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**TITTEL: Event study on changes in capital structure and volatility**



| FORFATTER(E) | | VEILEDER: Peter Molnar |
|---|---|---|
| Kandidatnummer:<br>1037<br>1057 | Navn:<br>Tatyana Helleland<br>Kristina Petkevic | |

# EVENT STUDY ON CHANGES IN CAPITAL STRUCTURE AND VOLATILITY

Kristina Petkevic[1], Tatyana Encheva Helleland[1]

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## ABSTRACT

The authors of this paper test whether the changes in the capital structure and more specifically the changes in Debt to Equity ratio can explain the changes in the implied volatility and realized volatility. In addition, the effect of changes in leverage on stock returns and volume trading was researched. This was done by performing an event study in a selection of 24 companies from the US market. The results of the empirical analysis suggest that the market has higher explanatory power than the changes in the leverage for the selection of stocks. Changes in leverage can explain the changes in stock's return, while the average volume trade over a 5-day period before and after the investigated events could not be explained by changes in the leverage.

[1] University of Stavanger, Stavanger, Norway

# INTRODUCTION

Capital structure contains information about firm's equity and obligations. Obligations involves costs and risks. Capital structure composition is a strategic choice that affects shareholders, investors, microeconomic business decisions and macroeconomic downturns. (Zhu Kateri, 2014) Therefore, capital structure's impact on volatility of stock prices is a relevant and interesting topic for authors.

A firm's capital structure and its' importance is a wide and relevant topic for economists and investors. Discussions arise from Modigliani and Miller's capital structure irrelevance theorem (Modigliani Franco & Miller H. Merton, 1958) which states that without taxes, capital structure is irrelevant and has no effect on company's value. The theoretical framework put many researchers to action to challenge it and search of empirical evidence. Ross suggested that the values of firms will increase with leverage, since increasing leverage increases the market perception. (Ross A. Stephen, 1977) In addition, debt level and inside equity position of a firm are the means of passing project risk on to outside investors and hence serve as a signal for the firm's true quality which is private. (Cheong Kwang Soo, 1999) Capital structure is determined by trading off benefits of debt against costs of debt. (Harris Milton & Raviv Artur, 1991)

Financial leverage is the process of borrowing capital to make an investment, with the expectation that the profits made from the investment will be greater than the interest on the debt. (Nuding Tim, 2014) Previous studies on debt-equity composition inspired Black and Scholes (1973) discussion that leverage in the underlying firm's capital structure has impact on stock's volatility. (Figlewski Stephen & Wang Xiaozu, 2000) The whole concept of leverage was clearly explained by Nuding Tim (2014). Different sector companies (central banks, commercial banks, the consumer goods sector) perceive leverage positive or negative based on the context, market situation and perspective: is it used to increase productivity or to boost consumption.

Leverage effect refers to the generally negative correlation between an asset return and its' changes of volatility (Ait-Sahalia Yacine, Fan Jianqing, & Li Yingying, 2013). The impact of leverage[2] on volatility is the focus in this paper. The authors are testing if the implied and realized volatility of the market stock prices is affected by the change of the financial structure (debt-equity composition). It is also researched if changes in the stock returns can be explained by the changes in the leverage, as well as if the changes in the average volume of the stocks traded on the market can be explained by changes in how the firms is geared and the source of financing.

Every action taken by the company is evaluated by investors. Capital change decisions send signals to investors about company's plans and in many cases, reflects market situation. Capital structure change is a decision made by management and is closely related to corporate finance theory. (Jensen & Meckling, 1976). As the management of a company has inside information about the financial stability and prospects of a firm, sending such signals to the outside world is an important piece of information for the investors. Based on this information the investors can make their decisions weather to invest, withdraw or stay neutral and neither buy or sell the stock. The volume of trading on the market is seen from the authors of this paper as a neutral move, and thus the changes in the volume of the trading on the market was also considered.

The authors of this paper concentrate on the consequences of issuing and repaying bonds which are a part of the tools for changing capital structure. Using implied and realized volatility data, combined with calculated independent

[2] Leverage is a proportion of debt to shareholder's equity.

variables in several models, they are looking for an answer to the question whether debt-equity ratio change can explain the implied and realized volatility of stocks. Issuance and repayment of corporate bonds is expected to have some effect on the stock market prices and from there on the implied and realized volatility behind those prices for the sample companies. Also, the authors are interested to see whether changes in leverage have explanatory value for the changes in the trading volume. The effect of changes in leverage on the changes in the stock returns was also analyzed.

The paper is organized as follows. Firstly, Methodology, then Data and Empirical results. Lastly, Conclusions and Acknowledgements.

## METHODOLOGY

This part will elaborate on the methods and models used for evaluating effect of capital structure changing events on stock prices and their corresponding volatilities, returns and trade volume. Previous studies on leverage effect suggest evidence that leverage is a key component for explaining time-variation in volatility. (Choi & Richardson, 2016; el Alaoui, Ismath Bacha, Masih, & Asutay, 2017) These results inspired the authors to investigate whether the changes in capital structure have impact on the implied and realized volatility on selection of 24 companies' stocks, US market. The goal of the paper is to investigate the connection between stocks returns and the changes in leverage for the unique data set.

Analysis is performed of implied volatility and realized volatility with respect to VIX[3] and S&P500. Literature reports a link between the corporate bond price and the VIX, as well as a link between the bond liquidity and the market risk (VIX) (Gonzalez-Perez, 2015) In this paper, multiple linear regression analysis, model with 2 independent variables, was chosen to test whether the changes in leverage have explanatory value in realized and implied volatilities changes calculated on stock returns. The same model was used for testing if changes in leverage can explain the changes in stock returns. The general form of a multiple linear regression is: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$ (1)

$\beta_0$ is intercept, $\beta_1$, $\beta_2$ regression coefficients, $X_{1,} X_2$ are independent variables. (Slinker K. Bryan & Glantz A. Stanton, 2008)

For controlling purposes, a simple, one independent variable, regression was applied to several of the regressions to confirm that the model has a strong variable that alone can explain substantial portion of the changes in the dependent variable.

In finance, event-studies are widely used to address different questions. (Campbell Y. John, Lo W. Andrew, & MacKinlay A. Craig, 1997) We focus on the effect of the debt issuance, repayment, buybacks and stock splits announcements. As the authors are interested to see if the announcement of a bond issue and the actual issue of the bond have different effect on the implied and realized volatility of the stocks in our data set, the events were separated into 2 general types.

*Type 1 events* have no actual transaction happening, but contain information about one such transaction in the future. Such events are bond issue announcements, buyback announcements and stock split announcements. Announcements about future equity issue would normally also belong in this

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[3] VIX is the ticker symbol for the Chicago Board Options Exchange (CBOE) Volatility Index (Whaley R. E., 1993)

group; however, data for new equity issue for any of the companies in this data set for the analyzed period was not found. Data for sales of own stocks from the firms to the market was also not available.

*Type 2 events* are associated with a transaction, where a change in the leverage is happening because of the issuance of the new bond or repayment done for a bond at maturity. Retained earnings, another event that would normally result in changes in the debt to shareholders equity ratio, are announced on the quarterly basis. For this research, the events that occur on or close to quarterly reports are not taken into consideration. Adjustments to Other Comprehensive Income was also not taken into consideration.

The authors are interested to see if changes in volatility in historical stock prices captures capital structure changing events in the real financial market. As most of the theoretical knowledge is based on the assumptions of ideal market where no actor has more information than other, as well as several other assumptions (no taxes, no agency costs), it is natural to develop the interest to test these theories with data from the real market.

The hypothesis for this paper is that the independent variables for leverage effect based on both book value of equity and market value of equity have little or no explanatory power over the dependent variables, RV and IV, and the theory holds even in real market conditions where taxes and agency costs are present.

## INPUT DATA

S&P500 is used as a benchmark. The rationality behind this is that 24 American well- known companies were selected for analysis and this index is a reasonable choice as it contains the most influential companies in the U.S.

Furthermore, it is widely used and recognized index around world. Novel data in this paper are announcements dates for issuing new bonds, buybacks and stock splits; actual issuance day and amount issued; bond repayment day and amount in the period of 2010-2014. Data for quantitative research is obtained from Eikon, Yahoo! Finance data base and Oxford-Man Institute of Quantitative Finance.

Available data from balance sheets for shareholders equity and total liabilities was used to calculate the financial leverage measure, Debt to Equity. Another approach to calculate the leverage could have been to use the formula:

Leverage = Total Liabilities/ (Total Liabilities + Shareholders Equity)

However, as this effectively transforms into Leverage = Total liabilities/ Shareholders equity +1 and during the calculations one subtracts the values for the leverage to find the changes, the calculation approach used will yield same result, as the +1 will be eliminated.

To calculate the debt to equity ratio, based on market value of the shareholders equity, the market value (MV) of the equity was acquired by multiplying the number of total shares by the adjusted closed price of the stock for a specific day; then, the total liabilities was divided on the MV to get the leverage associated with market value of the equity. Announcement and execution dates for debt issuance, debt repayment, buybacks and stock split announcements were collected. Values for 1 day before and 1 day after the events were also calculated. It was done for trading volume, realized volatility and implied volatility.[4] No information for equity issuance was present. Timing: after investigation of bonds trading on the market, and evidence that the bonds have

[4] The initial analysis included calculations for 5 days before and after announcement/event average. Although five trading days were considered as an appropriate event window because it takes an average of a 5-days working week and is not affected by any specific day of the week in the end it was decided that it is not the best choice as most of the announcements appear to be within 2 to 5 trading days before the actual issuance of the bond.

been trading between investors already the same day of issuance, the authors assume that the impact of the bond issue on the debt value is happening on the same day. For events that took place on a non-trading day, we applied the changes in the debt values on the closest following trading day.

Implied and realized volatility of individual stocks data input is from a paper written by Norwegian University of Science and Technology students (Bugge Sebastian A., Guttormsen Haakon J., & Ringdal Martin, 2016). Realized volatility measures the past events based on historical prices. In our model, RV[5] is obtained using a sampling frequency of 5 minutes that allows to ignore much of the microstructure noise. Heterogeneous Autoregressive model of Realized Volatility (HAR-RV) is used for calculations. (Corsi F., 2009)

A trading day is split into $m$ intervals. The intraday return $r_i$ data is more information-rich and thus they can produce more accurate estimates of the daily volatility over the time $\left[i - \frac{1}{m}, i\right]$ (Degiannakisa Stavros & Filis George 2017)

$$r_i = \ln\left(\frac{P_i}{P_{i-1/m}}\right), \text{for } i = \frac{1}{m}, \frac{2}{m}, \dots 1. \qquad (2)$$

where $P_i$ is the price at time i.

Annual volatility is converted into daily realized volatility by taking the square root of 250 trading days per year. Methodology is followed by Corsi (2009).

$$RV^D = \sqrt{\sum_{i=1}^{m} r_i^2} \times \sqrt{250} \qquad (3)$$

Implied volatility refers to future volatility assessed by the market. In other words, expectations for future events are reflected in implied volatility. VIX Index generalized formula is as follows:

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[5] Realized volatility

$$\sigma^2 = \frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2 \qquad (4)$$

Where $\sigma$ is VIX/100, T time to expiration in years, F forward level of underlying, $K_0$ first strike below F, $K_i$ Strike price of the i-th out-of-money option, $\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}$, R is the risk-free interest rate to expiration. (Chicago Board Options Exchange, 2016)

IV and RV data is used for 24 stocks in the data set and VIX and S&P500 indices were used as benchmarks. It total, there are 114 announcements and 256 transaction events observations in the data set that was analyzed for this paper. The two kinds of events are separated in 2 new data subsets and used separately in regression analysis, as the authors are testing if the origin of event type gives different signals for the market resulting in different results in regression results.

Daily stock prices and volumes are collected for all sample companies. Simple and logarithmic daily returns are calculated as follows:

$$r(t) = ln\left[\frac{S(t)}{S(0)}\right] = ln[S(t)] - ln[S(0)] \qquad (5)$$

Where S(t) stands for the closing value of the current day and S(0) is the closing value of the previous day. This calculation was executed day by day for 4 years period, only trading days, for the 24 companies in this paper.

Regression analysis is performed for both data subsets, based on these six models:

1. $R_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 R_{S\&P500}$
2. $R_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 R_{S\&P500}$
3. $RV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 RV_{S\&P500}$
4. $RV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 RV_{S\&P500}$
5. $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 VIX_{market}$

6. $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 VIX_{market}$

In total 12 regression analyses were run to access the effect changes in leverage have on the implied volatility, realized volatility and daily returns for the selection of stocks. One additional regression was performed, with only one independent variable, namely changes in leverage, to investigate if such changes can explain the changes in 5-day average trading volume for the stocks. The independent variable used was based on both book value calculated leverage and market value calculated leverage.

$$7. Volume_{stocks} = \propto + \beta_1 \times \Delta Leverage(MVorBV)_{stocks}$$

## DATA PREPARATION

The process of merging data acquired from various sources to get a complete data set for this research was an important part of the data preparation process. It was a time-consuming task to get accurate, consistent and free of human error data set. Part of the process was therefore automated by creating a script to import the data and automatically assign values to the corresponding lines and columns, using as an identifier key the date.

Using balance sheets information, we collected total liabilities, total equity and the number of total common shares outstanding for 24 sample companies from quarterly reports. This information was used for evaluating effects of announcement and transaction events related to volume and leverage. As the announcement on its own is only information provider, the authors assume that it may affect stock volatilities without directly changing the capital structure. (Andritzky, Bannister, & Tamirisa, 2007). As the information about the expected change in capital structure is available in the announcement (date and volume information), the authors use these future expected values to calculate the expected impact on the leverage. This was done to ensure that the announcement events are assigned a value different than zero, as having a zero in front of a variable would make any further regression analysis pointless.

For actual bond issuance or repayment day when financial transactions take place, we apply changes to the collected data from quarterly reports. For example, if a bond issue causes 8% change in leverage, we apply this 8% change to increase leverage on that day in dataset.

Several assumptions were applied for the data set and the following actions were performed:

1. The data set was inspected and all observations where one or more daily values/stock prices for SP500, VIX, IV, RV were not available were removed.
2. Events that are within 5 trading days before or after a quarterly report were eliminated due to noise in the market. (Hasselback Drew, 2015).
3. In the cases where several bond issue events were associated to just one announcement event, it is assumed that investor will react on the nearest event (keeping in mind that announcement can contain information about several events).[6] Thus, the expected change in the leverage was applied only to the nearest event as a value.
4. Information about buybacks was incomplete: the date of the announcement and the estimated buyback date were available. Unfortunately, no information about the actual volume of the buyback or

[6] As an alternative, it is possible to use average value for events on different dates, but this approach was not used, as estimating how the market will change several periods in the future will probably result in estimate that is not reliable or accurate.

any evidence that it happened was available. As a result, buybacks are presented in data set as announcements without associated value.

5. Small value events (less than 1% of long term debt) were not taken into analysis as it is not likely that they have same scale of impact on stocks volatility as a larger event would have.

## EMPIRICAL RESULTS FROM REGRESSIONS

Reading dataset can be challenging and for effective process we start with plotting it to get a visual understanding of behaviors hidden in numbers. (Artail, 2003) In multilinear regression models experiments data often contains outliers and bad influential observation, due to errors. It is important to identify these observations and eliminate them from the data set. (Chatzinakos & Zioutas, 2014) It was applied it for the data set we use for analysis.

The *1 Figure* plots histogram of leverage data. Such analysis was performed for the whole data set. It proved to be a wise choice as it identified the presence of outliners in the data and showed data distribution. Authors refer to 'outliers' as large sample values which do not belong to the population of interest. The definition is taken from Schluter and Trede (2008).

*2 Figure* illustrates outliers, identified by observation number. This gives the possibility to inspect and analyze these observations and look for the reason why these observations are so much different than the rest. If a solid reason was found that such observations are very different from the rest of the data set, they were eliminated in the regression analysis. After inspection, it appeared that buybacks are outliners due to incomplete information. Therefore, it was decided to eliminate them and run regressions with the remaining observations.

In total, twelve multiple regressions were run using R, starting with announcement events, then transaction events; in addition, four simple regressions, based on the available data for volume trading for both announcement events and transitions events, one for each type. The focus of this study was to evaluate which estimated models have significant values and see if change in capital structure affects RV and IV of stocks, as well as check if the leverage affects the daily returns. Several models with different combinations of variables were created to test for effect from the leverage calculated from book value of equity and market value of equity.

Values that were taken into regression analysis and are discussed in this part are:

- Changes in the implied volatility = IV (t+1) – IV (t-1)
- Changes in realized volatility = RV (t+1) – RV (t-1)
- Delta Book value = (total liabilities/BV) (t+0)– (TL/BV) (t-1)
- Delta MV = (total liabilities/market value of equity) (t+0)– (TL/MV) (t-1)
- For the daily stock and index returns we used the log returns,
  ln(t+1) – ln(t-1)

The residual plots for regressions are provided as graphs in Appendix. Randomness and unpredictability are crucial components of any regression model. (Naciri Ahmed, 2017) Residual plots should be consistent with random error and contain none of the explanatory information. To confirm this, the authors inspect if residuals are centered close to zero throughout the range of fitted values, indicating that the model presented by that plot is correct on average for all fitted values. The residuals should fall in a symmetrical patter and be spread through the entire range. This is what we see in most of our plot results.

In estimated models with two 2 variables it was tested whether the changes in leverage have explanatory value for the changes observed in the realized and implied volatilities of sample stocks. Moreover, one more test analyses if the changes in daily returns on sample stocks can be explained by the change in leverage or the changes in the daily returns of the index used for this paper (S&P500).

When running a regression analysis one of the values we observe is the P-value, which is the probability that the results of the analysis could have happened by chance. In our models, all p-values are very close to zero. Note the significance associated to Pr(>|t|) estimates: three stars represent a highly significant p-value. Adjusted $R^2$ considers the number of variables and is preferred over $R^2$. It shows how well the independent variables included in the model can explain changes in dependent variable. The analysis results indicate that the models used explain between 13% and 58% of the changes in the explanatory variable. None of the models has $R^2$ above 75%, which is believed to be a good starting point should a model will be used for predicting and estimating future values. The results of the analysis, across both subsets of data, indicate that:

1. Model with changes in daily stock returns as a dependent variable and changes in SP500 as an independent variable, regression result for the Transactions subset of data, explains 52% of the changes in the dependent variable. In the model, the variable change in leverage is calculated based on market value of equity and this model has a statistically significant independent variable $\Delta MV_{stocks}$ at 5% level. The result indicates that, for the data set gathered for this event study, the changes in the daily returns of the stocks can be partly explained by the changes in the leverage. This is not true if the

changes in leverage are calculated based on book value of equity; the result if this approach is chosen is 48% explanatory power of the model but the independent variable associated with the changes in leverage is not significant at any level. The models, when applied to the Announcement subset of data, do not produce results that indicate significance of the independent variable changes in leverage regardless of the way it is calculated.

2. Models with changes in implied volatility for sample stocks as dependent variable and changes in VIX index as independent variable explain more than 50% of changes in the dependent variable in both Transactions and Announcement event types. However, it showed that changes in leverage calculated based on both book value of equity and market value of equity were not significant in these models. Even though the changes in the index have good explanatory power over the dependent variables, other variables, different than the changes in leverage, should be added to the model if the model should be used for predicting. As the focus of this paper is to check whether the changes in leverage have or do not have effect on the changes in the implied volatility behind the selection of stocks, the discussion which other variables could improve the model was not taken.
3. Models with changes in realized volatility for sample stocks as dependent variable and changes in SP500 index for market as independent variable explain between 13% and 20% of changes in the dependent variable in both event types. Changes in leverage calculated based on both book value and market value were not significant in these models.
4. Model with changes in 5 days average trading volume as dependent variable and changes in the leverage calculated based on both book value of equity and market value of equity was also run during the research. A model with Volume

(t+1)-Volume (t-1) as response variable was also tested. Both models showed that changes in leverage cannot explain changes in the volume traded. The models also produced a very low R2 values, indicating that the model cannot explain the changes in the explanatory variable. Even though regressions showed insignificant results, the models are included in summary table and Appendix.

The results point that changes in capital structure had no significant effect on IV or RV changes for stocks. Changes in the market are the main force in these models and have a significant explanatory power over dependable variables. *Table 1* presents summary statistics for accumulated sample stocks. Coefficients $\beta_1$ being insignificant for all models except $R_{stocks} = \propto + \beta_1 \times \Delta MV_{stocks} + \beta_2 R_{S\&P500}$ suggests that the models could be improved by adding other independent variables and excluding not significant ones. Based on this analysis, there is no impact of changes in leverage on volatility changes, even though volatility changes were measured as precisely as possible, utilizing realized and implied volatility of individual stocks. Nevertheless, it was discovered that leverage has a significant effect on stock returns. The models in this paper served to find out if there is a relation between leverage and volatility. On the contrary, if the reader is interested in explaining volatility using other variables, models of the autoregressive conditional heteroskedasticity family, such as GARCH and EGARCH, Nelson (1991), are known as suitable tools for time series data on forecasting and analyzing volatility. There are quite many authors as Benlagha and Chargui (2017), also Bentes (2015), Sheraz and Preda (2014) who estimated models using GARCH.

*Table 1* Summary of results of all regressions for two types of events: Announcements and Transactions.

| ***Regression on event type*** | ***Model variables*** | ***Estimate*** | ***Std. error*** | ***T value*** | ***Pr(>\|t\|)*** | ***Adjusted $R^2$*** | ***P values*** | ***F statistic*** |
|---|---|---|---|---|---|---|---|---|
| ***Announcement*** | $R_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 R_{S\&P500}$ | | | | | 0.4647 | 1.22E-13 | 41.81 on 2 and 92 DF |
| ***1.*** | $\alpha$ (Intercept) | -0.0032 | 0.0010 | -3.1020 | 0.00255 ** | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | 0.0129 | 0.0197 | 0.6520 | 0.5163 | | | |
| | $\beta_2(R_{S\&P500})$ | 0.9729 | 0.1065 | 9.1340 | 1.52e-14 *** | | | |
| ***Announcement*** | $R_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 R_{S\&P500}$ | | | | | 0.4433 | 1.78E-12 | 37.23 on 2 and 93 DF |
| ***2.*** | $\alpha$ (Intercept) | -0.0026 | 0.0014 | -1.8680 | 0.065 | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | 0.0004 | 0.0116 | 0.0310 | 0.9750 | | | |
| | $\beta_2(R_{market})$ | 1.0003 | 0.1160 | 8.6230 | 2.27e-13 *** | | | |
| ***Announcement*** | $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.MV_{stocks}$ | | | | | 0.002978 | 0.266 | 1. on 1 and 84 DF |
| ***3.*** | $\alpha$ (Intercept) | -1263769 | 339408 | -3.723 | 0.000355 *** | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | -7401964 | 6610196 | -1.120 | 0.265999 | | | |
| ***Announcement*** | $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.BV_{stocks}$ | | | | | 0.0001821 | 0.3163 | 1.016 on 1 and 86 DF |
| ***4.*** | $\alpha$ (Intercept) | -1341594 | 376730 | -3.561 | 0.000605 *** | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | -1919298 | 1904272 | -1.008 | 0.316335 | | | |
| ***Announcement*** | $RV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 RV_{S\&P500}$ | | | | | 0.2141 | 1.36E-05 | 12.67 on 2 and 93 DF |
| ***5.*** | $\alpha$ (Intercept) | 0.0218 | 0.0355 | 0.6130 | 0.5410 | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | -0.4494 | 0.2912 | -1.5430 | 0.1260 | | | |
| | $\beta_2(RV_{S\&P500})$ | 0.1526 | 0.0314 | 4.8660 | 4.62e-06 *** | | | |
| ***Announcement*** | $RV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 RV_{S\&P500}$ | | | | | 0.1316 | 0.000649 | 7.973 on 2 and 90 DF |
| ***6.*** | $\alpha$ (Intercept) | 0.0129 | 0.0349 | 0.3710 | 0.7115 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | -1.6064 | 1.1938 | -1.3460 | 0.1818 | | | |
| | $\beta_2(RV_{S\&P500})$ | 0.1198 | 0.0307 | 3.9040 | 0.000183 *** | | | |
| ***Announcement*** | $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 VIX_{market}$ | | | | | 0.5628 | < 2.2e-16 | 57.64 on 2 and 93 DF |
| ***7.*** | $\alpha$ (Intercept) | 0.0070 | 0.0051 | 1.3620 | 0.1770 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | -0.0543 | 0.0964 | -0.5630 | 0.5750 | | | |
| | $\beta_2(VIX_{market})$ | 0.5117 | 0.0477 | 10.7250 | <2e-16 *** | | | |
| ***Announcement*** | $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 VIX_{market}$ | | | | | 0.5317 | 1.49E-15 | 51.09 on 2 and 90 DF |
| ***8.*** | $\alpha$ (Intercept) | 0.0083 | 0.0054 | 1.5370 | 0.1280 | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | -0.0169 | 0.0275 | -0.6140 | 0.5400 | | | |
| | $\beta_2(VIX_{market})$ | 0.5084 | 0.0503 | 10.1070 | <2e-16 *** | | | |
| ***Transaction*** | $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 VIX_{market}$ | | | | | 0.5786 | < 2.2e-16 | 133.5 on 2 and 191 DF |
| ***9.*** | $\alpha$ (Intercept) | -0.0009 | 0.0031 | -0.3010 | 0.7640 | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | -0.0124 | 0.0242 | -0.5120 | 0.6090 | | | |
| | $\beta_2(VIX_{market})$ | 0.5275 | 0.0325 | 16.2280 | <2e-16 *** | | | |
| ***Transaction*** | $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 VIX_{market}$ | | | | | 0.5508 | < 2.2e-16 | 121.1 on 2 and 194 DF |
| ***10.*** | $\alpha$ (Intercept) | -0.0034 | 0.0032 | -1.0640 | 0.2890 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | 0.0381 | 0.0881 | 0.4320 | 0.6660 | | | |
| | $\beta_2(VIX_{market})$ | 0.5279 | 0.0339 | 15.5590 | <2e-16 *** | | | |

*Continued the next page*

| *Regression on event type* | *Model variables* | *Estimate* | *Std. error* | *T value* | *Pr(>\|t\|)* | *Adjusted* $R^2$ | *P values* | *F statistic* |
|---|---|---|---|---|---|---|---|---|
| ***Transaction*** | $RV_{stocks} = \propto + \beta_1 \times \Delta Lev BV_{stocks} + \beta_2 RV_{S\&P500}$ | | | | | 0.1505 | 4.96E-08 | 18.36 on 2 and 194 DF |
| ***11.*** | $\alpha$ (Intercept) | -0.0133 | 0.0185 | -0.7200 | 0.4730 | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | 0.0916 | 0.1440 | 0.6360 | 0.5260 | | | |
| | $\beta_2(RV_{S\&P500})$ | 0.1386 | 0.0231 | 5.9900 | 1e-08 *** | | | |
| ***Transaction*** | $RV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 RV_{S\&P500}$ | | | | | 0.1499 | 5.30E-08 | 18.29 on 2 and 194 DF |
| ***12.*** | $\alpha$ (Intercept) | -0.0130 | 0.0185 | -0.7030 | 0.4830 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | 0.2677 | 0.5121 | 0.5230 | 0.6020 | | | |
| | $\beta_2(RV_{S\&P500})$ | 0.1380 | 0.0233 | 5.9290 | 1.37e-08 *** | | | |
| ***Transaction*** | $R_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 R_{S\&P500}$ | | | | | 0.4839 | < 2.2e-16 | 91.02 on 2 and 191 DF |
| ***13.*** | $\alpha$ (Intercept) | 0.0002 | 0.0005 | 0.3150 | 0.7530 | | | |
| | $\beta_1(\Delta Lev.BV_{stocks})$ | -0.0010 | 0.0042 | -0.2320 | 0.8170 | | | |
| | $\beta_2(R_{S\&P500})$ | 0.7761 | 0.0575 | 13.4870 | <2e-16 *** | | | |
| ***Transaction*** | $R_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 R_{S\&P500}$ | | | | | 0.5216 | < 2.2e-16 | 103.5 on 2 and 194 DF |
| ***14.*** | $\alpha$ (Intercept) | 0.0005 | 0.0005 | 0.8970 | 0.3709 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | -0.0288 | 0.0140 | -2.0650 | 0.0403 * | | | |
| | $\beta_2(R_{S\&P500})$ | 0.7510 | 0.0539 | 13.9390 | <2e-16 *** | | | |
| ***Transaction*** | $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.BV_{stocks}$ | | | | | 0.003035 | 0.2106 | 1.578 on 1 and 189 DF |
| ***15.*** | $\alpha$ (Intercept) | 8764 | 212509 | 0.041 | 0.967 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | -2066359 | 1644774 | -1.256 | 0.211 | | | |
| ***Transaction*** | $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.MV_{stocks}$ | | | | | 0.008613 | 0.1052 | 2.651 on 1 and 189 DF |
| ***16.*** | $\alpha$ (Intercept) | 21914 | 211929 | 0.103 | 0.918 | | | |
| | $\beta_1(\Delta Lev.MV_{stocks})$ | -9570862 | 5878496 | -1.628 | 0.105 | | | |

* Significant at the 5% level, ** Significant at the 1% level, *** Significant at the 0.1% level.

# CONCLUSIONS

Using a unique dataset of active and inactive bonds issuance and repayment days and announcements for these events, combined with realized and implied volatilities for stocks, we developed multiple regression models with two variables. This allowed us to investigate the effects of changing in the capital structure on the stocks return, implied volatility and realized volatility.

Our results show that market changes have high explanatory power over changes in inspected dependent variables in all regression results. The model with highest statistical significance includes as independent variables the changes in SP500 return and the leverage calculated with market value of equity. This model can explain 52% of the changes in the sample stocks return. Models with implied volatility or realized volatility as dependent variables did not give any statistically meaningful results that could explain the volatilities on stocks by changes in the capital structure. However, leverage can be more related to firm's assets volatility like Choi and Richardson (2016) suggests than with book value and market values of the equity which were used in models. In fact, it was discovered that leverage has a significant effect on stock returns. The research could be further developed based on this direction.

Figlewski Stephen and Wang Xiaozu (2000) find evidence that leverage is a down market effect and Bouchaud Jean-Philippe, Matacz Andrew, and Potters Marc (2008) point the market panic phenomenon should be accounted for negative correlation between volatility and returns. This suggests, that expanding or changing the sample period, which was 2010-2014 in this paper, or the number of the firms selected for the research can be considered. Including other variables in the model could also might be beneficial.

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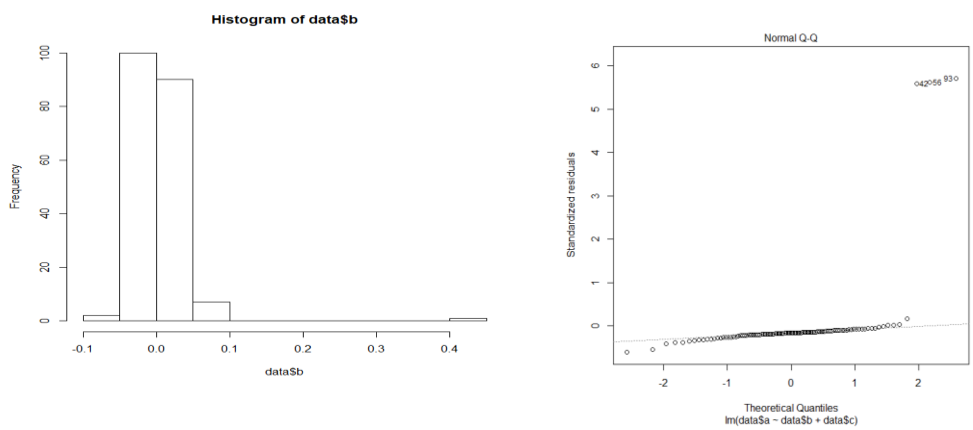
# APPENDIX

## HISTOGRAM

A B

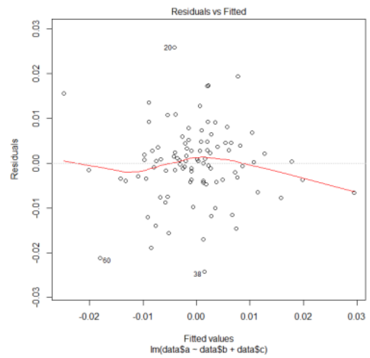


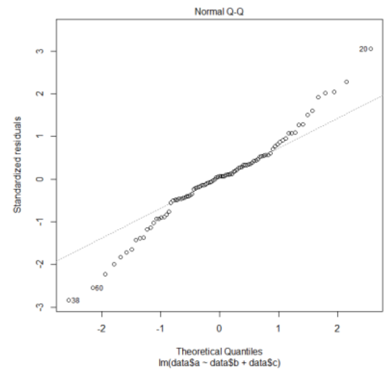

*1 Figure:* Histograms revealing outliners for regression with leverage variable.

## GRAPHS

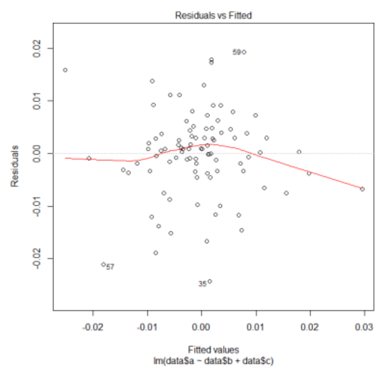
Residuals vs Fitted Plot Output | Normal Q-Q Plot Output

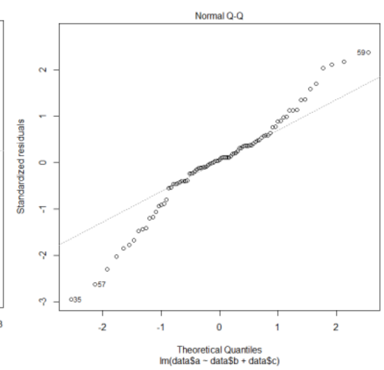
1 $R_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 R_{S\&P500}$



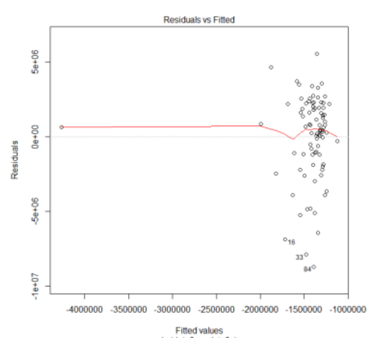



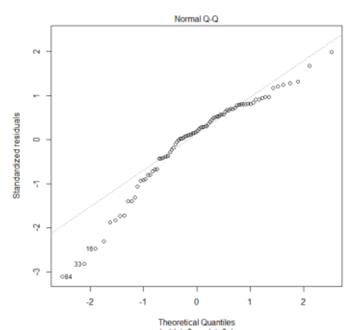

2 $R_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 R_{S\&P500}$



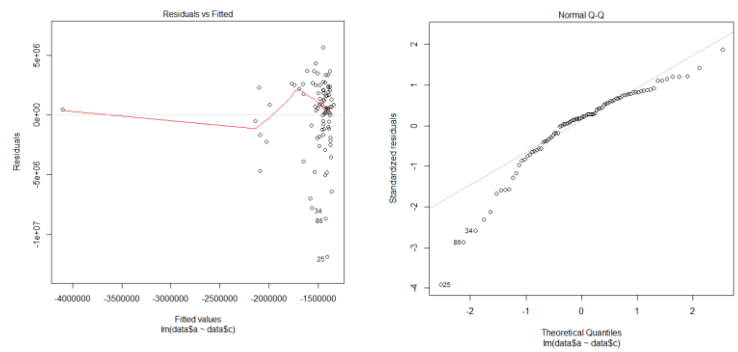




3 $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.MV_{stocks}$

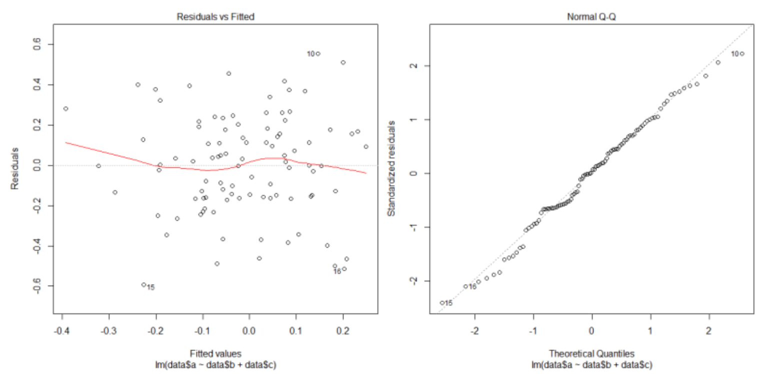


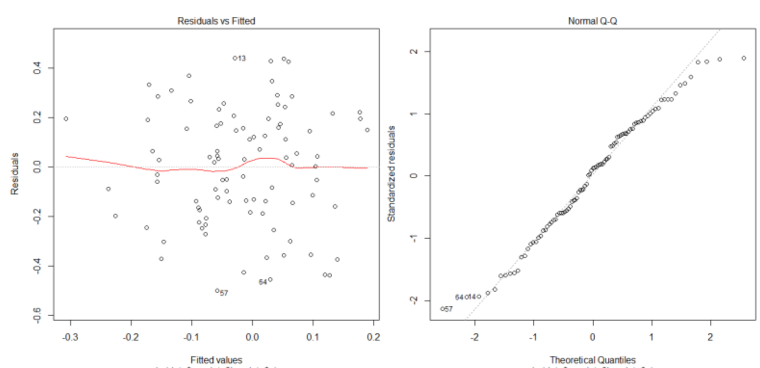
4 $$Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.BV_{stocks}$$



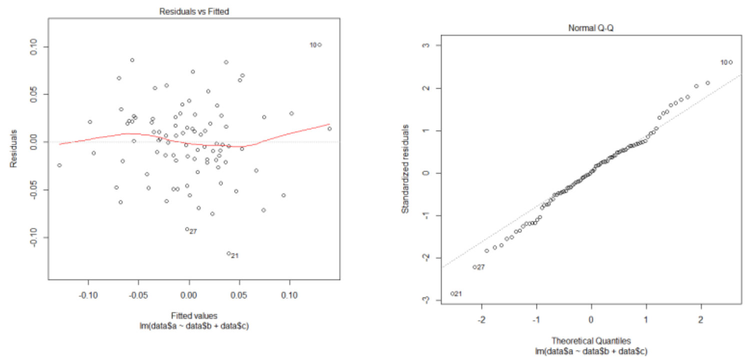

5 $$RV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 RV_{S\&P500}$$



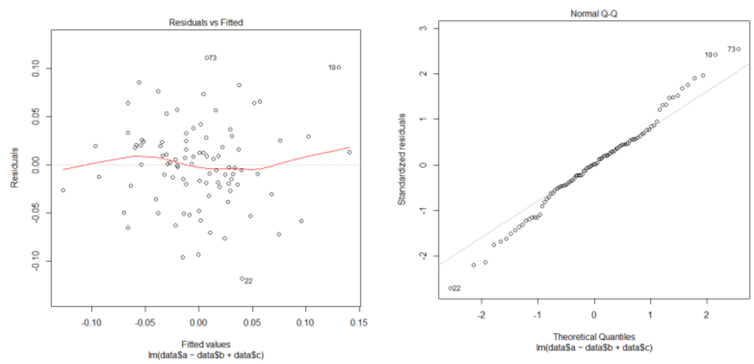

6 $$RV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 RV_{S\&P500}$$



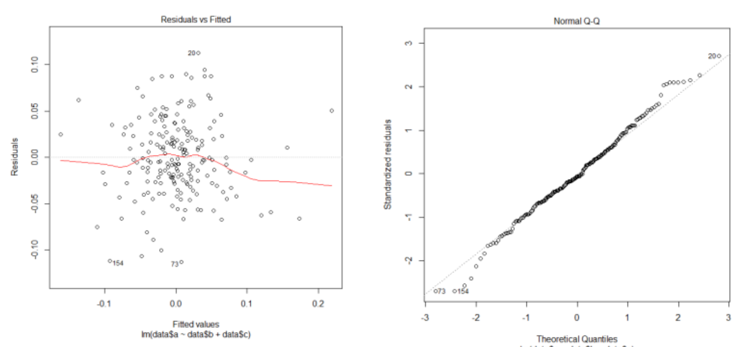
7 $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 VIX_{market}$



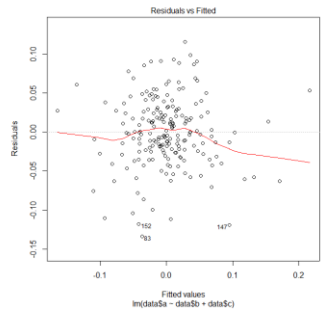

8 $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 VIX_{market}$

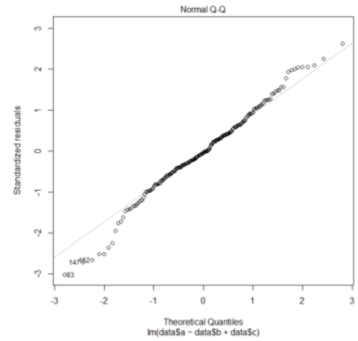



9 $IV_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 VIX_{market}$

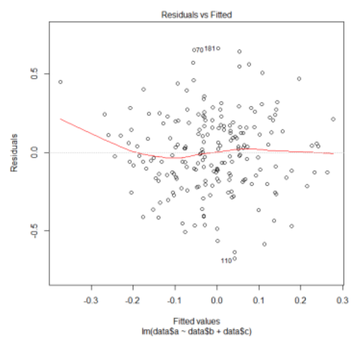


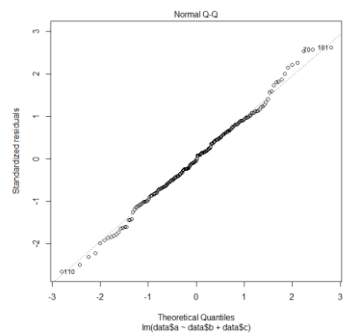
10 $$IV_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 VIX_{market}$$



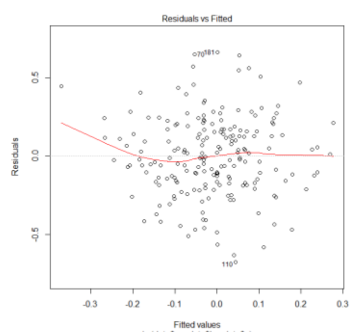



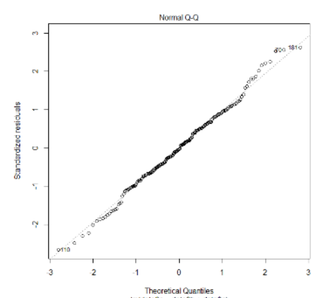

11 $$RV_{stocks} = \propto + \beta_1 \times \Delta LevBV_{stocks} + \beta_2 RV_{S\&P500}$$



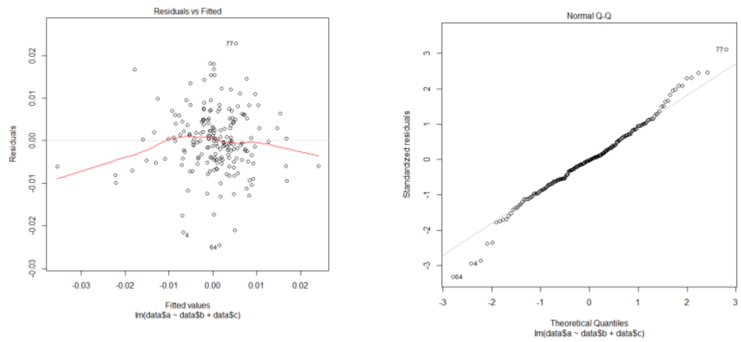




12 $$R_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 R_{S\&P500}$$

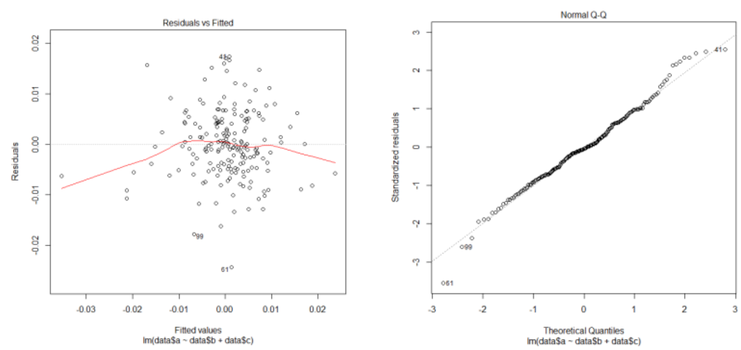


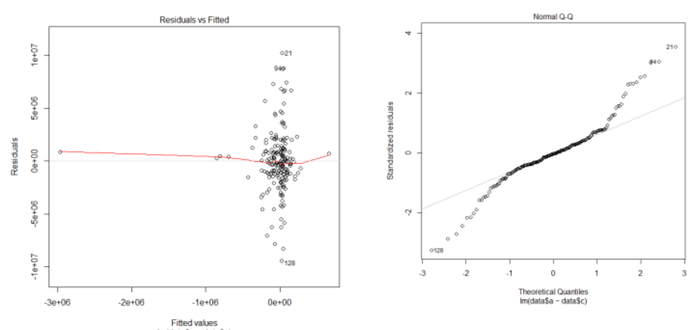
13 $R_{stocks} = \propto + \beta_1 \times \Delta Lev.BV_{stocks} + \beta_2 R_{S\&P500}$



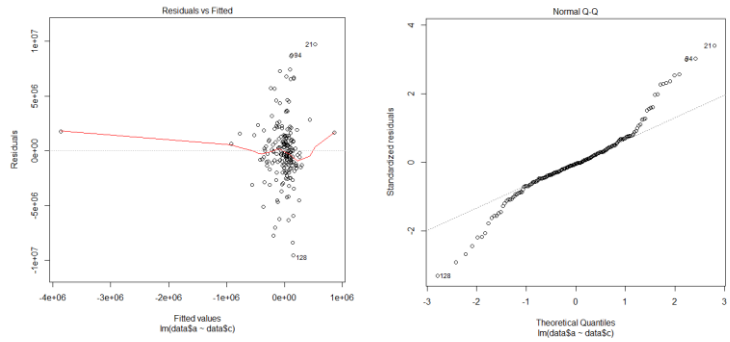

14 $R_{stocks} = \propto + \beta_1 \times \Delta Lev.MV_{stocks} + \beta_2 R_{S\&P500}$




15 $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.BV_{stocks}$



16 $Volume_{stocks,5days\ average} = \propto + \beta_1 \times \Delta Lev.MV_{stocks}$




*2 Figure:* Graphical representation of regressions' residuals and fitted plots. Numbers corresponds to regression models from summary table.

## THE LIST OF SAMPLE COMPANIES WITH TICKERS

| | | | |
|---|---|---|---|
| Apple | AAPL | Intel Corporation | INTC |
| Amazon | AMZN | Johnson & Johnson | JNJ |
| American Express Company | AXP | The Coca-Cola Company | KO |
| The Boeing Company | BA | McDonald's Corporation | MCD |
| Caterpillar | CAT | 3M Company | MMM |
| Cisco Systems | CSCO | Merck & Co. | MRK |
| Chevron Corporation | CVX | Microsoft Corporation | MSFT |
| E. I. du Pont de Nemours and Company | DD | NIKE | NKE |
| The Walt Disney Company | DIS | UnitedHealth Group Incorporated | UNH |
| Alphabet | GOOGL | Verizon Communications | VZ |
| The Home Depot | HD | Wal-Mart Stores | WMT |
| International Business Machines Corporation | IBM | Exxon Mobil Corporation | XOM |

## ABBREVIATIONS

MV market value

BV book value

IV implied volatility

RV realized volatility

VIX implied volatility index

DF degrees of freedom