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Influence of Moody's Rating Downgrade and Upgrade on the U.S. Equity Market:
A Case Study of IBM, Ford, and Boeing

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Abstract

The main purpose of my thesis is to determine the current influence of credit rating downgrades and upgrades made by Moody's on the U.S. equity market. Previous literature has already talked about the effect of credit ratings on stock or bond price, however, my paper is different from previous works. I will focus on a single nationally recognized credit rating organization; I will talk about the both downgrade effect and the upgrade effect; I will do a case study of the credit rating effect on Ford, IBM, and Boeing. The results indicates that overall, Moody's rating announcements have an important effect on the stock abnormal returns as expected with more significant and sizable effect for upgrades based on the case study of three companies. In the future research it would be interesting to collect more data for companies in various industries and see if the effect is different.

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Literature Review

Relevant Theories

Before diving into my topic, there are several theoretical frameworks I need to clarify to fully understand the topic, such as Moody's, credit ratings, information asymmetry, and signaling. "Moody's" is the abbreviated version for "Moody's Investors Service, Inc", which is one of the largest nationally recognized statistical rating organizations (NRSROs). It is one of the largest NRSROs because it accounts for 33.1% of outstanding credit ratings of the total outstanding credit ratings of all NRSROs in 2018. Two other well-known NRSROs are Fitch Ratings, Inc and S&P Global Ratings account for 13.5% and 49.2% of the total outstanding credit ratings in 2018 respectively. Moody's credit rating categories follow an alphabetic order from A to C, with Aaa the highest rating and C the worst rating. The following table is Moody's long-term rating scale and its definitions.

Table 1

Moody's Long-Term Rating Definitions

Rating Scale	Definition
--------------	------------

Aaa	Highest quality with minimum risk
Aa	High quality, very low credit risk
A	Upper-medium-grade, low credit risk
Baa	Medium grade with moderate credit risk, possess speculative characteristics
Ba	Have speculative elements, has substantial credit risk
B	Speculative, subject to high credit risk
Caa	Poor standing, subject to very high credit risk
Ca	Highly speculative, are likely in default, with some prospects in recovery in principal and interest
C	Lowest-rated class, typically in default, with little prospect in recovery in principal and interest

Notes: Moody's appends numerical modifiers 1,2 and 3 to each categorical ratings. 1 indicates the obligation ranks at the higher end of its rating category; 2 indicates a mid-range rating; 3 indicates the obligation ranks at the lower end of its rating category. Note: Reprinted from Moody's Rating Scale and Definitions, Retrieved from https://www.moodys.com/sites/products/productattachments/ap075378_1_1408_ki.pdf

The ratings measure the strength of the issuer's financial and future perspective as well as the likelihood for a bond to default. The higher the rating is, the better the future financial perspective for the company and less likely for its bonds to default. Because they are very closely related to changes in the current equity market, the credit ratings are predictive indicators for future trends. Therefore, it is not hard to see that rating downgrade and upgrade by Moody's can have a tremendous effect on a company in a particular field. Typically, investors will lower their expectations on a downgraded company, they may choose to not invest in these companies or reduce their investment. Downgrade ratings should adversely affect the stock price and long-

term equity returns. If a company receives a credit rating upgrade, it indicates to investors that the company is doing well so that investors may increase their investment. Presumably, upgrade ratings should have a positive effect on the company's stock market. In my study, I will calculate the stock market returns of each company before and after the announcement date and compare the abnormal return with the market return to see if the credit rating event has a significant impact on the company's stock price.

A study conducted by Leppanen and Traver (2015) suggests that credit rating downgrades can result in decreasing stock prices. In Samuli Leppanen's thesis (2015), he states that: "A notch decrease in a company's credit rating is associated with a 0.25% more negative stock price reaction to earnings releases. Furthermore, a notch lower credit rating results in 0.15% more of the outstanding shares being traded in the market around an earnings announcement" (Leppanen, 2015). This statement shows there is a positive correlation between the credit rating of a company and the company's stock price. The change of stock prices usually happens around the announcement date; this is also the reason I want to focus on the stock price fluctuation around the rating announcement day in my study. Also in his study, he concluded that "better credit ratings reduce information asymmetry in financial markets." According to Traver (2018), information asymmetry in the financial market means "one of the two-party involved will have more information than the other and will have the ability to make a more informed decision" (Traver, 2018). Under the specific circumstances related to credit rating organizations, information asymmetry exists between stock issuers and investors, and it may lead to undervalued or overvalued stock prices due to uncertainty and unfamiliarity with the firm's credit ratings.

The information asymmetry in the equity market is inevitable because unequal knowledge of information between the two parties always exists. This is also one of the reasons why the stock market is highly risky and volatile. Though information asymmetry is unavoidable, an effective method to reduce the risk is by signaling. Here are two crucial signals every investor should be familiar with: when a company starts to buy back its shares, it means that the company believes the stock is underpriced and the prospect for the company is bright; when a company initiates dividends, it means that the company has generated enough revenue to cover the costs which also signals a positive net income of the company. In terms of signaling in credit ratings, Ng and Ariff (2019) wrote in their paper "a firm can signal their prospects to investors through ratings received from credit rating agencies" (Ng & Ariff, 2019). Signaling is a good way for investors to obtain more signals about the firm's growth opportunities, potential credit risks, and overall performance. Therefore, the credit rating announcements provided by credit rating organizations such as Moody's, S&P, and Fitch Ratings become extremely valuable to investors so that they can arrange their actions accordingly to the change of the firm's credit ratings.

Additional Previous Studies

A lot of research has compared the different effects of credit rating upgrades and downgrades on the stock market. For example, Donahue (2007) quoted the following statement from Nayar and Roeff in his writing "Rating downgrades...produce significantly negative abnormal returns; upgrade has no effect" (Nayar & Roeff, 1992). A study conducted by Dichev and Piotroski (2001) further expand on this finding using statistics. They collected and analyzed all rating changes announced by Moody's and found out that the stock market had little negative return following an upgrade in the long-run. In the short-run, they said, "we find negative

abnormal returns on the magnitude of 10-14 percent in the first year following downgrade” (Dichev & Piotroski, 2001). However, their findings are only partially accurate. Rating downgrades for a company definitely can lower their inventors' expectations and result in lower stock prices, but these phenomena are not happening for all downgrades. There are two exceptions. First, some obvious credit rating changes can be predicted from publicly available information. In this case, investors may have already adjusted their expectations and action before the actual release of the downgrade rating announcement. Therefore, the actual release of the downgrade rating announcement will have little negative influence on the stock market. Second, “downgrade because of an anticipated move to transfer wealth from bondholders to stockholders should be good news for stockholders” (Goh & Ederington, 1993). The bondholders and stockholders are all considered investors of the company; the switch from investing in bonds to investing in stocks may result in a lower credit rating because of the change in a firm's leverage. However, this transfer of wealth will satisfy the stockholders and have no negative impact on the stock price. The findings by previous researchers and their limitations are the primary reasons I want to do a case study on several companies and focus on the influence of credit rating changes on the companies' stock price around the announcement date. Table 2 is the main reason for Moody's upgrade and downgrade.

Table 2

Reasons for Bond Upgrades and Downgrades

Group	Moody's Explanation of the rating change	Full Sample-Downgrade	Full Sample-Upgrade
1	Improvement or deterioration in a change in the firm's leverage, e.g., leveraged buyouts, debt-financed expansion, etc	185	178
2	Actions or decisions that result in a change in the firm's leverage, e.g., leveraged buyouts, debt-financed expansion, etc	122	9
3	Miscellaneous or no reason given	69	47

Note: Reprinted from Is a Bond Rating Downgrade Bad News, Good News, or No News for Stockholders? By Jeremy C. Goh and Louis H. Ederington.

According to Moody's explanation when giving a rating downgrade, the most significant reason is because of the deterioration in the firm's earnings, cash flows, financial prospects, and performance. Moreover, another reason for giving a rating downgrade by Moody's is actions that result in a change in the firm's leverage. As Goh and Ederington stated, this kind of downgrade will have a positive influence on stockholders.

One interesting research paper I found in the *Journal of Economics and Finance* attracted my attention. The authors wrote that "the effect of an announcement that a company is being put under review for a credit rating change had more effect than the actual change itself" (Followill & Martell, Page 453, 1997). The reason this quote is interesting to me is because the authors contradict the findings I previously talked about in the last paragraph. The previous findings are

all based on the idea that the actual change in the rating upgrade or downgrade has a significant impact on the equity market. The discovery by Followill and Martell, however, contradicts the most acceptable findings that many people agree with. They believe the actual change in the rating downgrade is insignificant and negligible compared to the effect of the announcement that occurred earlier than the actual change. Out of the contradictory findings, I will go with the research that most people accept. Therefore, my objective is to determine the impact of Moody's credit rating change on the equity market of IBM, Ford, and Boeing. In other words, I will put my attention on the stock price change before and after the credit rating announcement. To keep my paper more organized and to present the announcement dates more clearly to readers, I included a timeline and reasons for all credit rating announcements for IBM, Ford, and Boeing from the year 2000 to 2020. Each announcement will be used as an event in my case study.

Timeline of Downgrade and Upgrade Announcement

According to Moody's credit rating announcement found at Moody's Investor Service website, International Business Machines Corporation's ("IBM") has experienced a credit rating downgrade once since Jan 31, 1995, when Moody's started to do rating evaluation for IBM. Moody's placed IBM senior unsecured and long-term issuer ratings under review for downgrade on Oct 29, 2018, with the actual downgrade action of IBM senior unsecured and long-term issuer ratings to A2 from A1 happened on July 9, 2019, following the acquisition of "Red Hat Inc" for an all-cash transaction of \$34 billion. Moody's Senior Vice President, Richard Lane gave his explanation for the downgrade "an increase in leverage and represent a departure from IBM's historical acquisition philosophy of making small, tuck-in acquisitions that limit integration risk." The main reason for the downgrade is because this large amount of money used to acquire

Red Hat Inc increased the firm's leverage and therefore resulted in a gross adjusted debt to EBITDA ratio increase from 1.9x before acquisition to 3x.

Unlike IBM which was downgraded by Moody's one time, Ford Motor Company ("Ford") had multiple credit rating changes since Mar 10, 1995. Ford's senior debt rating was lowered from A2 to A3 on Oct 18, 2001, as a reaction to the increasingly competitive environment in the U.S. SUV and truck market; after Moody's confirms the Baa1 rating of Ford long-term rating, it got downgraded again to Baa3 on May 12, 2005, as Ford fell significantly short of the benchmarks identified by Moody's; again on Nov 07, 2008, the debt ratings of Ford Motor Company was lowered to Caa1 as a result of consumers' declining confidence in the U.S. automobile industry. Ford also experienced upgrades twice. Because Ford has been generating a stable cash flow that exceeded many investors' expectations through 2011, its credit rating was raised to Ba2 on Oct 8, 2010, and again to Baa2 on Feb 16, 2016. However, Ford's long-term senior unsecured rating was lowered to Ba1 on Sep 9, 2019, and again to Ba2 in the most recent announcement on Mar 25, 2020. The reasons for the most recent downgrade are due to the outbreak of Coronavirus in the U.S. and the deterioration of the global economy as a whole. Also, just as Inna Bodeck, the Senior Analyst at Moody's stated "The significant rise in used car prices over the last decade place pressure on the credit strengths of the auto captives, on which we maintain a negative outlook."

The Boeing Company ("Boeing") has also been upgraded and downgraded several times since 2000. Moody's downgraded Boeing's long-term and short-term debt rating to A3 from A2 on Dec 17, 2003, because of the prediction that less demand on Boeing's commercial aircraft will result in a loss of commercial aircraft market share for the next few years. On Mar 16, 2006, Boeing's long-term senior unsecured ratings were raised to A2. However, following the

catastrophic incidents of the 737 Max, concerned about both financial and operational problems within Boeing, Moody's lowered the senior unsecured rating to A3 on Dec 18, 2019, and again on Jan 30, 2020, from A3 to Baa1. Boeing has experienced a tremendous negative impact on the outbreak of coronavirus. The pandemic lowered demand for new commercial aircraft and increased uncertainties and risks in flight operation. In the most recent downgrade announcement on Apr 9, 2020, Moody's Senior Vice President and lead analyst, Jonathan Root say "We now estimate external funding needs in 2020 to at least double -- to \$30 billion -- compared to our pre-coronavirus expectations." All of these factors have resulted in a downgrade of Boeing's senior unsecured ratings to Baa2. In the following section, I will explain what methodology I use and what procedural steps I undertake to analyze the effect of Moody's credit rating change on the stock price of IBM, Ford, and Boeing.

Methodology

Mainly I used Eventus, R Studio, the stock prices on Finance Yahoo and Fama French daily data to evaluate and analyze the data. To keep the results more convincing and free-of-error, I decided to use two approaches to get the results and compare the results to see if they are consistent. The first approach is using Eventus on the WRDS database to generate results automatically; the second one is I will gather all necessary data and use R studio to generate results. In the following paragraphs, I will illustrate all the steps I took to get the abnormal returns and perform an event study on the three companies.

Wharton Database - Eventus

Eventus is a PERMNO date retrieval and event study software recommended by my thesis advisor Professor Goldman. It is a powerful and crucial tool on the WRDS database to

automatically generate case study results before and after the event date. Eventus gives all the users control over the estimation period and windows of different time lengths. Users are also able to choose among different benchmark model parameters. For my study, I conducted two different analyses with two different benchmark parameters: the default which is the Capital Asset Pricing Model (CAPM) benchmark, and the Fama French benchmark.

The CAPM benchmark is a linear regression to calculate the expected return on any asset $E(R_i)$, it's equation is:

$$E(R_i) = R_f + \beta_i (E(R_m) - R_f)$$

where expected return equals the market risk-free rate plus the market risk premium $(E(R_m) - R_f)$ multiplied by risk (β_i) . β is a measurement of risk that indicates the sensitivity or volatility of stocks to market movement. Fama French benchmark includes different factors that I will further explain in the Fama French subsection, therefore the results should vary a little and are worth analyzing.

The first step I took was preparing two text files with the PERMNO code of the three companies and all the announcement dates that are separated by upgrade and downgrade. PERMNO is a unique stock level identifier and most of the companies such as IBM, Ford, and Boeing have one class shares. There are 11 lines in the text file for downgrade since there are a total of 10 downgrade announcements for IBM, Ford, and Boeing or 10 security events plus one line of column headings. Under Market Index Options, I used the default setting "CRSP Equally Weighted" since all the security events are all equally weighted in my research, not one rating announcement date is more important or superior than the other announcement date. Under the "Estimation Period," I modified the default setting from -46 to -10 for "End before Event Date" as I don't need as much data as 46 days before the actual announcement date. Data 46 days

before can be completely irrelevant to my event or biased, even if it were to turn out that the mean abnormal return 46 days ago is significant, it's meaningless to my study because the data may be tremendously affected by some other events instead of by Moody's credit rating announcement. I applied the same rationale when choosing the event period on Eventus: PRE 10 days and POST 10 days. This way the result will only show me the mean abnormal return and significance level for all the security events 10 days before and after the actual announcement date. Eventus allow me to choose different event windows to compare results and analyze. My main focus was on the mean abnormal returns 1 day before and after the event announcement date, 2 days before and after, and 10 days before and after. So the six-event windows are from -1 to 0, +1 to 0, -2 to 0, +2 to 0, -10 to 0 and +10 to 0. The "Estimate Method" I used is Ordinary Least Squares Regression (OLS), it is a linear regression very commonly used to calculated mean abnormal returns of several different variables, in this case, different announcement dates.

Mathematically, the equation for the OLS model is:

$$Y = \beta_0 + \sum_{j=1..p} \beta_j X_j + \varepsilon$$

where Y is the result, p is the number of different variables, β_0 is the intercept of the model, X_j corresponds to the j^{th} explanatory variable of the model ($j= 1$ to p), and ε is the random error with expectation 0 and variance σ^2 . ("Ordinary Least Squares Regression," n.d.) This simple regression model is used to calculate the relationship between a continued dependent variable Y and several explanatory variables p. In my case study, OLS is used to correspond to the relationship between stock returns and different Moody's credit rating downgrade and upgrade announcements.

I used two different tests in my event study in Eventus – Patell's (1976) standardized residual test and CDA (t) test. The null hypotheses (H0) for these tests are no abnormal returns

exist in the event windows, and the alternative hypotheses (H1) are abnormal returns that exist in the event windows. They can be expressed as follows:

$$\begin{aligned} H0: \mu &= 0 \\ H1: \mu &\neq 0 \end{aligned}$$

According to Campbell, Lo, and MacKinley (1997), the return of a stock can be estimated by the following equation:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_i,$$

where R_{it} is the stock return at time t , R_{mt} is the market return at time t and ϵ_i is the error term.

β_i is the slope of a linear regression which is the systematic risk measured as the covariance between the asset's excess return and the market excess return divided by the variance of the market risk premium. α_i is a measure of how much investment I outperformed or underperformed what would be expected for the given market risk premium. The parameter α_i is usually close to zero. (Campbell, Lo & MacKinley, 1997)

The abnormal returns can be calculated as follows:

$$AR_t = R_t - (\hat{\alpha}_i + \hat{\beta} R_{mt})$$

the meaning of this function is abnormal returns are the differences between realized and predicted return in the t day period.

Patell (1976) test is defined as:

$$t_{patell} = \sqrt{\frac{n(L1-4)}{L1-2}} * \overline{SCAR}_{t1,t2}$$

where $\overline{SCAR}_{t1,t2}$ is the mean of standardized cumulative abnormal return, $L1$ is the time length of the estimation window. (Patell, 1976)

The other test I used in Eventus was the CDA t-test, it is an abbreviation for time-series standard deviation or Crude Dependence Test. The equation for testing for the average abnormal return (AAR) is:

$$t_{\text{aar}} = \sqrt{n} \frac{\text{AAR}t}{S_{\text{aar}}}$$

Where S_{aar} represents the standard deviation and n is the name of events.

I also performed a separate analysis of all the events using the Garch model and market-model benchmark. Of course, events are divided into downgrade events and upgrade events as usual. Just to summarize, I performed three different kinds of tests for downgrades and upgrades separately: the first is using the OLS method with a market-model benchmark, the second is using the Garch method with a market-model benchmark, the third is using OLS method with Fama-French benchmark. In Eventus the GARCH option invokes a single-factor market model with Garch(1, 1) errors:

$$\sigma^2_t = \omega + \alpha r^2_{t-1} + \beta \sigma^2_{t-1}$$

The forecast of variance at time t is modeled as a weighted average of the long-run average variance, today's variance forecast (σ^2_{t-1}), and the news (today's squared return r^2_{t-1}).

Fama French Model

Just to reiterate, my topic is a case study on how Moody's credit rating announcements influence the stock price and returns for IBM, Ford, and Boeing. Yahoo Finance is a public source where I can retrieve historical data. It enables me to choose a specific time range: I chose from 1/4/2000 which is the first public trading day in the year 2000 to 6/30/2020 which is the most recent date in Fama French 3 factors daily model. CSV file contains the Fama French 3 factor daily model is an open-source as well and can be downloaded from the Internet. This

model is developed by Eugene Fama and Kenneth French (1993) and is a more complicated version of the market model (Capital Asset Pricing Model) by adding size risk factors and value risk factors. As its name indicates, Fama French 3 Factors Model estimates stock returns through 3 different factors: risk-free rate (RF), the performance of small-cap companies subtract that of big-cap companies (SMB), the performance of high book-to-value companies subtract that of low book-to-value companies (HML). The calculation for the model is the following:

$$r = r_f + \beta_1 (r_m - r_f) + \beta_2 (\text{SMB}) + \beta_3 (\text{HML}) + \varepsilon$$

where again β is the slope of a linear regression which is the systematic risk that cannot be diversified or eliminated, $r_m - r_f$ is the market risk premium. (Fama & French 1993).

When retrieving the historical stock prices, I disregarded the columns of open price, high price, low price, close price, and volume since this information is irrelevant to my study, date and adjusted close price are the only information that is used. To analyze the returns and significance using R Studio, preparing all the data in Excel before generating the result in R can tremendously facilitate the process.

After downloading all the relevant stock data for IBM, Ford, and Boeing and the Fama French 3 factors daily data, I opened and edited them in Microsoft Excel. It is a powerful and efficient tool when there are thousands of observations – each date from 1/4/2000 to 6/30/2020 will occupy a line. As of right now I only have the stocks' adjust closing price for the 3 companies, however, what I need is the stock return in the excel sheet. Each stock return is calculated by taking the log difference between today's adjusted closing price and the previous day's adjusted closing price.

R

I then upload the excel file I prepared in excel into R. R is a programming tool for statistical computing and graphs. Figure 1 in Appendix is the code I created to generate the summaries including betas of all the stock returns from 01/04/2000 to 06/30/2020 using both the CAPM model and Fama French multifactor model for each of the three companies. For the purpose of seeing a general picture of how volatility changed over the 20 years for each company, I computed the R code using the Garch model and plotted the annualized volatility using a time-series object in Figure 2 in Appendix.

Depending the whole thesis conclusion solely on Eventus which is a system generated software is insufficient. I also use the R package called "eventstudies" to generate the return and a graph manually. This package was created by Ajay Shah and Sargam Jain in 2017 for the purpose to do standard event studies using daily returns data (Shah & Jain, 2017). All processes were done separately for downgrades and upgrades. The structure for all CSV files used in the R package needs to follow a required format for the code the run. I rearranged the downgrade announcement date in terms of "year-month-day" and put the company's name in front of the date. One example of an event is " IBM 2019-07-09" in two separate columns. I saved the stock returns for IBM, Ford, and Boeing that I computed previously in Excel as "returns_stocks.csv" to be ready to use in R. I saved the Fama French data as "factors.csv". I set the "event.window" to 10 days for both downgrade and upgrade to be consistent with Eventus. Figure 3 in Appendix is an illustration of the code used to plot the cumulative abnormal returns around the event windows.

Results and Discussion

Beta comparison among different samples and methods

Beta is a commonly used statistical indicator that indicates the correlation of the volatility in the market and the expected excess return of stocks. For instance, if market volatility rises 10%, the expected excess return of the stock or asset will increase by 10% multiplied by beta. Table 3 illustrates the betas that are calculated from the CAPM model, Garch model and Fama French model for each company, and compares the betas with the company's overall CAPM beta from 01/04/2000 to 06/30/2020.

Table 3

Beta Comparison – Downgrade

Company Name	Downgrade Announcement Date	Beta from CAPM Model	Beta from Garch Model	Beta from Fama French Model	Overall CAPM Beta from 01/04/2000 to 06/30/2020
INTERNATIONAL BUSINESS MACHS CO	07/09/2019	0.94	0.84	1.10	0.87
FORD MOTOR CO	10/18/2001	0.55	0.49	0.68	1.15
FORD MOTOR CO	05/12/2005	1.14	1.22	1.60	
FORD MOTOR CO	11/07/2008	1.86	1.63	1.55	
FORD MOTOR CO	09/09/2019	1.00	1.00	1.26	
FORD MOTOR CO	03/25/2020	1.24	1.24	1.30	
BOEING CO	12/17/2003	1.42	1.34	1.47	1.05
BOEING CO	12/18/2019	1.14	1.13	1.29	

BOEING CO	01/30/2020	1.10	1.11	1.28	
BOEING CO	04/09/2020	0.82	0.85	0.92	

Note: Downgrade Announcement Dates are extracted from Moody's credit rating announcements; Beta from CAPM model, Garch model and Fama French model are generated from the results in Eventus; Overall CAPM beta from 1/4/2000 to 6/30/2020 is calculated in R.

Betas from the CAPM model, Garch model and Fama French model are generated by Eventus using OLS method with data from a 255 trading day estimation to 30 trading days before the announcement. The last column in Table 3 is computed by R Studio with data from 01/04/2000 to 06/30/2020, all the results are significant according to the p-value. A beta less than 1 indicates a less risky investment than the market while a beta greater than 1 signifies a higher risk investment than the market. IBM has the lowest average investment risk for the 20 years compared to Ford and Boeing with a beta of only 0.87. However, betas before each announcement are higher than the average company's beta, therefore, the betas convey an idea that risks for a company one year before the credit rating downgrade are higher than the company's overall performance. The idea is also reasonable since companies are usually perceived by the credit rating agency as performing below average before the credit rating company announces a rating downgrade. Beta computed by the Fama French model is generally higher than beta for the market and for the Garch model because FF model is a more complicated version of the market model (Capital Asset Pricing Model) by adding size risk factors and value risk factors. Most betas computed from the CAPM model, Garch model or Fama French model are consistent in the fact that they are higher than the company's average beta, the reason that two different tests with three different models are performed was that betas from the same set of data but computed with different models can vary. In order to have a more comprehensive knowledge of the meaning and variation of the data, multiply data analysis tests with different

methods or parameters should be done. Table 4 illustrates some types of betas with table 3, but with upgrade announcements for the three companies.

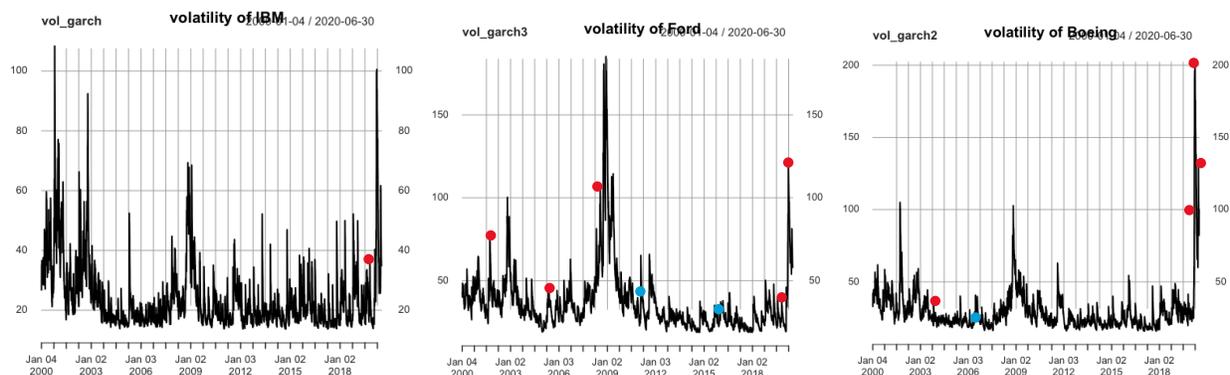
Table 4
Beta comparison – Upgrade

Company Name	Upgrade Announcement Date	Beta from CAPM Model	Beta from Garch Model	Beta from Fama French Model	Overall CAPM Beta from 01/04/2000 to 06/30/2020
FORD MOTOR CO	10/08/2010	1.44	1.46	1.49	1.15
FORD MOTOR CO	02/16/2016	1.14	1.14	1.27	
BOEING CO	03/16/2006	0.89	0.9	1.07	1.05

Note: Upgrade Announcement Dates are extracted from Moody’s credit rating announcements; Beta from CAPM model, Garch model and Fama French model are generated from the results in Eventus; Overall CAPM beta from 1/4/2000 to 6/30/2020 is calculated in R.

One may expect that the beta 1 year prior to rating upgrade announcement date is lower than the overall beta for the company. Surprisingly, the results shows sometimes the beta one year prior to the announcement date is higher than the overall beta, sometimes is lower and betas from FF model are higher than betas from CAPM and Garch model. The results shows that the beta or the risk for Ford and Boeing one year before the upgrade announcements in 2016 and 2006 are a little bit lower than the 20 year overall beta. Graph 1 shows the annualized volatility graphs for IBM, Ford and Boeing using R.

Graph 1
Annualized Volatility for IBM, Ford, and Boeing



R allows users to plot the annualized volatility using time series objects and daily standard deviation from a library called "fGarch". Graph 1 illustrates and compares the annualized volatility percent change from 1/4/2000 to 6/30/2020 for IBM, Ford, and Boeing. We observe a similar trend among all three companies according to Graph 1: we observe high peaks around the year 2008 and high peaks around the year 2020. From our experience and knowledge, high volatility in 2008 was the result of the financial crisis and high volatility in 2020 was due to the Covid-19 pandemic. Red dots on the graph correspond to each Moody's credit rating downgrade announcements based on the date, and blue dots correspond to rating upgrades. The rating announcements are highly correlated with the annualized volatility percent change: downgrade ratings are usually announced when the company is experiencing high volatility and upgrade ratings are usually announced when the company's volatility is relatively low. I'm not suggesting that credit rating announcements caused volatility change of the company since macroeconomic factors such as financial crisis or worldwide events play a more significant role, whereas, companies are more likely to receive a credit rating upgrade when there is low volatility and vice versa.

Eventus results

Unlike the previous beta and volatility results that focus on a broader perspective, Eventus results provide a narrower understanding of what is going on 10 days before and after the announcement specifically. Table 4 displays the results for all downgrade announcements with the Fama French Model.

Table 4

Downgrade Results with Fama French Model

Day	N	Mean Abnormal Return	Positive: Negative	StdCsect Z	Portfolio Time-Series (CDA) t
-10	10	0.89%	5:5	0.801	1.560\$
-9	10	0.39%	5:5	-0.011	0.686
-8	10	-0.93%	5:5	-1.110	-1.628\$
-7	10	0.22%	5:5	0.509	0.394
-6	10	-0.71%	3:7	-0.629	-1.248
-5	10	-1.63%	6:4	-0.969	-2.866**
-4	10	-0.85%	5:5	-0.590	-1.499\$
-3	10	1.07%	5:5	0.720	1.881*
-2	10	-1.46%	3:7	-2.037*	-2.566**
-1	10	1.05%	4:6	0.821	1.847*
0	10	0.53%	6:4	0.689	0.930
+1	10	-1.56%	4:6	-1.626\$	-2.739**
+2	10	-1.13%	4:6	-1.154	-1.997*
+3	10	1.56%	5:5	0.974	2.747**
+4	10	-1.20%	4:6	-0.672	-2.112*
+5	10	1.23%	6:4	0.794	2.169*
+6	10	-0.72%	4:6	-1.298\$	-1.263
+7	10	0.36%	5:5	0.798	0.627
+8	10	-1.97%	3:7	-1.728*	-3.460***
+9	10	2.61%	8:2>	1.576\$	4.591***
+10	10	-0.36%	6:4	-0.569	-0.629

Note: The symbols \$,*,**, and *** denote statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively, using a generic one-tail test. The table is extracted from Eventus downgrade results with Fama French model.

Day 0 is the announcement date; day -10 means 10 days before the announcement date and day +10 means 10 days after the announcement date. Most of the data under Mean Abnormal Return is negative, especially on day -2 and +1 where according to the Patell Z test the results are highly significant. The negative mean abnormal returns signify an overall negative effect on the stock price for IBM, Ford, and Boeing by the downgrade announcements. Also

from the ratio of positive to negative, since there are more negative returns than positive returns, we can conclude that Moody's credit rating downgrade announcements negatively impact the stock prices. Therefore, we reject the null hypothesis that there are no abnormal returns exist in the event window. It's interesting to see that the mean abnormal return is insignificant at day 0, instead, it is significant two days before the actual announcement and one day after. This phenomenon illustrates that the market reacts before the announcement. The phenomenon is also reasonable due to the existence of information asymmetry – those who have more accurate or inside information would react before most people do. Another reason why the market reacts earlier could be that some obvious credit rating changes can be predicted from publicly available information or from the previous news that a company is being put under a review. In this case, investors may have already adjusted their expectations and action before the actual release of the downgrade rating announcement. Therefore, the actual release of the downgrade rating announcement can have little negative influence on the stock market on day 0.

The significance of abnormal negative return on day 1 is also a value result, it indicates that some people adjust their actions slowly after the day 0 announcement. These indications are also applicable to stockholders in real life. Considering that not all investors can react immediately after an announcement, there will be some delays in adjustment. The CDA t results show us the time-series standard deviation from the Fama French model. According to the t-test, more days are significant from -10 day to +10 day. Day 0 is insignificant just as the Patell z test indicates. Eventus also presents mean cumulative abnormal returns with Fama French model, market model and Garch model respectively during the 6 different event windows displayed in Table 5.

Table 5

Mean Cumulative Abnormal Returns – Downgrade

Days	N	Mean Cumulative Abnormal Return	Precision Weighted CAAR	Positive: Negative	StdCsect. Z	Portfolio Time-Series (CDA) t
(-10,0)	10	-1.24%	-0.96%	3:7	-0.473	-0.671
(-2,0)	10	0.29%	-0.01%	4:6	-0.008	0.303
(-1,0)	10	1.50%	1.33%	6:4	0.838	1.898*
(0,+1)	10	-1.16%	-1.29%	4:6	-1.397\$	-1.473\$
(0,+2)	10	-2.13%	-2.06%	2:8<	-2.185*	-2.199*
(0,+10)	10	-0.08%	-0.84%	5:5	-0.291	-0.042

Note: This table is the Eventus mean cumulative abnormal returns for downgrade with Fama French model.

Days	N	Mean Cumulative Abnormal Return	Precision Weighted CAAR	Positive: Negative	Uncorrected Patell Z	Portfolio Time-Series (CDA) t	Generalized Sign Z
(-10,0)	10	-1.26%	-0.59%	4:6	-0.684	-0.641	-0.538
(-2,0)	10	0.64%	0.69%	5:5	0.399	0.624	0.094
(-1,0)	10	1.93%	2.23%	7:3)	2.529**	2.297*	1.360\$
(0,+1)	10	-1.12%	-1.13%	3:7	-1.395\$	-1.338\$	-1.171
(0,+2)	10	-1.85%	-1.69%	2:8<	-1.756*	-1.805*	-1.804*
(0,+10)	10	-0.60%	-0.96%	5:5	-0.556	-0.306	0.094

Note: This table is the Eventus mean cumulative abnormal returns for downgrade with the market model.

Days	N	Mean Cumulative Abnormal Return	Positive: Negative	Portfolio Time-Series (CDA) t	Generalized Sign Z
(-10,0)	10	-1.28%	4:6	-0.651	-0.534
(-2,0)	10	0.44%	5:5	0.430	0.099
(-1,0)	10	1.82%	7:3)	2.176*	1.365\$
(0,+1)	10	-1.14%	3:7	-1.369\$	-1.166
(0,+2)	10	-1.96%	2:8<	-1.916*	-1.799*
(0,+10)	10	-1.22%	5:5	-0.624	0.099

Note: This table is the Eventus mean cumulative abnormal returns for downgrade with the market Garch model.

The symbols \$, *, **, and *** denote statistical significance at the 0.10, 0.05, 0.01 and 0.001 levels, respectively, using a generic one-tail test. The symbols (< or >) etc. correspond to \$,* and show the direction and significance of a generic one-tail generalized sign test.

For the Patell z test for every model, the mean cumulative returns are significant for 0 to +1 and 0 to +2 days. The mean cumulative abnormal returns for these two windows are both negative, which are -1.473% and -2.199% base on FF model, -1.338% and -1.805% for the market model, -1.369% and -1.916% for the market model with Garch. For the CDA t-test, day 0 to +2 results are also negative and significant based on all models. These results further reinforce

the conclusion that stock prices are negatively influenced 1 day or 2 days after the credit rating downgrade announcement. Unlike downgrades announcements for IBM, Ford, and Boeing, there are only three upgrades in total for Ford and Boeing from the year 2000 to 2020. IBM doesn't have any rating upgrade. Table 6 displays the results for all upgrade announcements with the Fama French Model.

Table 6

Upgrade Results with Fama French Model

Day	N	Mean Abnormal Return	Positive: Negative	StdCsect Z	Portfolio Time-Series (CDA) t
-10	3	0.03%	1:2	0.386	0.039
-9	3	-0.49%	1:2	-0.656	-0.587
-8	3	-0.91%	0:3	-2.035*	-1.084
-7	3	-0.18%	1:2	-0.083	-0.212
-6	3	-0.28%	1:2	-0.162	-0.336
-5	3	1.51%	2:1	1.247	1.797*
-4	3	1.82%	2:1	0.733	2.167*
-3	3	-0.51%	1:2	-1.444\$	-0.605
-2	3	0.65%	3:0>	2.076*	0.771
-1	3	0.52%	3:0>	3.866***	0.623
0	3	0.94%	3:0>	6.701***	1.118
+1	3	0.79%	3:0>	3.379***	0.939
+2	3	-0.05%	2:1	0.258	-0.063
+3	3	-0.86%	1:2	-1.115	-1.028
+4	3	1.37%	2:1	1.799*	1.631\$
+5	3	-0.26%	1:2	-0.228	-0.313
+6	3	-1.04%	1:2	-0.928	-1.232
+7	3	-0.36%	1:2	0.049	-0.433
+8	3	0.01%	2:1	-0.143	0.013
+9	3	1.10%	3:0>	8.153***	1.304\$
+10	3	0.47%	2:1	0.564	0.558

Note: The symbols \$, *, **, and *** denote statistical significance at the 0.10, 0.05, 0.01, and 0.001 levels, respectively, using a generic one-tail test. The table is extracted from Eventus upgrade results with Fama French model.

Similar to the analysis of downgrade returns, "Day" represents the event window which is from 10 days before the announcement to 10 days after the announcement. N is the number of security events. Mean Abnormal Return shows a positive percentage change from day -5 to +1 except day -3. Based on the positive to the negative ratio from day -2 to +1, a ratio of "3:0" represents that all three events have higher than average returns. Many data are significant according to the Patell z-test: besides the two negative significant results on day -8 and day -3

which are "-2.035" and "-1.444" respectively, all other significant results are positive. Especially from day -2 to +1, where the z score is way higher than 1 and at 0.1% significance level. Different from downgrade results that day 0 is insignificant, day 0 for upgrade is highly significant. Although previous literature stated that the stock market had little negative return following an upgrade in the long-run, I found some positive abnormal returns 2 days before, on, and 1 day after the announcement date in the short-run. There are fewer significant returns computed by the t-test for an upgrade than for downgrade, whereas, the significant results such as 1.797, 2.167, 1.631, and 1.304 are all positive. This also indicates that Moody's credit rating upgrade announcements have a positive impact on the stock market around day 0 and day 0 in the short-run. Table 7 illustrates the mean cumulative abnormal returns for upgrade announcements during the 6 different event windows for FF model, market model and market model with Garch.

Table 7

Mean Cumulative Abnormal Returns – Upgrade

Days	N	Mean Cumulative Abnormal Return	Precision Weighted CAAR	Positive: Negative	StdCsect. Z	Portfolio Time-Series (CDA) t
(-10, 0)	3	3.35%	3.26%	3:0>	6.868***	1.191
(-2, 0)	3	2.16%	1.89%	3:0>	3.941***	1.472\$
(-1, 0)	3	1.49%	1.34%	3:0>	6.056***	1.246
(0, +1)	3	1.74%	1.64%	3:0>	11.193***	1.447\$
(0, +2)	3	1.70%	1.74%	3:0>	3.920***	1.156
(0, +10)	3	2.22%	2.56%	3:0>	1.539\$	0.790

Note: This table is the Eventus mean cumulative abnormal returns for upgrade with Fama French model.

Days	N	Mean Cumulative Abnormal Return	Precision Weighted CAAR	Positive: Negative	Uncorrected Patell Z	Portfolio Time-Series (CDA) t	Generalized Sign Z
(-10,0)	3	3.20%	3.36%	3:0>	1.324\$	1.122	1.790*
(-2,0)	3	2.02%	1.78%	3:0>	1.348\$	1.359\$	1.790*
(-1,0)	3	1.44%	1.42%	3:0>	1.319\$	1.184	1.790*
(0,+1)	3	1.56%	1.55%	3:0>	1.439\$	1.285\$	1.790*
(0,+2)	3	1.56%	1.66%	3:0>	1.261	1.047	1.790*
(0,+10)	3	1.36%	1.72%	3:0>	0.673	0.477	1.790*

Note: This table is the Eventus mean cumulative abnormal returns for upgrade with the market model.

Days	N	Mean Cumulative Abnormal Return	Positive: Negative	Portfolio Time-Series (CDA) t	Generalized Sign Z
(-10,0)	3	2.88%	3:0>	1.011	1.823*
(-2,0)	3	1.94%	3:0>	1.300\$	1.823*
(-1,0)	3	1.38%	3:0>	1.135	1.823*
(0,+1)	3	1.50%	3:0>	1.236	1.823*
(0,+2)	3	1.47%	3:0>	0.987	1.823*
(0,+10)	3	1.05%	1:2	0.368	-0.490

Note: This table is the Eventus mean cumulative abnormal returns for upgrade with market Garch model. The symbols \$,*,**, and *** denote statistical significance at the 0.10, 0.05, 0.01 and 0.001 levels, respectively, using a generic one-tail test. The symbols (< or > etc. correspond to \$,* and show the direction and significance of a generic one-tail generalized sign test.

The mean cumulative abnormal returns for upgrades computed by z test are all significant and higher than 1 for all three models. Based on the time-series t test for FF model and the market model, results from day -2 to 0 and from 0 to +1 are significant at 10% level. Day -2 to 0 also has a positive number of 1.300 based on the market model with Garch. The results support the previous conclusion that rating upgrades have a positive effect on the stock market before, on, and after the announcement date in the short-term. Therefore, all the abnormal returns show that the null hypothesis (H0) of no abnormal return should be rejected.

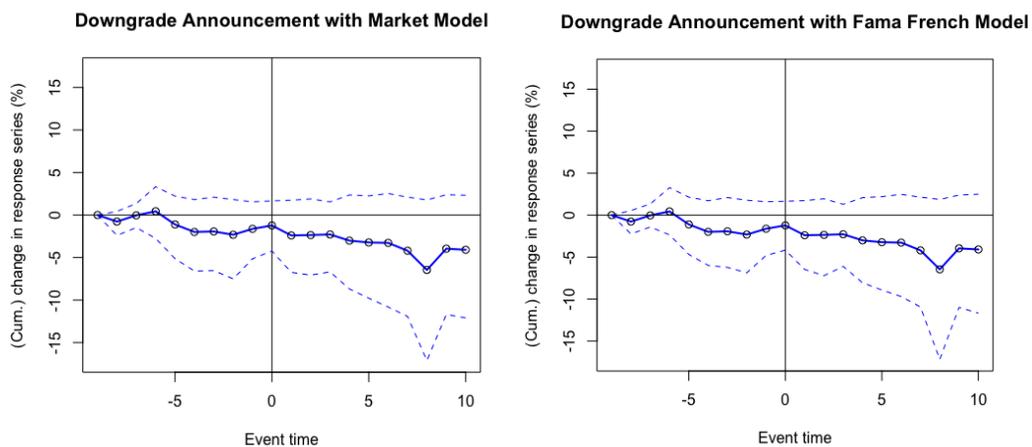
R Studio Results

The R code was set up as I discussed in the previous methodology section. Three separate CSV files were being used in generating the return from R: one includes the company name and event date; one has Fama French data such as market risk-free rate, SMB, and HML in

chronological order from 01/04/2000 to 06/30/2020; one includes stock price return for IBM, Ford, and Boeing for the same range of date. Graph 2 displays the trend for cumulative abnormal return change with both the CAPM model and the FF model in response to downgrade announcements.

Graph 2

Downgrade Announcements with Market and Fama French Model

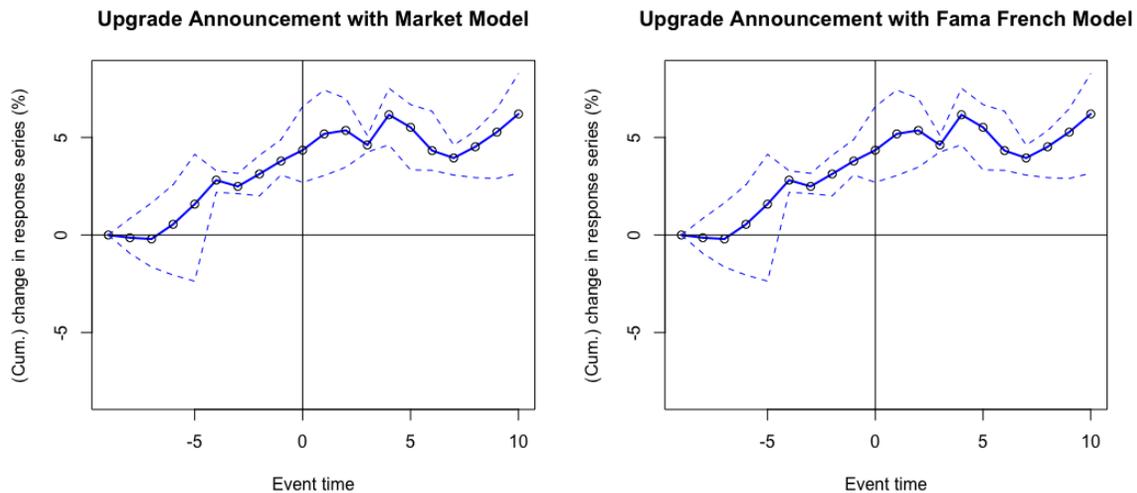


This graph represents the cumulative abnormal returns for downgrade announcements during the event window. The x-axis of the graph represents the 10-day event window. Each dot on the right side of 0 is ten abnormal returns from day 1 to day 10 and each dot on the left side of 0 are ten abnormal returns from day -10 to day -1. The y-axis of the graph represents the cumulative percent change in response series. The blue line that is connecting all the cumulative percent changes shows us a trend. This is the advantage of using a graph, while pure numerical data always can be boring to the readers and difficult to analyze, a graph is extremely straightforward and easy to comprehend. Although these two graphs use different benchmarks when computing the cumulative abnormal returns, they look almost identical in the display of a graph and both show a downward and negative trend in the percentage change. However, based on the

R package “eventstudies”, there is a critical flaw in this library: unlike Eventus which allows users to choose data within specific event windows, this package takes all date prior to the rating announcement into consideration. Data a long time from the announcement date is irrelevant to the study, therefore, the significance level on the graphs should be disregarded. Graph 3 displays the trend for cumulative abnormal return change with both the CAPM model and the FF model in response to upgrade announcements.

Graph 3

Upgrade Announcements with Market and Fama French Model



Graph 2 and graph 3 follow the same methodology and mechanism. The only difference is graph 3 presents cumulative abnormal returns following upgrade announcements, this explains why graph 3 is showing an upward and positive trend with most abnormal returns greater than 0.

Conclusion

In this paper, I conducted a case study on stock prices of three different companies – IBM, Ford, and Boeing using both the CAPM model and Fama French model, regarding Garch

method, beta, Patell Z test, and CDA t-test to analyze how the companies' stock prices change 10 days prior and 10 days after each Moody's credit rating announcement dates. Looking from a broader perspective, betas for each company one year before Moody's credit rating downgrades are way higher than the 20-year average CAPM beta and Garch beta, which indicates a higher risk of a company before a downgrade announcement. Plots of annualized volatility of the three companies with each announcement date indicated on the plots further support the conclusion that companies are more likely to receive credit rating downgrades from Moody's when the companies are experiencing high volatility and companies are more likely to receive credit rating upgrades from Moody's when the companies are experiencing low volatility. Analyses using Eventus and R Studio allow us to focus on the abnormal return with different event windows around each rating announcement date. The results indicate that downgrade announcements have little impact on the company's stock price on the announcement date, instead, the mean abnormal returns are significant two days prior and one day after the actual announcement date, and Moody's credit rating downgrade has a negative impact on the stock price. Eventus and R Studio results also indicate that Moody's rating upgrade has a negative effect on the company's stock price in the short term with some positive abnormal returns 2 days before, on, and 1 day after the announcement date in the short-run.

Overall, Moody's rating announcements have an important effect on the stock abnormal returns as expected with more significant and sizable effect for upgrades based on the case study of three companies. In the future research it would be interesting to collect more data for companies in various industries and see if the effect is different.

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Appendix

Figure 1

CAPM and Multifactor Models for Three Companies

```
da = read.csv("Data.csv") #<== Load data with header into R
attach(da)
rm=da$Mkt_RF #excess return for the market
rf=da$RF
hml=da$HML
smb=da$SMB

r_ibm=da$return_IBM-rf
r_boeing=da$return_Boeing-rf
r_ford=da$return_Ford-rf
summary(r_ibm)
summary(r_boeing)
summary(r_ford)
summary(rm)

# CAPM and Multifactor for 3 companies: IBM, BOEING, FORD
### IBM ###
m1=lm(r_ibm~rm) # CAPM MODEL with one regressor
summary(m1)

m2=lm(r_ibm~rm+hml+smb) #Multifactor model
summary(m2)

#BOEING
m3=lm(r_boeing~rm) # CAPM MODEL with one regressor
summary(m3)

m4=lm(r_boeing~rm+hml+smb) #Multifactor model
summary(m4)

#FORD
m5=lm(r_ford~rm) # CAPM MODEL with one regressor
summary(m5)

m6=lm(r_ford~rm+hml+smb) #Multifactor model
summary(m6)
```

Figure 2

Garch Model for Three Companies

```
library(fGarch)
m1_garch=garchFit(~garch(1,1),data=r_ibm,trace=F) # Fit an GARCH(1,1) model
summary(m1_garch)
## Annualized Volatility using daily standard deviation from GARCH:
v1=m1_garch@sigma.t*sqrt(252)*100 # annualized volatility in %

#Plot volatility using ts time series object
vol_garch=as.ts(v1, date)
plot(vol_garch,xlab='year',ylab='volatility of IBM',type='l', col=1)
title(main='volatility of IBM')

m2_garch=garchFit(~garch(1,1),data=r_boeing,trace=F) # Fit an GARCH(1,1) model
summary(m2_garch)
## Annualized Volatility using daily standard deviation from GARCH:
v2=m2_garch@sigma.t*sqrt(252)*100 # annualized volatility in %

#Plot volatility using xts time series object
vol_garch2=as.ts(v2, date)
plot(vol_garch2,xlab='year',ylab='volatility of Boeing',type='l', col=1)
title(main='volatility of Boeing')

m3_garch=garchFit(~garch(1,1),data=r_ford,trace=F) # Fit an GARCH(1,1) model
summary(m3_garch)
## Annualized Volatility using daily standard deviation from GARCH:
v3=m3_garch@sigma.t*sqrt(252)*100 # annualized volatility in %

#Plot volatility using xts time series object
vol_garch3=as.ts(v3, date)
plot(vol_garch3,xlab='year',ylab='volatility of Ford',type='l', col=1)
title(main='volatility of Ford')
```

Figure 3

cumulative abnormal returns around the event windows

```
install.packages("eventstudies")
setwd("~/Desktop/thesis/forms professor sent/CaseStudy")
downgrades=read.csv("eventstudies.csv") # The sample
str(downgrades)
head(downgrades)
stock_returns=read.csv("returns_stocks.csv") # The returns for stocks
ff_factors=read.csv("factors.csv") # FF factors

library(zoo)
downgrades$when=as.Date(downgrades$when)

date=as.Date(stock_returns$Date)
head(date)
returns=stock_returns[,2:4]
returns=zoo(returns,date)
str(returns)
head(returns)

factors=zoo(ff_factors[,2:4],date)
head(factors)

#OtherReturns=StockPriceReturns # market data+FF data
#head(OtherReturns)
library(eventstudies)

#FF model
es.ff <- eventstudy(firm.returns = returns,
                    event.list = downgrades,
                    event.window = 10,
                    type = "marketModel",
                    to.remap = TRUE,
                    remap = "cumsum",
                    inference = F,
                    inference.strategy = "bootstrap",
                    model.args = list(market.returns=factors$Mkt_RF
                                     ,others=factors$SMB,others=factors$HML)
)
plot(es.ff)
```