E C O N O M I C S B U L L E T I N

Financial Constraints and the Risk-Return Relation

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Abstract

Stock return volatilities are related to firms' financial status. Financially constrained firms are more volatile. Their stock return volatilities react more negatively to lagged return changes than financially unconstrained firms. This strong negative relation between volatilities and lagged returns for financially constrained firms are not affected by industry differences or firm leverage. Moreover, the debt-equity ratio is not as important as financial constraints for the firm-level risk-return relation.

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1. Introduction

Evidence suggests that firms could be financially constrained (Fazzari et.al., 1988). Firms' investment decisions might be more sensitive to internal cash flows when firms face external financial constraints. Financial constraints might also affect stock returns. Lamont et.al. (2001) construct an index of financial constraints based on regression coefficient estimates in Kaplan and Zingales (1997). They find that financially constrained firms have low average stock returns. Using an alternative estimation method, Whited and Wu (2006) find that financially constrained firms earn a positive but insignificant average return.

In this paper, I study the impact of firms' external financial status on firms return volatility. The paper differs from the previous literature in two regards. First, instead of examining the impact of financial status on firms' investment decisions or stock returns, the paper emphasizes on the impact of financial constraints on firms' total risk. Whether financial constraints as a whole is a systematic factor or an idiosyncratic risk, firms with higher degree of financial constraints would have higher total risk. In the paper, I use two measures of firm-level financial constraints. One is constructed using a discriminant analysis method. The other is based on the modified coefficient estimates as in Lamont et.al. (2001).

Secondly, this study estimates the model in the framework of Christie (1982) and Duffee (1995) in examining the relation between firm-level volatilities and lagged returns. One particular feature about stock return volatilities is that firm-level volatilities tend to be negatively correlated with lagged stock returns. This phenomenon, the so-called asymmetric volatility, has been explained by the leverage effect, i.e., a drop in the value of the stock increases financial leverage, which makes the stock riskier and increases its volatility[1]. However, previous studies on firm-level asymmetric volatility have mainly emphasized on the effect of leverage. By examining the role of financial constraints, this study could potentially shed more light on the issue of the negative relation between firm-level volatilities and lagged returns.

The study finds that financial constraints contribute to the negative relation between volatilities and lagged returns. Financially constrained firms have higher stock return volatilities, their volatilities also react stronger (negatively) to lagged stock returns. Moreover, the contribution of financial constraints to firm volatility is significant and independent of other possible factors such as industry effects and leverage effects. As a result, financial constraints magnify the negative relation between firm-level volatilities and lagged returns.

The remainder of the article is organized as follows. Section 2 formulates the estimation design and the data. Section 3 presents and interprets the estimation results and section 4 concludes.

2. Data and the Model

2.1. The Model

This study specifies the volatility and the return relation as that in Duffee (1995) and French et.al. (1987):

[1] A competing theory, the volatility feedback hypothesis, has been proposed to explain the asymmetric volatility. However, this hypothesis is mostly tested using the aggregate stock market data.(French et.al. 1987 and Campbell and Hentschel 1992).

$$V_{it} = \alpha + \lambda R_{it-1} + \varepsilon_t \quad (1)$$

where V_{it} is the monthly volatility of firm i at time t, R_{it-1} is the monthly return of firm i at time $t-1$ and λ represents the relation between the lagged stock return and the volatility. The paper follows French et.al. (1987), Schwert (1989), and Schwert and Seguin (1990) in using daily data within each month to construct the monthly volatility V_{it} where $V_{it} = \sum_{j=1}^{N_t} r_{itj}^2$, N_t is the number of trading days in the month *t*, and r_{itj} is the daily return of firm *i* for day *j* in month *t*. In the literature, λ is typically negative.

There is evidence that financial constraints might be one of the factors contributing to stock returns. For the purpose, if there is a financial constraints factor, the stock return volatilities of firms should be higher for firms with financial constraints. If the financial constraints factor does not exist, then changes in firms' financial status represent firm-specific shocks, which affect firm volatilities as well. To examine the impact of financial constraints, the following equation is estimated:

$$V_{it} = \alpha + \lambda R_{it-1} + \beta_1 D_{FC} + \beta_2 D_{FC} * R_{it-1} + \beta_3 D_{UC} + \beta_4 D_{UC} * R_{it-1} + \varepsilon_t \quad (2)$$

where firms are divided into three groups, the financially constrained, unconstrained and the less constrained. D_{FC} equals 1 if the firm belongs to the financially constrained group and 0 otherwise; D_{UC} equals 1 if the firm belongs to the unconstrained group and 0 otherwise. Thus, a negative β_2 indicates that financially constrained firms have stronger negative relation between volatilities and lagged returns.

2.2. The Data

The sample of companies used in the analysis is restricted to the following industry groups and their respective SIC codes: agricultural, mining, forestry fish and construction with SIC codes 1-1999, manufacture with SIC codes 2000-2999, retail and wholesale trade with SIC codes 5000-5999, and services with SIC codes 7000-8999. Financial and utility companies are not in the sample.

The CRSP daily stock file is used to calculate monthly stock return volatilities and monthly returns from the CRSP monthly file are used as monthly returns. Every firm's financial status data from Compustat is matched each year with the return and volatility series from July of that year to June of next year from the CRSP file. The reason is that most of the annual financial reports are not filed till several months after the New Year; the indicator for firms' financial status thus corresponds to the return and volatility several months later. The study requires firms with at least five year's financial constraints data and forty-eight monthly volatility observations. It also requires that the number of missing monthly volatility observations in each firm's time series not greater than four. Such requirement helps eliminate firms with short-lived history while include as many firms as possible.

The final sample consists of 5782 firms diversified across industries. The time horizon ranges from July 1963 to June 1999. The firm with the minimum length of period has 48 months of records and the maximum length of time has 432 months of records. On average firms have 162 monthly volatility-return observations.

2.3. Financial Constraints

The study uses two methods to construct firms' financial status. First, the paper uses a quasi-discriminant analysis method to determine firms' financial status. The discriminant analysis, as a dimension-reduction method, is widely used in the literature to predict bankruptcy and financial distress. Similar method has been used by Cleary (1999) to distinguish different levels of financial constraints on a much smaller dataset. Second, firms' financial status is calculated by following Kaplan and Zingales (1997) and Lamont et.al. (2001) which provides a robustness check.

The first step of the discriminant analysis is to construct several mutually exclusive groups of firms according to their dividend payout behavior. Annual dividend payout is widely accepted as one of the most revealing indicators of how well firms' internal finances are[2]. An initiation or increase in dividend payout is a good sign that the firm is not in financial constraints and vice versa. Firms are divided into 3 groups each year according to their financial status. Group 1 is the dividend-increasing, group 2 is the dividend-unchanged and group 3 is the dividend-decreasing group. Group 2 also includes those firm-years before the dividend payout initiation. Although dividend changes can be very revealing of firm's financial status, dividend no-change is not a clear signal of how well firms' finance situation is. So Group 2 will not be used as the basis for the initial step of the discriminant analysis.

Five financial ratios are constructed using data from firms' previous-year annual reports: debt/equity ratio (DR), cash flow to net fixed assets (CF), net income margin (IS), sales growth (SG), and market/book value (MB).[3] The assumption is that these variables can predict whether a firm will raise, or reduce dividend payout in the next period.

With these variables, I can perform the discriminant analysis and establish a linear relation between independent discriminant variables and a discriminant score. The higher the discriminant score is, the more likely that the firm is unconstrained and vise versa. Every year, firms are re-ranked according to their discriminant scores and the highest one-third firms are defined as unconstrained (UC), the lowest one-third as constrained (FC), and the middle-one third firms as less constrained (LFC).

Table 1 presents the mean statistic of the sample. Firms with high sale growth rate, high cash flow to net fixed assets, high net income margin, low debt-equity ratio and low market-book value have high discriminant scores. Firms with low discriminant scores are financially constrained.

As a robustness check, I use revised KZ index coefficient estimates provided in Lamont et.al. (2001) to construct another measure of financial constraints, the KZ index. The two classifications are quite consistent and detailed comparison is available upon request.

3. Estimation Results

The main purpose of this study is to examine the impact of financial constraints on firm-level volatility. The regression equations (1) and (2) are estimated using the panel regression method allowing for the first-order autocorrelation.

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[2] For example, Fazzari et.al. (1988) classify firms into the following three groups based on their dividend behavior over the 1970-1984 period: (1) those that have dividend-income ratio less than 0.10 for at least 10 years; (2) those that have dividend-income ratio between 0.10 to 0.20 for at least 10 years; and (3) all other firms.

[3] Details of these variables are described in the Appendix. Variables are also winsorized to approximate normality.

3.1. Basic Results

The results from Table 2 show that all groups of firms have negative relations between volatilities and lagged returns, consistent with the literature on asymmetric volatility (Duffee 1995). However, the return coefficients differ according to their financial status. The unconstrained group has the smallest return coefficient in absolute value at -0.028. For the LFC (FC) group, the coefficients are -0.0377 (-0.085). Thus, the higher the financial constraints level is, the more the volatility increases given the same amount of the decline in lagged returns.

To test whether the observed coefficients difference is statistically significant, two dummy variables are introduced: D_{FC} equals 1 if the firm belongs to the financially constrained group and 0 otherwise; D_{UC} equals 1 if the firm belongs to the unconstrained group and 0 otherwise. The results are shown in Table 2 under the column of total sample. The coefficient for the interaction between D_{FC} and lagged returns is -0.0512 and statistically significant at the 1 percent level, indicating volatilities from financially constrained firms react stronger to drops in stock prices. The coefficient for the D_{FC} dummy itself is 0.0132 and statistically significant at the 1 percent level, suggesting financially constrained firms also have higher volatility. On the other hand, the coefficient for the D_{UC} dummy is -0.006 and statistically significant, suggesting that unconstrained firms have lower risk. The regression yields similar results if all data are included in the regressions.

The same regressions are conducted using the KZ index. Table 3 shows the results. The lagged return coefficient of the financially constrained group is -0.0686 and significantly different from that of other groups of firms. The coefficient for the D_{FC} dummy is 0.0126 and statistically significant. Therefore, the test results using the KZ index generate similar results as those using the discriminant analysis method.

Overall, the results show that financially constrained firms are more volatile than firms with less financial constraints. Financial constraints also magnify the negative relation between volatilities and lagged returns.

3.2. Industry Factor

Different industries could have different capital structures and may as a result have different financial status. To examine whether the results above differ across industries, the sample is classified into 4 subgroups according to industry affiliations, Group 1 represents agriculture, forestry, mining and construction firms with SIC code of 1-1999; Group 2, manufacturing firms with code of 2000-3999; Group 3, wholesale and retail trade firms with code of 5000-5999; and Group 4, service firms with SIC of 7000-8999.

Table 4 shows that the general negative relation between volatilities and lagged returns still holds well across 4 groups of firms. Within each group, the financially constrained group has significantly higher sensitivity coefficient for lagged returns. Financial constraints also contribute significantly to the overall volatility as indicated by higher coefficients for the D_{FC} dummies. On the other hand, financially unconstrained firms have significantly lower volatilities.

Therefore, results suggest that the effect of financial constraints on the volatility-lagged return relation does not depend on industry differences.

3.3. Leverage Effect

One of the hypotheses for the negative relation between volatilities and lagged returns is the leverage hypothesis. Declines in stock prices increase firms' financial leverage (debt to equity ratio), which makes stocks riskier and raises their volatilities.

One possibility that financially constrained firms have high volatility-lagged return sensitivity and higher volatility might be that those firms have high debt-to-equity (D/E) ratios. To examine whether results above can be explained by D/E ratios, I divide firms into three groups based on their D/E ratios: high, mid, and low D/E groups each year with one third of the firms in each group.

If the effect of financial constraints is captured by debt to equity ratios, the high D/E ratio firms should have higher group-wide volatility level and stronger reaction to lagged return changes. Moreover, the coefficient for the interaction term between the D_{FC} dummy and lagged returns should be either insignificant or significantly smaller for high D/E firms than that in Table 2.

Panel A of Table 5 presents the results for three D/E groups. For the lagged returns coefficients, the high D/E group has the largest coefficient at -0.0316. Statistically, it is different from the coefficients for the low D/E group and the mid D/E group (results are available upon request). On the other hand, within each D/E groups, the coefficients for the D_{FC} dummies are still positive, and statistically significant. The coefficients for the interaction term between the D_{FC} dummy and the lagged return are negative and statistically significant. For the high (low) D/E group, the coefficient is -0.0508 (-0.0601). These numbers are not that different from the coefficient number (-0.0512) in Table 2. Thus, the effect of financial constraints is independent of the leverage effect as represented by debt-equity ratios.

Panel B of Table 5 provides additional results by combining the D_{FC} dummy, the high D/E dummy (D_{HDE}) and their interactions with lagged returns in the same regression. The results show that the D_{FC} dummy coefficient (0.0144) is twice as large as the high D/E dummy coefficient (0.0071). It also shows that the coefficient of the interaction term between D_{FC} and the lagged return (-0.0536) is almost 6 times as large as that for the high D/E interaction term (-0.009). Therefore, between the debt-equity ratio and financial constraints, the financial constraints effect is more important statistically.

4. Conclusions

This paper studies whether financially constrained firms are more risky and whether financial constraints magnify the risk-lagged return relation. In light of recent studies of financial constraints on stock returns by Lamont et. al. (2001) and Whited and Wu (2006), and continuing research in asymmetric volatility pioneered by Black (1976) and Christie (1982), I link firms' stock return volatility to their financial status and examine the volatility-lagged return relation empirically. Based on two indices for financial constraints, it is found that firms with financial constraints are more risky. Such high riskiness is shown both in overall level of volatility and in volatility sensitivity to lagged return changes. Moreover, the effect of financial constraints is independent of other factors such as industry differences and leverage in explaining firm-level stock return volatility. It might be interesting for future research to examine why financial constraints magnify the negative relation between volatility and the lagged return in more detail.

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Appendix

The financial ratio variables are calculated using the data from the annual Computat data file: Assets-Total (data6), Property, plant and Equipment (Net) (data8), Long-Term Debt-Total (data9), Sale (Net) (data12), Depreciation and Amortization (data14), Income Before Extraordinary Items (data18), Price-Calender Year-Close (data24), Common Shares Outstanding (data25), Debt in Current Liabilities (data34), Common Equity-Total (data60), and Net Income (data172). The ratios are calculated as follows:

(1) debt/equity ratio (DR) = (data9+data34)/data6;
(2) cash flow to net fixed assets (CF) = (data18+data14)/data8;
(3) net income margin (IS) = data172/data12;
(4) sales growth (SG) = (data12-lagged data12)/lagged data12;
(5) market/book value (MB) = data24*data25/data60;

The discriminant score of firm i at year t, D_{it}, is calculated based on the following equation, the coefficients are the results of the discriminant analysis:

$$D_{it} = 0.7658 * SG_{t-1} + 0.3972 * CF_{t-1} + 3.2186 * IS_{t-1} - 0.3781 * DR_{t-1} - 0.1884 * MB$$

By construction, the firms with high sale growth rate, high cash flow, high income margin, low debt-equity ratio and low market-book value will have high discriminant scores, and tend to be less financially constrained; the firms with low discriminant scores are financially constrained firms.

Table 1: Descriptive statistics of selected financial variables

The financially constrained group is represented by FC, the less financially constrained, LFC and financially unconstrained, UC. MC is the market capitalization. DR is the debt/equity ratio. CF is the cash flow to net fixed assets. SG is the sales growth. IS is the net income margin. MB is the market/book value and D-score is the discriminant score.

	Total Sample	UC	LFC	FC
MC($m)	899.78	906.63	1343.82	480.51
DR	0.43	0.31	0.46	0.53
CF	0.30	0.76	0.33	-0.19
SG(%)	0.15	0.31	0.11	0.01
IS	0.02	0.10	0.04	-0.09
MB	2.41	2.53	1.81	2.85
D-score	-0.22	0.41	-0.11	-0.97

Table 2: Regression results for volatility and financial constraints

The regression is either $V_{it} = \alpha + \lambda R_{it-1} + \varepsilon_t$

or $V_{it} = \alpha + \lambda R_{it-1} + \beta_1 D_{FC} + \beta_2 D_{FC} * R_{it-1} + \beta_3 D_{UC} + \beta_4 D_{UC} * R_{it-1} + \varepsilon_t$ with fixed-effect panel regressions allowing for first-order autocorrelations. D_{FC} and D_{UC} are the dummy variables for the financially constrained and unconstrained firms respectively. UC, LFC and FC are the unconstrained, less constrained and financially constrained groups. T-statistics are in the parentheses. One asterisk and two asterisks represent significance at the 5 percent and 1 percent level respectively. All data column is the regression based on all the available data in Compustat and CRSP, some of which do not survive the sample selection process.

	UC group	LFC group	FC group	Total Sample		All Data
R_{it-1}	-0.0280	-0.0377	-0.0850	-0.0535	-0.0307	-0.0326
	(-45.77**)	(-47.87**)	(-34.54**)	(-53.07**)	(-14.28**)	(15.40**)
D_{FC}					0.0132	0.0170
					(23.36**)	(24.18**)
$D_{FC} * R_{it-1}$					-0.0512	-0.0731
					(-19.68**)	(-28.92**)
D_{UC}					-0.0060	-0.0082
					(-10.30**)	(-11.64**)
$D_{UC} * R_{it-1}$					0.0056	0.0005
					(1.94)	(0.18)
Number of firms	4,846	4,593	4,787	5,782	5,782	7797
Number of obs.	304,565	305,000	289,540	907,552	907,552	1,142,998

Table 3: Regressions based on the KZ index classification method

The regressions are conducted using the KZ index classification for financial constraints (1997). T-statistics are in the parentheses.

	UC group	LFC group	FC group	Total Sample
R_{it-1}	-0.0430	-0.0416	-0.0686	-0.0366
	(-45.46**)	(-42.58**)	(-27.36**)	(-17.73**)
D_{FC}				0.0126
				(18.88**)
$D_{FC} * R_{it-1}$				-0.0364
				(-14.14**)
D_{UC}				-0.0050
				(-7.28**)
$D_{UC} * R_{it-1}$				-0.0032
				(-1.12)
Number of Firms	3,738	4,284	3,973	5,750
Number of Obs.	294.966	291,708	280,663	873,585

Table 4: Industry factors and financial constraints

Group 1: agriculture, forestry and mining; Group 2: manufacturing; Group 3: wholesale and retail trade; and Group 4: services. T-statistics are in the parentheses. One asterisk and two asterisks represent significance at the 5 percent and 1 percent level respectively.

	Group 1	Group 2	Group 3	Group 4
R_{it-1}	-0.0528	-0.0255	-0.0492	-0.0384
	(-5.95**)	(-9.53**)	(-16.15**)	(-4.67**)
D_{FC}	0.0171	0.0113	0.0135	0.0189
	(7.25**)	(17.32**)	(11.36**)	(8.10**)
$D_{FC} * R_{it-1}$	-0.0289	-0.0535	-0.0290	-0.0500
	(-2.83**)	(-16.32**)	(-7.35**)	(-5.37**)
D_{UC}	-0.0067	-0.0048	-0.0064	-0.0091
	(-2.96**)	(-7.21**)	(-4.72**)	(-3.99**)
$D_{UC} * R_{it-1}$	0.0314	0.0016	0.0190	-0.0119
	(2.93**)	(0.44)	(4.08**)	(-1.17)
Number of firms	506	3,461	872	943
Number of obs.	75,801	587,821	129,359	114,571

Table 5: Leverage effect and financial constraints

Panel A: each year firms are classified into high debt/equity (D/E) group, mid D/E group and low D/E group. T-statistics are in the parentheses and one asterisk and two asterisks represent significance at the 5 percent and 1 percent level respectively.

	Low D/E Group	Mid D/E Group	High D/E Group
R_{it-1}	-0.0263	-0.0230	-0.0316
	(-9.03**)	(-10.38**)	(-5.54**)
D_{FC}	0.0082	0.0071	0.0162
	(9.05**)	(10.91**)	(11.33**)
$D_{FC} * R_{it-1}$	-0.0601	-0.0471	-0.0508
	(-16.58**)	(-15.99**)	(-7.71**)
D_{UC}	-0.0048	-0.0028	-0.0088
	(-6.74*)	(-3.94**)	(-4.75**)
$D_{UC} * R_{it-1}$	0.0059	0.0004	0.0021
	(1.60)	(-0.12)	(0.25)
Number of Firms	4,052	4,245	3,761
Number of obs.	276,298	281,215	268,647

Panel B: $V_{it} = \alpha + \lambda R_{it-1} + \theta_1 D_{FC} + \theta_2 D_{FC} * R_{it-1} + \theta_3 D_{HDE} + \theta_4 D_{HDE} * R_{it-1} + \varepsilon_t$ where D_{FC} equals 1 when the firm is financially constrained and 0 otherwise; and D_{HDE} equals 1 when the firm has a high debt-equity ratio and 0 otherwise.

	Coefficient	t-statistics	P-value
R_{it-1}	-0.0231	-13.56	0.000
D_{FC}	0.0144	26.96	0.000
$D_{FC} * R_{it-1}$	-0.0536	-23.70	0.000
D_{HDE}	0.0071	11.23	0.000
$D_{HDE} * R_{it-1}$	-0.0090	-3.92	0.000