leverage or low cash holding.

We also show that volatility predicts future active adjustments in leverage. Firms with high return volatility in current year will reduce their leverage ratios in the subsequent year. The predictability of stock return volatility for active leverage adjustments is unbalanced, asymmetric, and short-run. Although firms adjust simultaneously debt downward and equity upward when the total volatility risk is high, they tend to respond more significantly to surprise volatility shocks with debt reduction rather than equity issuance. The volatility effect is asymmetric, i.e., active adjustment in leverage is much stronger in response to positive (rising) volatility shocks than to negative (falling) ones. The impact of surprise shocks on capital structure is mainly short-term within one year, consistent with the notion of uncertainty shock (Bloom, 2009). The predictive power is stronger for firms with lower rating, smaller size, and lower profitability, but nonmonotonic with respect to external financing need.

To the best of our knowledge, this paper is the first comprehensive examination of the effects of uncertainty shocks on firms' financial and investment decisions. Our paper provides new empirical evidence to two strands of literature, one on the effects of uncertainty shocks on investment, the other on the effects of financing constraints on investment. Bloom, Bond, and Reenen (2007) show that uncertainty reduces the sensitivity of investment to demand shocks, while Bloom (2009) shows theoretically that rising aggregate uncertainty discourages investment and hiring. Panousi and Papanikolaou (2012) find that idiosyncratic volatility negatively affects investment at individual firm level, attributing the cause to managerial risk aversion. Recently, Arellano, Bai, and Kehoe (2012) and Gilchrist, Sim, and Zakrajek (2014) have examined the interactions of uncertainty shocks and financing frictions in general equilibrium. We provide evidence of the multifaceted responses individual firms have to uncertainty shocks. Importantly, we demonstrate that the effects of uncertainty on investment are mostly driven by the surprise component in volatility shocks, not by the expected component, whereas the latter can have stronger effects on certain capital structure adjustments.

A large body of work have studied theoretically and empirically the impact of financial constraints on investment, including Whited (1992), Gomes (2001), Almeida, Campello, and Weisbach (2004), Riddick and Whited (2009), Campello, Graham, and Harvey (2010), Faulkender and Petersen (2012), Bolton, Chen, and Wang (2011), Bolton, Chen, and Wang (2013), Doshi, Kumar, and Yerramilli (2014), among others. In a dynamic model of investment with costly external financing, Bolton, Chen, and Wang (2011) show that higher cash-flow volatility will lead firms to cut investment, increase cash holding, and delay equity payout. Our empirical findings are consistent with these predictions.

Empirical evidence indicates that firms change their capital structures over time (Fama and French, 2002; Baker and Wurgler, 2002; Leary and Roberts, 2005). The survey results reported by Graham and Harvey (2001) confirm that corporate managers consider distress risk in their financing decisions. Traditional capital structure determinants do not perform well or consistently in explaining the with-in firm leverage change over time (Graham and Leary, 2011). Early research focuses on capital structure and earnings volatility, but reaches conflicting conclusions (Harris and Raviv, 1991).[1] One caveat of using accounting-based volatility measures is that they must rely on low frequency data over long history, which may not represents the current firm and market situations accurately. In comparison, stock return volatility not only contains rich and timely current information, but also reflects firm's future fundamental in a forward-looking manner. Evidence shows that stock return volatility shock significantly affects leverage adjustment in the presence of earnings volatility shock.

Our work is also related a few recent papers on leverage, volatility, and investment. Welch (2004) investigates the interaction between capital structure and stock return, while controlling for the negative relationship between implied leverage ratio and stock return volatility. Nikolay, Heider, and John (2010) find that Black-Scholes formula implied volatility marginally explains change in debt level conditional on firm experiencing internal financial deficit. In contrast, we focus on examining volatility of observed stock returns and active changes in leverage in a more general setting.

[1] For example, Titman and Wessels (1988) find that earnings volatility does not appear to be related to the various measures of leverage, whereas Bradley, Jarrell, and Kim (1984) and Friend and Lang (1988) find leverage negatively correlated with earnings volatility. Kim and Sorensen (1986) find that EBIT variations are positively correlated with debt ratios. This paper shows that the predictive power of earnings volatility on leverage and leverage adjustment depends on how earnings volatility is measured. In particular, earnings volatility estimated with the ratio of operating income before depreciation to total assets has negative and statistically significant predictive power on change in leverage in the subsequent year, while earnings volatility estimated with percentage change in operating income before depreciation does not. However, change in earnings volatility shows no significant predictive power on capital structure and investment decisions.

2 Empirical Design

The innovation of our approach is to introduce new explanatory variables for capital structure changes, based on the stochastic volatility model of Engle (1982) and Bollerslev (1986). Our empirical methodology follows Welch (2004, 2011) to focus on the "active" adjustments of firms' leverage decisions. The statistical properties of key variables are also discussed.

2.1 Volatility Shock

The trade-off theory (Modigliani and Miller, 1958; Scott, 1976) predicts that firms with high volatility face higher probability of financial distress. We use realized volatility, $VOL_{i,t}$ as primary measure of uncertainty. The trade-off model further suggests that firms adjust capital structure when volatility fluctuates. So we estimate change in volatility, $\Delta VOL_{i,t-1}$ as the difference between $VOL_{i,t}$ and $VOL_{i,t-1}$. We also apply econometric tools for stochastic volatility to construct surprise volatility shock, $\Delta VOL_{i,t}^{Surp.}$. In particular, we use ARMA(1,1) model of realized volatility similar to GARCH(1,1) model of Bollerslev (1986), but with an explicit observable proxy for latent surprise volatility as in Andersen, Bollerslev, Diebold, and Ebens (2001):

$$VOL_{i,t} = \theta_{0,i} + \theta_{1,i} VOL_{i,t-1} + \theta_{2,i} \varepsilon_{i,t-1} + \varepsilon_{i,t}. \tag{1}$$

Surprise volatility shock is computed as $\Delta VOL_{i,t}^{Surp.} = VOL_{i,t} - \widehat{VOL_{i,t}}$.

To connect with existing literature, we also decompose total volatility into systematic and idiosyncratic volatilities, by estimating daily idiosyncratic returns using the residuals from the Fama and French (1993) three-factor model,

$$r_{i,t} - r_t^f = \beta_i^M (r_t^M - r_t^f) + \beta_i^{SMB} r_t^{SMB} + \beta_i^{HML} r_t^{HML} + \xi_{i,t}, \tag{2}$$

where r_t^M, r_t^f, r_t^{SMB}, and r_t^{HML} represent market return, risk-free rate, and the returns for size and book-to-market ratio portfolios, respectively.[2] We compute annual systematic volatility $Vol_{i,t}^{Sys}$ as the standard deviation of the estimated systematic returns, $\widehat{r}_{i,t}^{Sys.} = \widehat{\beta}_i^M(r_t^M - r_t^f) + \widehat{\beta}_i^{SMB} r_t^{SMB} + \widehat{\beta}_i^{HML} r_t^{HML} + r_t^f$, and annual idiosyncratic volatility $VOL_{i,t}^{Idio}$ as the standard deviation of the idiosyncratic returns, $\widehat{r}_{i,t}^{Idio.} = r_{i,t} - \widehat{r}_{i,t}^{Sys.}$. When estimating surprise systematic and idiosyncratic volatility shocks, we apply the same ARMA(1,1) model with lags of each type of volatilities:

$$\begin{aligned}
VOL_{i,t}^{Sys.} &= \theta_{0,i}^{Sys.} + \theta_{1,i}^{Sys.} VOL_{i,t-1}^{Sys.} + \theta_{2,i}^{Sys.} \varepsilon_{i,t-1} + \theta_{3,i}^{Sys.} VOL_{i,t-1}^{Idio.} + \varepsilon_{i,t}, \\
VOL_{i,t}^{Idio.} &= \theta_{0,i}^{Idio} + \theta_{1,i}^{Idio.} VOL_{i,t-1}^{Idio} + \theta_{2,i}^{Idio.} \varepsilon_{i,t-1} + \theta_{3,i}^{Idio.} VOL_{i,t-1}^{Sys.} + \varepsilon_{i,t}.
\end{aligned}$$

Surprise systematic and idiosyncratic volatility shocks are then computed in the same way as for total volatilities.

2.2 Capital Budgeting

As outlined above, there are three sources of cash inflow:

- $FCF_{i,t} = \frac{NI_{i,t} + DEP_{i,t}}{AT_{i,t-1}}$, free cash flow, where NI, DEP, and AT denote net income, depreciation, and total assets, respectively;
- $\Delta E_{i,t} = \frac{E_{i,t} - E_{i,t-1}}{AT_{i,t-1}}$, change in equity due to net issuance, where E denotes shareholder's equity;
- $\Delta D_{i,t} = \frac{D_{i,t} - D_{i,t-1}}{AT_{i,t-1}}$, change in debt due to net issuance, where D denotes total liabilities.

We consider four channels of cash outflow:

- $I_{i,t} = \frac{CAPXi,t}{AT_{i,t-1}}$, capital investment, where $CAPX$ denotes capital expenditure;

[2] For robustness check, we also apply the CAPM model to estimate systematic returns. The regression results with the systematic and idiosyncratic volatilities estimated from the CAPM model are very similar to those estimated from the Fama-French model. For simplicity, we report the results associated with the Fama-French model only.

- $\Delta CH_{i,t} = \frac{CH_{i,t} - CH_{i,t-1}}{AT_{i,t-1}}$, change in cash holdings, where CH denotes cash;
- $\Delta CA_{i,t} = \frac{CA^{Noncash}_{i,t} - CA^{Noncash}_{i,t-1}}{AT_{i,t-1}}$, change in (non-cash) current assets, where $CA^{Noncash}$ denotes non-cash current assets;
- $DIV_{i,t} = \frac{DIVi,t}{AT_{i,t-1}}$, dividend payout, where DIV denotes cash dividend.

Further examine components of and corporate decisions related capital budgeting, we distinguish long-term debt and short-term liabilities, and measure

- $\Delta D^{Long}_{i,t} = \frac{D^{Long}_{i,t} - D^{Long}_{i,t-1}}{AT_{i,t-1}}$, change in long-term debt, where D^{Long} denotes long-term debt;
- $\Delta CL_{i,t} = \frac{CL_{i,t} - CL_{i,t-1}}{AT_{i,t-1}}$, change in current liabilities, where CL denotes current liabilities.

Within current liabilities, we measure

- $\Delta AP_{i,t} = \frac{AP_{i,t} - AP_{i,t-1}}{AT_{i,t-1}}$, change in accounts payable, where AP denotes accounts payable.

In response to volatility shocks, firms engage in short-term liquidity and solvency risk management. Within the category of current assets, firms could reduce inventory and sales credit to their customers. We measure

- $\Delta INVT_{i,t} = \frac{INVT_{i,t} - INVT_{i,t-1}}{AT_{i,t-1}}$, change in firm inventory, where $INVT$ denotes total inventory;
- $\Delta AR_{i,t} = \frac{AR_{i,t} - AR_{i,t-1}}{AT_{i,t-1}}$, change in accounts receivable, where AR denotes accounts receivable.

Operating expenses directly affect firms' free cash flow. Three types of expenses are of particular interest:

- $R\&D_{i,t} = \frac{R\&D_{i,t}}{AT_{i,t-1}}$, research and development expenses;

- $Labor_{i,t} = \frac{LABORe_{i,t}}{AT_{i,t-1}}$, labor expenses;
- $SGA_{i,t} = \frac{SGA_{i,t}}{AT_{i,t-1}}$, selling, general and administrative expenses.

2.3 Capital Structure

We examine the predictability of stock return volatility for active leverage adjustment, in the presence of traditional capital structure determinants suggested by theories and empirical evidence. Book leverage is defined as

$$LEV_{i,t} \equiv \frac{D_{i,t}}{D_{i,t} + E_{i,t}^{Book}}, \tag{3}$$

where $D_{i,t}$ and $E_{i,t}^{Book}$ denote total liabilities and book equity, respectively. We compute the change in book debt ratio at t as

$$\Delta LEV_{i,t} \equiv \frac{D_{i,t}}{D_{i,t} + E_{i,t}^{Book}} - \frac{D_{i,t-1}}{D_{i,t-1} + E_{i,t-1}^{Book}}, \tag{4}$$

and change in book leverage due to net debt/equity issuance as

$$\Delta LEV_{i,t}^{Issue} \equiv \frac{D_{i,t}}{D_{i,t} + (E_{i,t} - \Delta RE_{i,t})} - \frac{D_{i,t-1}}{D_{i,t-1} + E_{i,t-1}}, \tag{5}$$

where $\Delta RE_{i,t} = RE_{i,t} - RE_{i,t-1}$ and $RE_{i,t}$ denotes accumulative retained earnings.

We also follow Welch (2004, 2011) to compute market leverage as

$$LEV_{i,t}^{Mkt} \equiv \frac{D_{i,t}}{D_{i,t} + E_{i,t}^{Mkt}}, \tag{6}$$

where $E_{i,t}^{MKT}$ denotes market value of equity. Market leverage changes when equity price fluctuates, so it is important to purge out such mechanical effect to measure active capital structure adjustment. A latent implied leverage ratio is defined as

$$ILEV_{i,t}^{Mkt} \equiv \frac{D_{i,t-1}}{D_{i,t-1} + E_{i,t-1}^{Mkt}\left(1 + x_{i,t-1,t}\right)}, \tag{7}$$

where $x_{i,t-1,t}$ is capital gain of firm i's equity over time $t-1$ to t. The actual and implied debt ratios formulated above allow us to define change in market leverage at time t as

$$\Delta LEV_{i,t}^{Mkt} \equiv LEV_{i,t}^{Mkt} - LEV_{i,t-1}^{Mkt} = \frac{D_t}{D_{i,t} + E_{i,t}^{Mkt}} - \frac{D_{i,t-1}}{D_{i,t-1} + E_{i,t-1}^{Mkt}}, \tag{8}$$

and change in market leverage due to net debt/equity issuance as

$$\Delta LEV_{i,t}^{Mkt.Active} \equiv LEV_t^{Mkt} - ILEV_{i,t}^{Mkt} = \frac{D_{i,t}}{E_{i,t}^{Mkt} + D_{i,t}} - \frac{D_{i,t-1}}{D_{i,t-1} + E_{i,t-1}^{Mkt}.(1 + x_{i,t-1,t})}. \tag{9}$$

2.4 Short-term Solvency and Debt Maturity

We also consider short-term solvency, or liquidity, measures:

- $\Delta_C Ri,t = \frac{CR_{i,t} - CR_{i,t-1}}{AT_{i,t-1}}$, change in cash ratio, where $CR = \frac{Cash}{CurrentLiabilities}$;
- $\Delta QR_{i,t} = \frac{QR_{i,t} - QR_{i,t-1}}{AT_{i,t-1}}$, change in quick ratio, where $QR = \frac{CurrentAssets - Inventory}{CurrentLiabilities}$;
- $\Delta CC_{i,t} = \frac{CC_{i,t} - CC_{i,t-1}}{AT_{i,t-1}}$, change in cash coverage, where $CC = \frac{EBIT + Depreciation}{Interest}$.

Debt maturity jointly changes with capital structure. We measure

- $\Delta CL/Di,t = \frac{CL_{i,t}}{D_{i,t}} - \frac{CL_{i,t-1}}{D_{i,t-1}}$, change in the ratio of current liabilities to total liabilities;
- $\Delta D^\ell/Di,t = \frac{D_{i,t}^\ell}{D_{i,t}} - \frac{D_{i,t-1}^\ell}{D_{i,t-1}}$, change in the ratio of long-term debt to total liabilities.

2.5 Control Variables

Previous research documents that firm capital structure is influenced by a set of fundamental and macroeconomic factors.[3] Besides lagged leverage $LEV_{i,t-1}$, we consider the following variables in our analysis: $R_{i,t}$ denote stock return between time $t-1$ and t. Welch (2004) shows that market debt ratio may change passively with stock price fluctuation, which does not reflect directly active financing decisions. The natural logarithm of lagged total assets,

[3] Harris and Raviv (1991), Rajan and Zingales (1995), Frank and Goyal (2003), and Graham and Leary (2011) present reviews of the capital structure literature.

$\ln(AT_{i,t-1})$, as a proxy for size. Titman and Wessels (1988) and Baker and Wurgler (2002) find a positive relationship between debt ratio and firm size. Lagged cash holdings and capital expenditure normalized by total assets, denoted by $CH_{i,t-1}$ and $I_{i,t-1}$, respectively. We include $\ln(AT_{i,t-1})$, as a proxy for size. Tobin's Q, denoted by $Q_{i,t}$, as a proxy for growth. Cash flow, denoted by $CFL_{i,t}$ is computed as $\frac{NI_{i,t}-DIV_{i,t}+DEP_{i,t}}{AT_{i,t-1}}$. It measures short-term solvency and is expected to be positively correlated with leverage. Lagged dividend dummy, denoted by $Payout_{i,t-1}$, takes 1 if a firm pays out cash dividend at $t-1$, otherwise 0. Financial deficit normalized by sales, denoted by $DEF_{i,t}$, as a measure of the degree of external financing need.[4]

We include three variables to measure market condition and macroeconomic environment: S&P value-weighted return, denoted by R_t^{MKT}, and industrial production index growth, denoted by ΔPG_t, between time $t-1$ and t. Further, we control for the industry effect. Further, we apply the robust standard error method proposed in Petersen (2009) to control simultaneously for the firm and time clustering effects.

2.6 Summary Statistics

We collect data on firm financial information, stock returns and macroeconomic variables from several sources. The annual financial information used to compute debt ratios and the control variables is obtained from COMPUSTAT. To avoid selection bias, we include all available U.S. firms from the database's starting year of 1950 up to 2010. The daily stock returns of all U.S. firms available in CRSP between the database's starting year of

[4] Following the literature, we compute

$$\begin{aligned} DEF_{i,t} &= \frac{Cash\ Outflow_{i,t} - Internally\ Generated\ Cashflow_{i,t}}{Sales_{i,t}} \\ &= \frac{(INV_{i,t} + \Delta WC_{i,t}) - (NI_{i,t} - DVD_{i,t} + DEP_{i,t} + DT_{i,t})}{Sales_{i,t}}, \end{aligned}$$

where $INV_{i,t}$ represents investment in capital assets ($PPE_{i,t} - PPE_{i,t-1}+$ investment in intangible assets). $\Delta WC_{i,t}$ represents change in working capital between time $t-1$ and t, where working capital is defined as current assets excluding cash *minus* current liabilities. $NI_{i,t}$ denotes net income. $DVD_{i,t}$ denotes dividend. $DEP_{i,t}$ and $DT_{i,t}$ are the non-cash expenses—depreciation and amortization and deferred tax, respectively.

1948 and 2010 are downloaded. Our study requires an unbroken time series of debt ratios for each firm. Hence, we only keep firms that have financial information that enables us to compute at least four consecutive years' debt ratios. There are 78,003 firm-year observations when debt ratios and stock return volatilities are merged together. After removing the financial and utility firms, we have 61,925 observations from 4,413 firms in a period between June 1959 and May 2010. The daily S&P value-weighted index returns are obtained from CRSP as well. The Fama-French three factors and monthly industrial production index are downloaded from WRDS and the Federal Reserve Bank at St. Louis website, respectively.

Descriptive statistics of the key variables—median across the sample firms—are reported in Table 1. The average book leverage ratio, LEV, is 49.40%, which is highly persistent with AR(1)'s of 0.99. The change in book debt ratio has a mean of 1.11% and a standard deviation of 6.21%, respectively. The AR(1)'s of the active book and market debt ratio changes are 0.08 and 0.10, respectively, suggesting that they are much more suitable variables to study capital structure decisions. The AR(1) of the total debt ratio change, dct, is -0.06, consistent with the notion that debt ratios are mean-reverting Fama and French (2002); Baker and Wurgler (2002); Leary and Roberts (2005).

The volatility of stock returns has a mean of 42.86% and a standard deviation of 15.01%. It is highly persistent with an AR(1) of 0.97. The average change in expected volatility and volatility surprise are slightly negative of -0.09% and -0.10%, respectively. The change in expected volatility is negatively autocorrelated with an AR(1) of -0.24, while the volatility surprise is positively autocorrelated with an AR(1) of 0.30. The average systematic and idiosyncratic volatilities are 13.19% and 41.24%, respectively. The average annual stock return is 17.00% with a standard deviation of 46.37% and AR(1) of 0.12. For simplicity, we omit the discussion of other control variables, given that they are similar to those reported in existing literature.

Figure 2 illustrates the median active book (market) debt ratio changes with respect to expected volatility shock and volatility surprise shock over the sample period. The active book and market debt ratio change closely resemble each other. They tend to move in the opposite direction as the expected/surprise volatility shocks do, especially around the NBER recession. Book debt ratios, however, behave differently over time.

The volatility measures are positively correlated with each other. In particular, the correlation between volatility and volatility surprise (idiosyncratic volatility) is 0.85 (0.98). The correlation between volatility surprise and idiosyncratic volatility is 0.79, suggesting that firms are likely to experience greater surprise idiosyncratic shocks where volatility risk level is high. The stock return is negatively correlated with volatility with a correlation of -0.13. The correlations between the stock return and subsequent active book and market debt ratio changes are 0.07 and 0.09, respectively. The industrial production index growth is negatively correlated with stock return volatility, expected and surprise volatility shocks with correlations of -0.31, -0.11, and -0.33, respectively. The industrial production index growth is positively correlated with future capital structure adjustment, change in earnings, and change in investment. The correlations are 0.15, 0.15, 0.13, and 0.18, respectively.

3 Empirical Analysis

3.1 Leverage, Liquidity, and Debt Maturity

We start our analysis by examining how stock return volatility and volatility shocks relate to contemporaneous changes in the standard measures of leverage, liquidity, and debt maturity, which are common metrics for summarizing corporate decisions on capital structure and liquidity management.

In Table 2, we examine four different measures of leverage ratio, two on book leverage and two on market leverage. Since high stock return volatility tends to be associated with low cash flows, we control for contemporaneous cashflows and stock returns in all the regressions. Columns (1) and (3) show that high stock return volatility is contemporaneously insignificantly related to changes in book leverage, and significantly positively related to changes in market leverage. However, the results become very different when we focus on the "active part" of the leverage adjustment. Column (2) shows that the part of the change in book leverage due to firms' active issuance (and retirement) of debt and equity is in fact significantly negative when volatility is high. The coefficient of -1.668 implies that on average, one standard deviation increase in stock return volatility (15.01%) will lead a firm to lower its book debt ratio by 0.25%. Similarly, Column (4) shows that once we remove the direct effect of the change in market value of equity on market leverage, the "active" part of market leverage adjustment (Welch, 2004) is also negative when volatility is high.

Next, Columns (5) through (7) examine the relation between volatility and firm liquidity. We consider changes in the current ratio (ΔCR, a measure of cash holding relative to current liabilities), quick ratio (ΔQR, a measure of current assets relative to current liabilities), and cash coverage (ΔCC, a measure of free cash flow relative to interest expenses). In all three cases, high volatility is associated with an improvement in liquidity (with control for contemporaneous cashflows and stock returns). A one standard deviation increase in stock return volatility is associated with an increase in the current ratio of 1%, an increase in the quick ratio of 1.37%, and an increase in the cash coverage of 0.38.

Columns (8) and (9) examine the relation between volatility and debt maturity. We use the fraction of current liability in total debt as proxy for the fraction of short-term debt (CL/D), and the fraction of long-term debt in total debt as proxy for the fraction of long-term debt (D^ℓ/D).[5] As the Table shows, high volatility is associated with a reduction in the fraction of short-term debt and an increase in the fraction of long-term debt.

In summary, the results above suggest that firms that experience high volatility in stock returns tend to actively (attempt to) reduce their leverage, improve their liquidity, and lengthen their debt maturity. It is also clear that these standard metrics only give a crude summary of the adjustments firms are making in response to high uncertainty. In particular, by focusing on the "wrong" measures (e.g., for leverage ratio), we can reach

[5] Current liability includes debt with maturity of less than 1 year, while long-term debt are debt with maturity longer than 1 year. Besides these two types of debt, total debt also include other liabilities such as deferred taxes and pension liabilities.

opposite conclusion on the direction of firms' adjustments. This result highlights the importance of a more-detailed analysis of the multiple dimensions of firm decisions, which we consider next.

3.2 Decomposition of the Volatility Effects

As discussed in the introduction, we decompose the effects of volatility on firm decisions through the different uses and sources of cash, which are summarized by the following budget equation:

$$\underbrace{I_t + \Delta CH_t + \Delta CA_t + DIV_t}_{uses} = \underbrace{FCF_t + \Delta E_t + \Delta D_t}_{sources}.$$

In Table 3, we regress each of the components in the budget equation that are related to firm decisions in period t (FCF_t is the only exception) on contemporaneous volatility and other controls. We start with the different uses of cash. Consistent with the existing theory and evidence of uncertainty on investment (Bloom, Bond, and Reenen, 2007; Bloom, 2009), we also find high volatility to be associated with lower capital expenditure (I) after controlling for contemporaneous cashflows and stock returns. At the same time, high volatility is on average associated with an increase in cash holding (CH), a reduction in non-cash current assets (CA), and a reduction in dividend (DIV).

Next, on the sources of cash, we look at the net issuance of debt and equity ($\Delta D, \Delta E$). Controlling for cashflows, high volatility is associated with a smaller net amount of debt issued (or larger amount of debt retired), and it is associated with a larger net amount of equity being issued (or smaller amount of equity repurchase).

These results suggest that, besides reducing investment, firms facing high uncertainty are simultaneously adjusting their financial policies in multiple ways to reduce leverage and increase financial slack. In a dynamic model of investment with costly external financing, Bolton, Chen, and Wang (2011) show that higher cash-flow volatility will lead firms to cut investment, increase cash holding, and delay equity payout. Although the negative relation between uncertainty and investment is also potentially consistent with capital adjustment frictions associated with irreversibility, taken together with the other financial adjustments, our results are consistent with the effects of financial constraints on investment as predicted by Bolton, Chen, and Wang (2011).

Table 4 provides an even more granular look at the different components of financial adjustments. Columns (1) and (2) show that both long-term and short-term liability tend to be reduced by firms facing high volatility, but more so for short-term liability, which explains why the fraction of long-term debt increases (see Table 2). Part of the stronger reduction in short-term debt can be mechanical, since firms can more easily reduce short-term debt (by not rolling them over) than long-term debt (by recalling or renegotiating the debt). Moreover, both demand and supply effects could be at work in changing the amount of debt outstanding. On the one hand, as predicted by the tradeoff theory, firms might want to lower leverage to reduce the risks of financial distress when uncertainty is high. On the other hand, banks and suppliers might limit the amount of credit extended (the latter in the form of trade credit) when the borrower is facing more uncertainty (see the evidence in Faulkender and Petersen (2006)). Column (3) shows that account payable (AP) indeed tends to be reduced for firms facing high volatility.

In Table 3 we have seen that high volatility tends to be associated with an increase in cash holding and a decrease in non-cash current assets. Important parts of the non-cash current assets are account receivables (AR) and inventories ($INVT$). As Columns (4) and (5) of Table 4 show, both the account receivables and inventories tend to be reduced with high volatility.

Columns (6) through (8) examine three types of non-capital expenditures, namely R&D expenses ($R\&D$), labor expenses ($Labor$), and general non-production expenses (SGA). Consistent with the reduction in capital expenditure, we also find significant reduction in labor cost for firms with high volatility. While it is reasonable to expect a financially constrained firm to cut more on other forms of investment in order to shield its long-term R&D from temporary rise in uncertainty, Column (6) actually shows that R&D expenses are positively associated with volatility. This result could reflect the different effects of volatility on R&D depending on its source. For example, high uncertainty generated by technological breakthroughs can generate significant increases in R&D expenses. Finally, the non-production expenses do not appear to be significantly associated with firm volatility.

3.3 Decomposing Volatility

To further examine how volatility is connected to corporate capital budgeting and capital structure adjustments, we decompose volatility information by constructing two different shocks, that is, change in realized volatility and volatility surprise based on a measure of expected volatility, as specified in Section 2.1.

Table 5 shows that the active adjustments in leverage as documented earlier, including the (negative) debt and (positive) equity issuance adjustments, are primarily associated with lagged volatility, not contemporaneous changes in volatility. Similarly, the adjustment in cash holding is also mostly related to lagged volatility. In contrast, investment, adjustments in non-cash current assets, and payout are affected by changes in volatility and lagged volatility by similar amounts. For example, the coefficient of change in volatility is -9.032, suggesting that one standard deviation increase in volatility change (14.02%) leads to a decrease in payout rate by 1.27%.

The differential effects of the two components of volatility on different financial and investment decisions are in fact quite intuitive. It takes time for firms to change leverage through (long-term) debt and equity adjustments, as is to increase the cash reserve, which means these measures are likely to respond to volatility shocks with lags. In contrast, investment and payout policies can be adjusted more promptly following a rise in volatility.

Table 6 shows volatility surprises are negatively correlated to reduction in debt, while expected volatility is not. This is mainly due to the negative response of current liability to volatility surprises. On the equity side, firms tend to reduce equity at surprise volatility shocks. In contrast, firms are more inclined to issue equity when volatility is expected to be high. Both expected volatility and surprise shock are negatively associated with leverage reduction, stronger for expected volatility. Payout rate responds negatively to expected volatility and surprise shocks. The coefficient of surprise shock is -7.879. One standard deviation increase in surprise volatility (14.68%) leads to a decrease in payout rate of 1.15%. Investment is negatively correlated to both surprise volatility shocks. Both current assets and current liabilities fall at rising surprise volatility. The relatively higher coefficient for change in current assets explains the negative correlation between surprise volatility shock and change in working capital. Surprise shock exerts much stronger impact on capital investment compared to the expected component in volatility. The finding echoes Abel and Eberly (1994) in that uncertainty is less influential when it is more predictable.

We further decompose expected volatility and volatility shocks into systematic and idiosyncratic parts to analyze their effects on financial and investment decisions. In Table 7, both the expected and surprise components of systematic volatility are negatively and significantly related to active leverage adjustment, while only the expected idiosyncratic volatility is significantly negatively related to active leverage adjustment. Moreover, the size of the effect of systematic volatility (both in terms of the expected volatility and volatility surprises) is much stronger than that of the idiosyncratic volatility. This finding is consistent with the prediction of Chen (2010), who show that high systematic volatility has larger impact on the optimal capital structure choice because of systematic risk premium associated with the costs of financial distress. Similarly, we see larger effects of systematic volatility on debt and equity issuance, investment, cash holding, current assets, and payout.

3.4 The Effect of Financial Constraints

As dynamic models of financial constraints show (see e.g., Riddick and Whited (2009), Bolton, Chen, and Wang (2011), Bolton, Chen, and Wang (2013)), the effect of financing constraint on investment and financial policies can be quite non-linear, and it can vary significantly across firms with different degrees of financing constraints, as well as across time with different aggregate financing conditions. In this section, we examine the differential effect of leverage on investment and financial policies for firms with different levels of leverage and cash holdings. While both leverage and cash holding are endogenously chosen by firms, it is also well documented that they are sticky (see e.g., Leary and Roberts (2005), Flannery and Rangan (2006), Venkiteshwaran (2011)). Thus, we use lagged book leverage and lagged cash-to-asset ratio as proxies for firms' financing constraints.

Table 8 shows that the "effect" of volatility on active leverage adjustment is stronger for firms with higher leverage, as reflected by the significantly negative coefficient on the interaction term between volatility and lagged book leverage $VOL_{i,t} \times LEV_{i,t-1}$. Moreover, volatility also has stronger effect on investment, changes in cash holding, and changes in non-cash current assets for highly levered firms. The interaction term does not have a significant effect on payout. However, this could simply be due to the fact that highly levered firms do not tend to pay dividends.

Next, in Table 9, we interact volatility with lagged cash-to-asset ratio, where a firm with higher lagged cash-to-asset ratio is likely less constrained, all else equal. In this case, all the coefficients of the interaction terms are statistically significant and have opposite signs from the coefficients on VOL, which indicates that the "effect" of volatility on investment and financial adjustments is consistently weaker for firms with higher lagged cash holdings.

4 Future Leverage Adjustment and Investment

In Section 3, we have mainly focused on the contemporaneous relations between volatility, investment, and other financial adjustments. Our results on the decomposition of volatility into lagged volatility and changes in volatility in Table 5 show that active capital structure adjustments tend to respond to volatility shocks with a lag. This result implies the predictive power of volatility shocks on future capital structure adjustments. Similarly, through its effect on current investment, capital accumulation, and financial slack, volatility shocks could also have persistent effects on future profitability and investment. We examine these questions in this section.

4.1 Predicting Leverage Adjustments

Table 10 first compares the regression of active book debt ratio adjustment at time $t+1$ on volatility and stock return. Column (1) shows that in a univariate regression, subsequent adjustment in book leverage is negatively and significantly correlated to stock return volatility. The coefficient of -7.069 implies that on average, one standard deviation increase in stock return volatility (14.63%) will lead a firm to lower its book debt ratio by 1.03%. The t-statistic is -23.35 and the R^2 is 6.20%, suggesting that the influence of volatility risk on capital structure decisions is not only economically significant, but also statistically significant. This evidence confirms the finding in Leary and Roberts (2005) that firms adjust capital structures over time. It quantifies the the trade-off theory prediction in answering the question to what extent firms reduce leverage to counter-balance the rising likelihood of default due to increased volatility risk (Black and Scholes, 1973; Merton, 1974). Column (2) shows that stock return positively affects subsequent leverage adjustment as well, with a marginally significant t-statistics of 1.98. Firms tend to use more debt when their stocks perform well. The coefficient of 0.492 suggests that one standard deviation increase in stock return (46.37%) helps to elevate book debt ratio by 0.23%. The R^2 is 0.10%, much lower than 6.20% for volatility. The result does not contradict the prediction of the market timing theory that debt ratio should be negatively related to stock performance, since positive stock return does not necessarily mean equity being overvalued (Baker and Wurgler, 2002).

We then regress change in book debt ratio on volatility, stock return, and lagged book debt ratio, and report the result in Column (3) of Table 10. The correlation between volatility and subsequent debt ratio adjustment remains strong. The coefficient of volatility is -7.426 with a t-statistic of -26.69. The stock return volatility contains additional information beyond stock returns and leverage itself in predicting future leverage adjustment. The forecasting power of volatility is in the same order of the lag leverage—(i) the R^2 increases from 6.20% in Column (1) to 13.80% in Column (3); (ii) one standard deviation increase in volatility and book debt ratio (14.63% and 10.07%) causes 1.09% and 1.16% upward adjustment in debt ratio, respectively. The result reported in Column (4) confirms that the effect of volatility risk on capital structure adjustment is robust in the presence of the market- and firm-level leverage determinants. The negative coefficient of stock return volatility remains statistically significant at the 1% level. In comparison, the coefficient of stock return switches sign from positive to be negative. Stock return has a positive correlation (0.27) with return on assets, and ROA seems to dominate stock return for explaining leverage adjustment.[6] The S&P500 index volatility is not statistically significant. Industrial production index significantly predicts positive debt ratio change, suggesting that leverage is procyclical. Column (5) shows that the stock return volatility is negatively and significantly correlated with future book debt ratio.[7]

4.1.1 Debt Adjustment and Equity Adjustment

To address the question how firms adjust capital structure in response to volatility shocks, we compute financing-resulted percentage changes in debt and equity between time t and $t+1$, and regress them on stock return volatility and volatility shocks. The results are reported in Table 11. Column (1) and (5) show that stock return volatility affects negatively debt change but positively equity change. Both are statistically significant at the 1% level. The multivariate regression results reported in Column (3) and (7) confirm such effects. We find that surprise volatility shocks affect debt change negatively and equity change positively, while the expected volatility shocks do not have significant impacts. Column (2) and (6) report that the surprise shocks' impacts are statistically significant at

[6]Unreported, we regress active change in book leverage, $\Delta LEV_{i,t+1}^{Issue}$, on stock return and ROA at time t, and find that the coefficient sign of stock return is driven to be negative, suggesting that fundamental profitability information subsumes that embedded in stock returns.

[7]We split our sample into early and late samples, and conduct sub-sample regressions. We find that the results are sensitive to how to split samples. However, the predictability of stock return volatility on subsequent leverage adjustment is strong and robust after the 1970s. This may be due to few observations and unreliable data quality in early years.

the 1% and 10% level for the debt and equity changes, respectively. The surprise shocks' negative impact on the debt change remains significant in the presence of the control variables, but becomes insignificant on the equity change, as reported in Column (4) and (8) . It seems that when surprise volatility shocks hit home, firms tend to actively reduce outstanding debt rather than issuing new equity. Equity issuance and repurchase are more driven by firm fundamentals than by surprise volatiity shocks.

4.1.2 Temporal Effect of Volatility Shocks

We examine the temporal effect of volatility risk on leverage adjustment, by including the lagged observations of stock return volatility, VOL, change in expected volatility, ΔVOL^{Expd}, volatility surprise, $\Delta VOL^{Surp.}$ between time $t-5$ and t in univariate and multivariate regressions, respectively. The multivariate regressions contain firm and market control variables observed at time t. The results are reported in Table 12. Column (1) shows that the coefficient of VOL_t is -6.12, and the t-statistic is -8.07. The further lags of VOL are not statistically significant. The multivariate regression result reported in Column (2) shows that VOL_t remains significant in the presence of the other lagged volatility observations, among which VOL_{t-1} and VOL_{t-2} remain insignificant. The results suggest that volatility's predictability on leverage adjustment is short-term, consistent with the notion that uncertainty shock is short-lived (Bloom, 2009). Column (3) shows that the coefficients of all lagged observations of ΔVOL^{Expd} are negative and statistically significant at least at the 5% level. As shown in Column (4), VOL_t^{Expd} remains significant at the 1% level and VOL_{t-1}^{Expd} is significant at the 10% level in the presence of the control variables. The results suggest that expected volatility shocks tend to have long-term impacts due to its persistence, but to some extent the impacts of further lags are subsumed by more recent firm fundamental and business cycle information. Column (5) and (6) indicate that $\Delta VOL_t^{Surp.}$ is the only surprise shock that is consistently significant at the 1% level in both the univariate and multivariate regressions, suggesting that the impact of the surprise shock is unequivocally short-term.

4.1.3 Financial Constraints

To understand the economic meaning of volatility's predictability for leverage change, we analyze how the relationship between leverage adjustment and stock return volatility interacts with some key firm characteristics including credit quality, size, profitability, and external financial need. The predictive power of volatility shocks for leverage adjustment is stronger for firms with lower rating, smaller size, and lower profitability, but nonmonotonic with respect to external financing need.

Table 13 reports the results of the univariate regressions of active book debt ratio change, $dbca_{t+1}$ on VOL_t, ΔVOL_t^{Expd}, and $\Delta VOL_t^{Surp.}$ by credit rating, firm assets and ROA, respectively. Panel A reports the regression results by firm rating groups: AAA-A, BBB, and BB & Below. The evidence suggests that a firm will be more sensitive to volatility risk for financial decision as default risk increases. As shown in Column (1), (3), and (5), the coefficients (t-statistics) are -2.30 (-1.66), -4.30 (-3.28), and -5.83 (-7.57), respectively. The R^2's increase monotonically from 0.2% to 0.9% then to 2.7%. Further, surprise volatility shocks negatively affects the debt ratio changes for all rating groups, when controlling for the effects of expected volatility changes. The impacts are significant at the 1% for BBB and BB & Below, but not significant for AAA-A, suggesting that the high investment grade firms' financial decisions are not very sensitive to volatility shocks.The BBB group has the highest coefficient of -6.29 and R^2 of 1.3%. The BBB firms are the most sensitive to surprise volatility shocks and, hence, adjust capital structure accordingly. Since those firms have the greatest concerns over being downgraded from the investment grades to speculative grades. This result lends further support to the trade-off theory—firms more sensitive to credit screening adjust their leverage downward more actively when volatility surprise shock has risen.

Column (1), (3), and (5) in Panel B show that stock return volatility negatively predicts subsequent leverage adjustment, statistically significant at the 1% level for all three size groups. The coefficients (R^2's) are -6.94 (5.1%), -6.76 (3.8%), and -6.12 (3.2%), respectively. The results imply that small firms are slightly more sensitive to volatility risk in adjusting capital structure. As shown in Column (2), (4), and (6), the regressions of surprise volatility shocks do not show remarkable difference between different groups. This result indicates size effect of the influence of total volatility risk on capital structure decisions.

Panel C reports the regression results by ROA. The negative impact of stock return volatility on subsequent debt ratio adjustment is statistically significant at the 1% level for all three groups. The R^2's are 4.2%, 1.1%, and 1.5%, respectively, as shown in Column (1), (3), and (5). Low (negative) profitability firms are more sensitive to volatility risk for their capital structure adjustments. This pattern is confirmed by the regression results with volatility shocks. Column (2), (4), and (6) show that the R^2's decrease from 0.7% to 0.6% then to 0.5% as firm profitability increases. Firms with higher profitability should be able to issue or rollover debt more easily.

We examine how firm external financing need affects the predictability of stock return volatility on subsequent leverage adjustment, by dividing our sample by internal financial deficit into quantiles, and by internal financial surplus versus deficit. Panel A and B of Table 14 reports the univariate and multivariate regression results, respectively.

Columns (1)-(4) in Panel A show that stock return volatility significantly predicts subsequent leverage adjustment in all quantiles. The R^2's are 5.4%, 4.1%, 2.9%, and 8.0% as firms' external financing need grows. The results suggest that volatility risk matters more for financial decisions when firms are either in very urgent external need or not in external financing need at all. As reported in the lower section of Panel A, surprise shock negatively predicts leverage adjustment, statistically significant at the 1% level for all quantiles. The R^2's are 1.8%, 1.4%, 0.6%, and 0.8%, respectively, as the internal deficit grows. (The R^2's reported in Column (5) and (6) do not show consistent patterns.)

The multivariate regression results in Panel B confirm the significant predictive power of stock return volatility and shocks. Comparing the R^2's of both the volatility and volatility shocks in Columns (1)-(4), we find the R^2 in Column (4) are remarkably higher than those in Columns (1)-(3), around 30% versus 10-12%. It is evident that firms with urgent external financing are the most responsive to the fundamental and market information in adjusting leverage. The R^2's reported in Column (5) and (6) confirm such a pattern, around 25% versus 12%. Combining the results in Panel A and Panel B suggests the following: volatility shocks have greater impacts for firms without urgent external financing needs, while the fundamentals have greater impacts for firms needing external financing.

4.2 Predicting Future Investment

Finally, we relate stock return volatility to future investment policy to identify the economic channels through which stock return volatility weighs into the corporate decision-making. Bloom (2009) shows that rising aggregate uncertainty, measured by stock index return volatility, negatively affects corporate investment and hiring. Panousi and Papanikolaou (2012) find that idiosyncratic stock volatility negatively affects investment at the firm level. We analyze the predictability of stock return volatility and volatility shocks on subsequent investment adjustments, as an economic channel through which stock return volatility affects future capital structure decisions. We measure change in future investment using change in capital expenditure at time $t+1$ normalized by net property, plant and equipment at time t:

$$\Delta CAPX_{i,t+1} \equiv \frac{CAPX_{i,t+1} - CAPX_{i,t}}{PPENT_{i,t}}, \tag{10}$$

where $CAPX$ denotes capital expenditure and $PPENT$ denotes net property, plant and equipment. Following the literature, we delete observations with absolute ratio of $CAPX_{i,t+1}$ to $PPENT_{i,t}$ exceeding one. We regress $\Delta CAPX_{i,t+1}$ on stock return volatility and volatility shocks, together with the control variables. We examine the correlation between contemporaneous leverage adjustment and investment adjustment as well.

Table 15 reports the results. Column (1) and (5) show that stock return volatility negatively and significantly predicts subsequent change in investment in the absence (presence) of the control variables. The impact is phenomenal. The multivariate regression coefficient is -0.934, implying that one standard deviation rise in the stock return volatility (14.63%) leads to a 13.66% reduction in capital expenditure. Column (2) shows that the simultaneous changes in investment and active debt ratio are positively and significantly correlated. The coefficient (t-statistic) of $\Delta LEV_{i,t+1}^{Issue}$ is 0.188 (8.72). The R^2 is 1.1%. Column (3) shows that the surprise volatility shock significantly affects investment change—the coefficient and t-statistic of $\Delta VOL_{i,t}^{Surp.}$ are -4.01 and -4.22, respectively, while expected volatility changes is insignificant. Column (4) shows that the predictive power of idiosyncratic volatility on investment change is negative and highly significant, while that of systematic volatility is only marginally significant.

The evidence indicates that rising stock return volatility, the second moment shock in Bloom (2009), predicts reduction in future cash flow, the first moment shock. Firms reduce simultaneously investment and leverage with falling earnings, which are all predicted by rising stock return volatility. In particular, the surprise component and/or the idiosyncratic component of volatility shocks constitute the most significant driving forces behind the effects of economic uncertainty on corporate investment and financing decisions.[8]

5 Conclusions (to be updated)

[8]We also investigate the relation between volatility risk premium (VRP) and corporate decisions. VRP is constructed as the difference between put option-implied volatility and stock return volatility. The univariate correlation between VRP (change in VRP) and subsequent change in leverage is approximately -0.03 (0.03). Regressions show that VRP is not significantly correlated with subsequent leverage adjustment, change in investment, and change in earnings. If volatility risk premium does not affect future cash flows, firms may not respond to risk premium by actively adjusting investment and capital structure.

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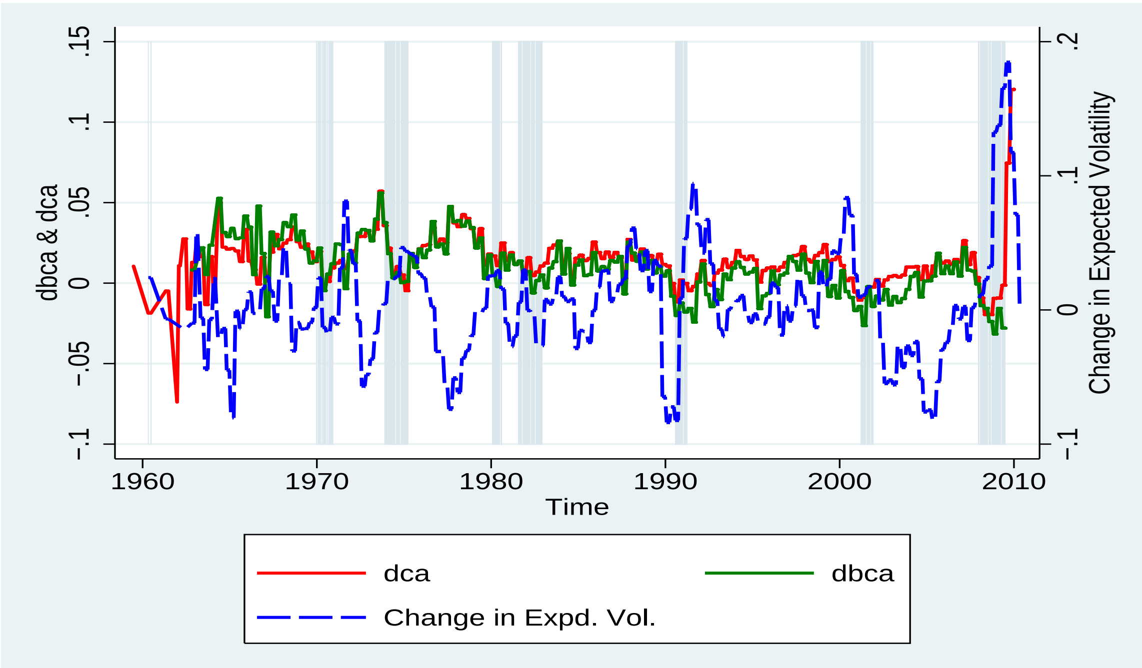
Figure 1: **Leverage Changes and Expected/Surprise Volatility Shocks**
This figure plots active book (market) debt ratio change, *dbca* (*dca*), with respect to expected volatility shock, ΔVol^{Expd}, and surprise volatility shock, $Vol^{Surprise}$ over time. The top graph plots *dbca*, *dca* and ΔVol^{Expd}. The bottom graph plots *dbca*, *dca* and and $Vol^{Surprise}$. The gray areas represent NBER recession time.



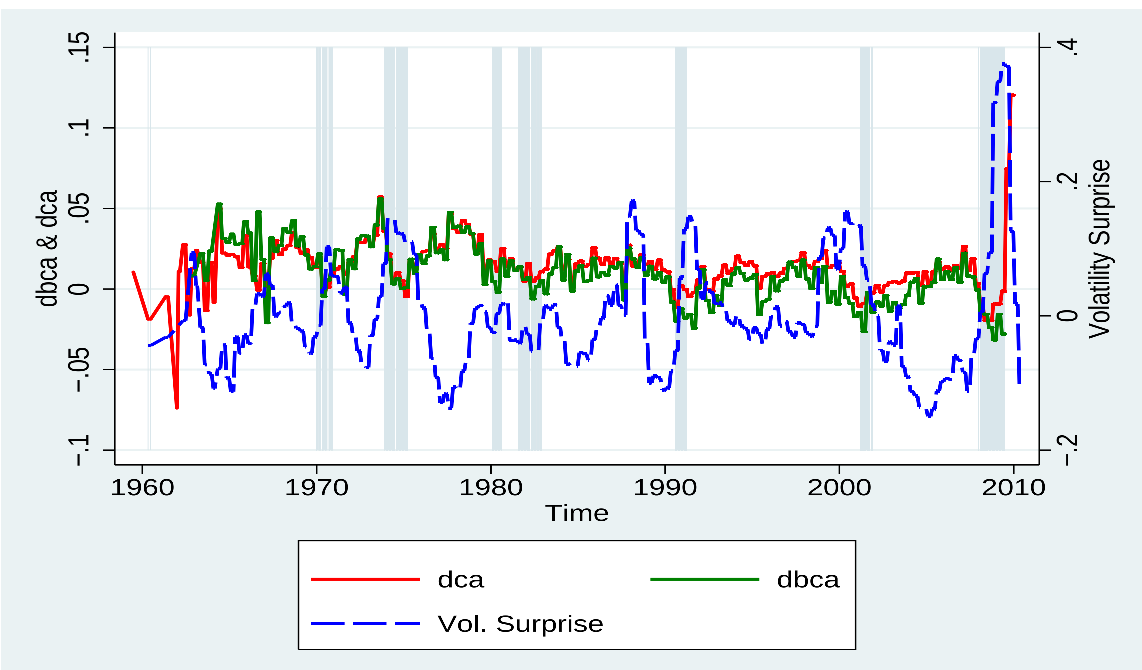


Figure 2: **Leverage Changes and Expected/Surprise Volatility Shocks**
This figure plots active book (market) debt ratio change, *dbca* (*dca*), with respect to expected volatility shock, ΔVol^{Expd}, and surprise volatility shock, $Vol^{Surprise}$ over time. The top graph plots *dbca*, *dca* and ΔVol^{Expd}. The bottom graph plots *dbca*, *dca* and and $Vol^{Surprise}$. The gray areas represent NBER recession time.

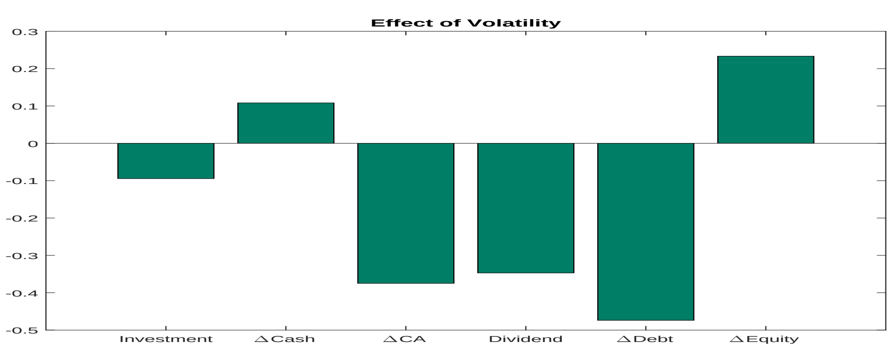


Table 1: **Summary Statistics**

This table presents the notations and descriptive statistics of key variables. All variables, except assets, are winsorized at 5% and 95%. The statistics are computed as the median of the statistics of sample firms that have at least five consecutive observations.

Variable	Notation	Mean	Std. Dev	Skewness	Kurtosis	AR(1)
Volatility	VOL	0.4286	0.1501	0.9003	3.2747	0.9685
Expected volatility	$EVOL$	0.4191	0.0829	0.6472	3.0694	0.9827
Change in volatility	ΔVOL	0.0066	0.1402	0.3858	3.5886	-0.1719
Volatility surprise	$\Delta VOL^{Surp.}$	0.0044	0.1468	0.7370	3.3661	0.3406
Systematic volatility	$VOL^{Sys.}$	0.1313	0.0658	1.3959	4.4011	0.9919
Idiosyncratic volatility	$VOL^{Idio.}$	0.3959	0.1308	0.7591	2.8955	0.9689
Stock return	R	0.1831	0.4697	0.8213	3.5499	0.1019
Change in book leverage	ΔLEV	0.0035	0.0603	0.4513	3.0327	-0.0363
Change in book leverage due to net issuance	ΔLEV^{Issue}	0.0117	0.0532	0.0803	2.9370	0.0891
Net debt issuance	ΔD	0.0459	0.1078	0.6632	2.9155	0.2146
Net equity issuance	ΔE	0.0089	0.0544	1.0328	4.9354	0.2004
Retained earnings	RE	0.0381	0.0562	-0.5967	3.2024	0.6976
Capital investment	I	0.0661	0.0370	0.8307	2.9633	0.8725
Change in cash holdings	ΔCH	0.0086	0.0551	0.3237	3.1978	-0.0816
Change in working capital	ΔWC	0.0106	0.0626	0.0770	2.7679	-0.0249
Change in current assets	ΔCA	0.0343	0.0729	0.3942	2.8792	0.3013
Change in current liabilities	ΔCL	0.0235	0.0611	0.3782	2.7537	0.0766
Dividend payout	DIV	0.0157	0.0097	0.8822	3.2725	0.9071
Free cash flow	FCF	0.1093	0.0643	-0.1306	3.2062	0.8761
Assets (million dollars)	$ASSET$	551.7500	326.3800	0.5641	2.2141	0.9999
Book leverage	LEV	0.4940	0.1037	0.2405	2.4335	0.9939
Cash holdings	CH	0.0859	0.0614	0.7765	2.7814	0.8761
MB ratio	MB	2.0842	1.0670	0.8043	3.2219	0.9192
ROA	ROA	0.0963	0.0569	-0.1118	2.6923	0.9144
Tobin's Q	Q	1.4773	0.4572	0.8010	2.9491	0.9684

Table 2: **Leverage, Liquidity, and Debt Maturity**

This table reports the regression results of change in leverage, liquidity, and debt maturity on stock return volatility. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$. Industry fixed effects are included.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	leverage ratio				liquidity ratio			debt maturity	
	$\Delta LEV_{i,t}$	$\Delta LEV_{i,t}^{Issue}$	$\Delta LEV_{i,t}^{MKT}$	$\Delta LEV_{i,t}^{MKT,Active}$	$\Delta CR_{i,t}$	$\Delta QR_{i,t}$	$\Delta CC_{i,t}$	$\Delta(CL/D_{i,t})$	$\Delta(D^{\ell}/D_{i,t})$
$VOL_{i,t}$	-0.207	-1.668***	1.819***	-1.318***	6.829***	9.158***	2.556***	-0.626***	0.674***
	(-0.81)	(-6.63)	(5.16)	(-6.82)	(6.04)	(5.15)	(6.01)	(-3.21)	(4.77)
$CFL_{i,t}$	-29.292***	6.054***	-8.464***	-1.629***	58.472***	113.329***	39.781***	4.264***	-5.042***
	(-37.63)	(9.53)	(-11.78)	(-4.10)	(16.99)	(21.93)	(21.54)	(7.24)	(-8.85)
$R_{i,t}$	-0.756***	-0.156	-8.430***	0.243***	4.565***	5.403***	2.512***	0.687***	-0.749***
	(-6.89)	(-1.44)	(-29.43)	(3.13)	(8.94)	(6.38)	(9.96)	(5.67)	(-6.65)
$LEV_{i,t-1}$	-7.673***	-7.889***	-5.785***	-3.806***	3.304*	19.222***	0.389	3.147***	-3.035***
	(-19.47)	(-21.65)	(-16.17)	(-19.31)	(1.95)	(8.31)	(0.54)	(12.69)	(-12.12)
$CH_{i,t-1}$	-3.005***	-1.878***	-1.767***	-1.062***	-66.941***	-69.706***	3.405***	0.649	-0.831*
	(-7.35)	(-4.74)	(-4.25)	(-3.96)	(-21.34)	(-15.88)	(3.07)	(1.42)	(-1.69)
$I_{i,t-1}$	11.261***	5.843***	12.902***	8.635***	-46.069***	-50.735***	-27.528***	-8.925***	7.536***
	(12.99)	(7.39)	(17.80)	(17.17)	(-12.07)	(-8.27)	(-14.08)	(-12.34)	(10.40)
$\ln(AT_{i,t})$	0.341***	0.369***	0.292***	0.179***	-0.156	-0.862***	-0.327***	-0.230***	0.209***
	(8.68)	(8.66)	(5.51)	(6.66)	(-0.81)	(-3.23)	(-4.91)	(-9.03)	(9.63)
$Q_{i,t}$	-0.051	-0.261***	0.005	-0.202***	2.287***	3.164***	1.098***	0.040	-0.056
	(-0.77)	(-4.26)	(0.08)	(-5.73)	(7.03)	(7.15)	(7.09)	(1.03)	(-1.46)
$Payout_{i,t-1}$	0.112	0.197**	-0.229*	-0.081	-0.792	-0.087	-0.221	-0.233**	0.258***
	(1.17)	(2.01)	(-1.90)	(-1.15)	(-1.49)	(-0.12)	(-0.95)	(-2.57)	(2.78)
R_t^{MKT}	-0.882	-0.399	-4.849***	-0.683	4.990	7.471	-4.032***	-1.969***	2.494***
	(-1.45)	(-0.65)	(-4.41)	(-1.35)	(1.43)	(1.64)	(-4.26)	(-3.96)	(6.33)
ΔIP_t	3.439	6.185***	1.622	5.847***	-43.008***	-56.490***	11.781***	10.918***	-6.933***
	(1.41)	(3.28)	(0.42)	(3.67)	(-3.59)	(-3.90)	(3.15)	(6.49)	(-4.99)
N	38093	37720	38093	38093	37230	36848	33601	37232	38064
adj. R^2	0.189	0.139	0.478	0.078	0.087	0.077	0.070	0.020	0.019

Table 3: **Capital Budgeting and Stock Return Volatility**

This table reports the regression results of capital budgeting on stock return volatility. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)
	$I_{i,t}$	$\Delta CH_{i,t}$	$\Delta CA_{i,t}$	$DIV_{i,t}$	$\Delta D_{i,t}$	$\Delta E_{i,t}$
$VOL_{i,t}$	-0.629***	0.721***	-2.499***	-2.313***	-3.159***	1.555***
	(-3.29)	(2.92)	(-5.30)	(-4.08)	(-5.05)	(4.21)
$CFL_{i,t}$	7.242***	12.657***	16.410***	-2.890***	-10.142***	-23.916***
	(18.69)	(18.23)	(22.36)	(-3.00)	(-8.87)	(-21.70)
$R_{i,t}$	0.349***	1.621***	1.530***	-0.172	1.353***	1.617***
	(4.94)	(14.94)	(9.20)	(-1.21)	(5.23)	(12.41)
$LEV_{i,t-1}$	-0.749***	-1.532***	-1.138***	0.758	-6.041***	2.840***
	(-4.44)	(-5.55)	(-3.53)	(0.58)	(-11.60)	(7.01)
$CH_{i,t-1}$	-0.149	-6.983***	0.883*	3.662**	-2.743***	0.599
	(-0.55)	(-11.95)	(1.70)	(2.55)	(-3.65)	(1.02)
$I_{i,t-1}$	65.814***	-6.248***	6.109***	-7.690***	29.917***	15.923***
	(64.41)	(-7.77)	(4.46)	(-3.55)	(19.16)	(14.21)
$\ln(AT_{i,t})$	-0.033	0.084***	-0.205***	-0.405***	0.516***	-0.139***
	(-1.21)	(2.74)	(-3.64)	(-2.83)	(6.00)	(-2.96)
$Q_{i,t}$	0.228***	0.864***	0.476***	1.200***	0.349***	1.424***
	(5.87)	(13.53)	(6.74)	(4.34)	(3.43)	(14.94)
$Payout_{i,t-1}$	-0.152*	-0.758***	-0.913***	3.571***	-1.235***	-2.082***
	(-1.92)	(-7.91)	(-4.41)	(10.21)	(-5.70)	(-13.68)
R_t^{MKT}	-0.648	0.218	-3.199**	0.078	-2.440*	-0.259
	(-1.38)	(0.51)	(-2.36)	(0.42)	(-1.71)	(-0.64)
ΔIP_t	3.492**	-0.305	21.782***	-4.588***	20.771***	13.357***
	(2.25)	(-0.17)	(4.83)	(-3.47)	(4.64)	(6.22)
N	37997	38091	37042	38093	38093	37900
adj. R^2	0.563	0.109	0.107	0.254	0.059	0.263

Table 4: **Current Liabilities, Current Assets and Operating Expenses**

This table reports the regression results of key items in current liabilities, current assets, and operating expenses on stock return volatility. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Delta D^{\ell}_{i,t}$	$\Delta CL_{i,t}$	$\Delta AP_{i,t}$	$\Delta AR_{i,t}$	$\Delta INVT_{i,t}$	$R\&D_{i,t}$	$Labor_{i,t}$	$SGA_{i,t}$
$VOL_{i,t}$	-0.820***	-1.580***	-0.645***	-0.330***	-1.042***	1.079***	-7.645***	1.210
	(-3.94)	(-4.73)	(-5.44)	(-3.80)	(-5.77)	(2.83)	(-3.16)	(1.18)
$R_{i,t}$	-0.024	1.088***	0.560***	0.241***	0.403***	-0.065	1.259**	-0.128
	(-0.21)	(7.86)	(10.11)	(3.88)	(6.10)	(-0.81)	(2.20)	(-0.46)
$LEV_{i,t-1}$	-2.446***	-2.143***	-0.390***	-1.118***	-0.816***	0.310	-7.705**	0.592
	(-9.30)	(-9.25)	(-4.10)	(-8.52)	(-5.31)	(0.61)	(-2.21)	(0.36)
$CH_{i,t-1}$	-2.004***	-0.810**	0.066	1.557***	-0.139	9.196***	-18.197***	-5.722**
	(-4.51)	(-2.28)	(0.40)	(6.95)	(-0.53)	(9.70)	(-2.96)	(-2.32)
$I_{i,t-1}$	17.085***	7.542***	1.102***	-1.572***	2.408***	5.754***	29.807***	-11.283**
	(20.55)	(8.42)	(3.20)	(-5.85)	(3.49)	(3.61)	(3.10)	(-2.37)
$\ln(AT_{i,t})$	0.242***	0.137***	0.011	0.086***	-0.122***	0.073	-1.837***	-2.273***
	(7.08)	(3.15)	(0.79)	(5.09)	(-5.14)	(1.26)	(-5.40)	(-11.60)
$CFL_{i,t}$	-6.511***	-1.984***	0.587***	0.315	5.939***	-12.413***	46.550***	5.978**
	(-12.49)	(-3.06)	(2.74)	(1.12)	(16.54)	(-11.88)	(7.33)	(2.28)
$Q_{i,t}$	-0.129***	0.342***	0.065***	-0.057***	0.081**	1.289***	-1.088*	3.743***
	(-2.80)	(6.98)	(3.08)	(-3.10)	(2.25)	(12.96)	(-1.66)	(11.72)
$Payout_{i,t-1}$	-0.372***	-0.686***	-0.245***	-0.214***	-0.241**	-0.913***	1.311	1.058
	(-3.55)	(-5.77)	(-5.17)	(-6.53)	(-2.48)	(-3.64)	(0.81)	(1.38)
R^{MKT}_t	0.432	-2.074**	-0.884***	-0.153	-1.533***	0.506*	-3.164	1.088
	(0.89)	(-2.24)	(-2.96)	(-0.57)	(-2.59)	(1.69)	(-1.20)	(0.76)
ΔIP_t	2.983*	16.591***	8.173***	2.451***	7.115***	2.981***	6.580	2.465
	(1.80)	(5.65)	(7.83)	(2.82)	(3.50)	(2.61)	(0.66)	(0.48)
N	38076	37244	37335	33860	37864	22769	5148	34674
Adj. R^2	0.040	0.041	0.049	0.011	0.065	0.507	0.396	0.294

Table 5: **Decomposition of Volatility Shocks**

This table reports the regression results associated with decomposition of unconditional stock return volatility into change in volatility and lagged volatility. $VOL_{i,t-1}$ denotes lagged volatility. $\Delta VOL_{i,t}$ denotes the difference between $VOL_{i,t}$ and $VOL_{i,t-1}$. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	$\Delta LEV_{i,t}^{Issue}$	$\Delta D_{i,t}$	$\Delta E_{i,t}$	$I_{i,t}$	$\Delta CH_{i,t}$	$\Delta CA_{i,t}$	$DIV_{i,t}$
$\Delta VOL_{i,t}$	0.015	-0.988*	-0.624*	-0.645***	-0.250	-2.166***	-1.056***
	(0.06)	(-1.79)	(-1.72)	(-2.90)	(-0.71)	(-4.19)	(-3.28)
$VOL_{i,t-1}$	-1.454***	-2.384***	1.882***	-0.545**	1.220***	-2.601***	-2.502***
	(-4.52)	(-3.12)	(5.05)	(-2.33)	(4.98)	(-4.80)	(-3.72)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	29638	29765	29764	37907	38001	36952	38093
Adj. R^2	0.148	0.073	0.282	0.563	0.111	0.106	0.270

Table 6: **Expected Volatility vs. Volatility Surprise**

This table reports the regression results associated with decomposition of conditional stock return volatility into surprise change in volatility and expected volatility. $EVOL_{i,t}$ denotes expected volatility at t, formed at $t-1$. $\Delta VOL_{i,t}^{Surp.}$ denotes the difference between realized volatility $VOL_{i,t}$ and expected volatility $EVOL_{i,t}$. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	$\Delta LEV_{i,t}^{Issue}$	$\Delta D_{i,t}$	$\Delta E_{i,t}$	$I_{i,t}$	$\Delta CH_{i,t}$	$\Delta CA_{i,t}$	$DIV_{i,t}$
$\Delta VOL_{i,t}^{Surp.}$	-0.619*	-2.954***	-0.972***	-1.019***	0.107	-3.684***	-0.755***
	(-1.87)	(-3.63)	(-2.96)	(-4.55)	(0.37)	(-6.58)	(-3.08)
$EVOL_{i,t}$	-1.306***	-0.744	3.152***	-0.095	1.432***	-1.125**	-3.504***
	(-4.02)	(-1.10)	(7.25)	(-0.43)	(5.12)	(-2.29)	(-3.79)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	29570	29697	29696	37907	38001	36952	38093
Adj. R^2	0.146	0.074	0.285	0.563	0.111	0.108	0.275

Table 7: **Systematic Volatility vs. Idiosyncratic Volatility**

This table reports the regression results of systematic volatility and idiosyncratic volatility. Systematic (idiosyncratic) volatility, $VOL_{i,t}^{Sys.}$ ($VOL_{i,t}^{Idio.}$), is calculated with daily systematic (idiosyncratic) returns estimated with the Fama-French three-factor model between $t-1$ and t. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	$\Delta LEV_{i,t}^{Issue}$	$\Delta D_{i,t}$	$\Delta E_{i,t}$	$I_{i,t}$	$\Delta CH_{i,t}$	$\Delta CA_{i,t}$	$DIV_{i,t}$
$\Delta VOL_{i,t}^{Sys.Surp.}$	-6.044***	-9.104*	2.452	-2.410*	3.138**	-3.955	-0.546
	(-3.17)	(-1.82)	(1.57)	(-1.84)	(1.97)	(-1.23)	(-0.55)
$EVOL_{i,t}^{Sys.}$	-7.797***	-10.734***	8.307***	-1.697*	6.522***	-6.787**	-6.780***
	(-5.76)	(-3.01)	(5.35)	(-1.72)	(5.67)	(-2.51)	(-4.13)
$\Delta VOL_{i,t}^{Idio.Surp.}$	-0.161	-2.483***	-1.101**	-1.044***	-0.160	-4.022***	-1.020***
	(-0.56)	(-4.09)	(-2.44)	(-4.88)	(-0.45)	(-7.45)	(-2.48)
$EVOL_{i,t}^{Idio.}$	-1.004***	-0.204	3.520***	0.015	1.453***	-1.061*	-4.725***
	(-2.89)	(-0.26)	(6.94)	(0.07)	(4.15)	(-1.69)	(-3.74)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	28973	29096	29095	37201	37290	36254	37337
Adj. R^2	0.150	0.078	0.280	0.565	0.111	0.109	0.284

Table 8: **Interaction between Volatility and Leverage**

This table reports the regression results of capital structure and spending on the interaction between stock return volatility and leverage. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	$\Delta LEV_{i,t}^{Issue}$	$\Delta D_{i,t}$	$\Delta E_{i,t}$	$I_{i,t}$	$\Delta CH_{i,t}$	$\Delta CA_{i,t}$	$DIV_{i,t}$
$VOL_{i,t}$	0.084	0.142	-0.549	-0.240	-0.004	-1.330***	-3.134***
	(0.21)	(0.20)	(-0.98)	(-1.04)	(-0.01)	(-2.58)	(-5.19)
$VOL_{i,t} \times LEV_{i,t-1}$	-1.907***	-3.801***	2.931***	-0.682*	1.448**	-2.153***	2.191
	(-2.63)	(-3.34)	(3.31)	(-1.94)	(2.41)	(-3.03)	(1.51)
$LEV_{i,t-1}$	-7.596***	-6.129***	1.141*	-0.294	-2.504***	0.245	-0.531
	(-12.75)	(-6.36)	(1.84)	(-0.92)	(-5.94)	(0.38)	(-0.25)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	29638	29765	29764	37907	38001	36952	38093
Adj. R^2	0.147	0.074	0.280	0.563	0.110	0.106	0.269

Table 9: **Interaction between Volatility and Cash Holdings**

This table reports the regression results of capital structure and spending on the interaction between stock return volatility and cash holdings. We follow Petersen (2009) to adjust two-dimensional (firm and time) clustered standard errors. t statistics are reported in parentheses. * denotes $p < 0.10$; ** denotes $p < 0.05$; *** denotes $p < 0.01$.

	$\Delta LEV_{i,t}^{Issue}$	$\Delta D_{i,t}$	$\Delta E_{i,t}$	$I_{i,t}$	$\Delta CH_{i,t}$	$\Delta CA_{i,t}$	$DIV_{i,t}$
$VOL_{i,t}$	-1.262***	-2.368***	1.273***	-1.123***	1.795***	-3.203***	-0.236
	(-3.87)	(-3.28)	(3.50)	(-5.31)	(11.16)	(-6.27)	(-1.25)
$VOL_{i,t} \times CH_{i,t-1}$	2.974**	4.389*	-2.365	3.754***	-7.445***	5.572***	-12.459***
	(2.51)	(1.93)	(-1.48)	(5.53)	(-4.49)	(5.00)	(-3.96)
$CH_{i,t-1}$	-3.143***	-6.249***	2.012*	-2.420***	-2.398**	-2.419***	11.625***
	(-3.59)	(-3.81)	(1.96)	(-5.03)	(-2.49)	(-2.63)	(3.51)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	29638	29765	29764	37907	38001	36952	38093
Adj. R^2	0.147	0.073	0.279	0.564	0.112	0.107	0.282

Table 10: **Active Leverage Ratio Adjustment and Stock Return Volatility**

This table reports the regression results of book leverage ratio adjustment and stock return volatility. $\Delta LEV^{Issue}_{i,t+1}$ represents active book debt ratio change due to net debt/equity issuance between time t and $t+1$. $LEV_{i,t+1}$ represents book debt ratio. Volatility, $VOL_{i,t}$ is the realized volatility estimated using past one year daily equity returns. Two-dimensional (firm and time) clustered standard errors in the regressions are adjusted as in Petersen (2009). The numbers in the brackets are t-statistics.

	(1)	(2)	(3)	(4)	(5)
	$\Delta LEV^{Issue}_{i,t+1}$	$\Delta LEV^{Issue}_{i,t+1}$	$\Delta LEV^{Issue}_{i,t+1}$	$\Delta LEV^{Issue}_{i,t+1}$	$LEV_{i,t+1}$
$VOL_{i,t}$	-7.069		-7.426	-1.843	-2.116
	(-23.35)		(-26.08)	(-6.13)	(-4.30)
$R_{i,t}$		0.492	0.372	-0.368	-0.460
		(1.98)	(2.78)	(-4.14)	(-4.63)
$LEV_{i,t-1}$			-0.115	-0.122	0.824
			(-28.69)	(-22.42)	(102.09)
$\ln(AT_{i,t})$				0.423	0.564
				(10.66)	(11.45)
$TANG_{i,t}$				0.250	0.177
				(1.33)	(0.77)
$MB_{i,t}$				-0.0685	0.0126
				(-2.44)	(0.35)
$ROA_{i,t}$				14.610	14.560
				(19.86)	(13.12)
$TAX_{i,t}$				0.364	0.405
				(2.05)	(1.84)
$CR_{i,t}$				-0.000	-0.000
				(-1.62)	(-3.69)
$Payout_{i,t}$				-9.092	-17.290
				(-2.14)	(-2.55)
DEF_{it}				0.0723	-0.009
				(1.19)	(-0.12)
R^{MKT}_t				1.540	1.860
				(3.58)	(3.54)
VOL^{MKT}_t				1.256	1.447
				(0.85)	(0.89)
ΔIP_t				0.147	0.142
				(7.52)	(6.43)
Adj. R-sq	0.062	0.001	0.138	0.221	0.796

Table 11: Debt versus Equity Adjustment

This table reports the regression results of debt change and equity change between time t and $t+1$ on expected volatility shocks, $\Delta VOL_{i,t}^{Expd}$, surprise volatility shock, $\Delta VOL_{i,t}^{Surp.}$, and lagged expected volatility, Vol_{t-1}^{Expd}. Debt change is computed as $\Delta D_{i,t+1} = (D_{i,t+1} - D_{i,t})/D_{i,t}$. Equity change is computed as $\Delta E_{i,t+1} = ((E_{i,t+1} - \Delta RE_{i,t}) - E_{i,t})/E_{i,t}$, where $\Delta RE_{i,t}$ is change in accumulative retained earnings between time t and $t+1$. Two-dimensional (firm and time) clustered standard errors in the regressions are adjusted as in Petersen (2009). The numbers in the brackets are t-statistics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Delta D_{i,t+1}$				$\Delta E_{i,t+1}$			
$VOL_{i,t}$	-3.566		-2.931		10.440		2.922	
	(-3.36)		(-4.56)		(18.82)		(6.30)	
$\Delta VOL_{i,t}^{Expd}$		2.923		0.233		-0.555		-1.863
		(1.38)		(0.13)		(-0.76)		(-2.67)
$VOL_{i,t}^{Surp.}$		-12.740		-4.345		1.193		0.238
		(-5.04)		(-3.59)		(1.77)		(0.41)
$R_{i,t}$			3.535	3.409			2.467	2.600
			(8.81)	(8.31)			(15.47)	(16.11)
$LEV_{i,t-1}$			-0.231	-0.234			0.0385	0.0451
			(-21.21)	(-21.58)			(5.94)	(7.02)
Controls	No	No	Yes	Yes	No	No	Yes	Yes
Adj. R-sq	0.002	0.009	0.086	0.086	0.071	0.000	0.211	0.209

Table 12: Lag Volatilities

This table reports the regression results of active book debt ratio change, $\Delta LEV_{i,t+1}$, on stock return volatility, VOL, expected volatility shocks, ΔVOL^{Expd}, and surprise volatility shock, $\Delta VOL^{Surp.}$ with lags ranging between time $t-5$ to t. Two-dimensional (firm and time) clustered standard errors in the regressions are simultaneously adjusted as in Petersen (2009). The numbers in the brackets are t-statistics.

	(1)	(2)	(3)	(4)	(5)	(6)
Time Lag	Vol		ΔVol^{Expd}		$Vol^{Surprise}$	
t	-6.123	-1.507	-5.129	-1.491	-4.296	-1.288
	(-8.07)	(-3.62)	(-5.76)	(-2.67)	(-4.67)	(-3.15)
$t-1$	0.300	0.324	-4.103	-1.092	-0.334	-0.303
	(0.44)	(0.80)	(-6.02)	(-1.86)	(-0.46)	(-0.75)
$t-2$	-0.702	-0.448	-2.963	0.0287	-1.490	-0.424
	(-1.49)	(-0.99)	(-4.07)	(0.05)	(-3.03)	(-1.15)
$t-3$	0.460	0.982	-2.362	-0.214	-0.0633	0.323
	(0.85)	(2.02)	(-2.32)	(-0.31)	(-0.11)	(0.92)
$t-4$	-0.934	-1.193	-2.833	-1.258	-1.098	-0.763
	(-1.52)	(-2.46)	(-2.42)	(-2.37)	(-1.71)	(-1.91)
$t-5$	-0.485	0.358	-2.062	-0.875	-0.781	-0.416
	(-0.88)	(0.74)	(-2.73)	(-1.73)	(-1.40)	(-0.92)
Controls	No	Yes	No	Yes	No	Yes
Adj. R-sq	0.063	0.213	0.008	0.207	0.011	0.208

Table 13: The Impacts of Rating, Size and Profitability

This table reports the regression results of active book leverage change, $\Delta LEV_{i,t+1}$, on stock return volatility, VOL_t, expected volatility shocks, $\Delta VOL_{i,t}^{Expd}$, and surprise volatility shock, $\Delta VOL_{i,t}^{Surp.}$ by S&P credit rating group, asset value group and return on assets (ROA), respectively. Panel A reports the by rating results. Panel B reports the by asset value results. Panel C reports the by ROA results. Two-dimensional (firm and time) clustered standard errors in the regressions are simultaneously adjusted as in Petersen (2009). The numbers in the brackets are t-statistics.

Panel A: By Credit Rating

	(1)	(2)	(3)	(4)	(5)	(6)
	AAA-A		BBB		BB & Below	
$VOL_{i,t}$	-2.299		-4.296		-5.829	
	(-1.66)		(-3.28)		(-7.57)	
ΔVol_t^{Expd}		3.968		3.499		3.143
		(1.85)		(1.64)		(3.08)
$\Delta VOL_{i,t}^{Surp.}$		-3.038		-6.292		-4.590
		(-1.60)		(-3.91)		(-7.35)
Adj. R-sq	0.002	0.002	0.009	0.013	0.027	0.009

Panel B: By Assets

	(1)	(2)	(3)	(4)	(5)	(6)
	Small		Middle		Large	
$VOL_{i,t}$	-6.939		-6.757		-6.115	
	(-19.13)		(-15.83)		(-13.46)	
$\Delta VOL_{i,t}^{Expd}$		-0.566		0.726		3.393
		(-0.80)		(0.64)		(3.29)
$\Delta VOL_{i,t}^{Surp.}$		-3.805		-4.425		-6.195
		(-6.38)		(-3.82)		(-4.87)
Adj. R-sq	0.051	0.010	0.038	0.008	0.032	0.015

Panel C: By ROA

	(1)	(2)	(3)	(4)	(5)	(6)
	Low		Middle		High	
$VOL_{i,t}$	-6.247		-2.898		-4.519	
	(-18.24)		(-8.75)		(-6.81)	
$\Delta VOL_{i,t}^{Expd}$		-0.545		1.571		0.643
		(-0.78)		(2.07)		(0.59)
$\Delta VOL_{i,t}^{Surp.}$		-3.156		-3.560		-3.769
		(-4.94)		(-3.99)		(-3.79)
Adj. R-sq	0.042	0.007	0.011	0.006	0.015	0.005

Table 14: The Impacts of Internal Financial Deficit

This table reports the regression results of active book debt ratio change, $\Delta LEV_{i,t+1}$, on stock return volatility, VOL_t, expected volatility shocks, $\Delta VOL_{i,t}^{Expd}$, and surprise volatility shock, $\Delta VOL_{i,t}^{Surp.}$ by internal financial deficit quantile, and by negative deficit (surplus) versus positive deficit. Quantile 1 and 4 contain firms of the lowest and highest internal financial gap, respectively. Two-dimensional (firm and time) clustered standard errors in the regressions are simultaneously adjusted as in Petersen (2009). The numbers in the brackets are t-statistics.

Panel A: Univariate Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	Quantile 1 (Lowest)	Quantile 2	Quantile 3	Quantile 4 (Highest)	$DEF_t < 0$ (Surplus)	$DEF_t > 0$ (Deficit)
$VOL_{i,t}$	-6.482	-5.008	-4.535	-8.928	-5.932	-8.037
	(-14.46)	(-11.74)	(-10.17)	(-14.87)	(-16.29)	(-19.11)
Controls	No	No	No	No	No	No
Adj. R-sq	0.054	0.041	0.029	0.08	0.051	0.076
ΔVol_t^{Expd}	-0.456	1.965	1.906	0.201	0.532	0.744
	(-0.37)	(1.65)	(1.75)	(0.22)	(0.57)	(0.97)
$\Delta VOL_{i,t}^{Surp.}$	-5.494	-5.152	-3.828	-4.361	-5.406	-4.260
	(-5.48)	(-5.95)	(-4.46)	(-4.94)	(-6.76)	(-5.01)
Controls	No	No	No	No	No	No
Adj. R-sq	0.018	0.014	0.006	0.008	0.017	0.007

Panel B: Multivariate Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	Quantile 1 (Lowest)	Quantile 2	Quantile 3	Quantile 4 (Highest)	$DEF_t < 0$ (Surplus)	$DEF_t > 0$ (Deficit)
$VOL_{i,t}$	-3.399	-2.652	-2.452	-4.956	-3.143	-3.856
	(-6.06)	(-4.74)	(-4.98)	(-6.98)	(-7.57)	(-8.09)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-sq	0.122	0.107	0.11	0.304	0.118	0.245
$\Delta VOL_{i,t}^{Expd}$	-1.591	1.097	1.640	0.785	-0.499	1.263
	(-1.16)	(1.01)	(1.68)	(0.72)	(-0.52)	(1.91)
$\Delta VOL_{i,t}^{Surp.}$	-2.114	-2.818	-1.944	-1.710	-2.422	-1.886
	(-1.93)	(-3.79)	(-2.60)	(-2.20)	(-3.44)	(-3.59)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-sq	0.117	0.103	0.106	0.291	0.114	0.237

Table 15: Investment and Stock Return Volatility

This table reports the regression results of change in investment, $\Delta CAPX_{i,t+1}$, on stock return volatility, VOL_t, expected volatility shocks, $\Delta VOL_{i,t}^{Expd}$, and surprise volatility shock, $\Delta VOL_{i,t}^{Surp.}$. Change in investment is proxied by change in capital expenditure between time t and $t+1$ normalized by $PPENT$ at time t: $\Delta CAPX_{i,t+1}$=($CAPX_{i,t+1}$-$CAPX_{i,t}$)/$PPENT_{i,t}$, where $PPENT$ is property, plant and equipment. Two-dimensional (firm and time) clustered standard errors in the regressions are simultaneously adjusted as in Petersen (2009). The numbers in the brackets are t-statistics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$	$\Delta CAPX_{i,t+1}$
$VOL_{i,t}$	-2.666				-0.934			
	(-4.05)				(-2.87)			
$\Delta LEV_{i,t+1}$		0.188				0.136		
		(8.72)				(9.44)		
ΔVol_t^{Expd}			0.480				-0.841	
			(0.55)				(-0.84)	
$\Delta VOL_{i,t}^{Surp.}$			-4.008				-0.352	
			(-4.42)				(-0.60)	
$VOL_{i,t}^{Sys}$				-5.259				3.600
				(-2.02)				(2.00)
$VOL_{i,t}^{Idio}$				-2.277				-1.111
				(-3.90)				(-3.49)
Controls	No	No	No	No	Yes	Yes	Yes	Yes
Adj. R-sq	0.003	0.011	0.003	0.003	0.053	0.060	0.053	0.053