Online Financial Analysis: 
Measuring Reliability and Predication

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DECLARATION

I hereby declare that this project is entirely my own work and that it has not been submitted as an exercise for a degree at this or any other university

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Name Date
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I would also like to thank Patrick, Séan, Louis and Dan for their support.
Abstract

This study explores the relationship between stock market predictions and the actual changes in equity value on the stock market. To do this a system has been developed which harvests the contents of various stock prediction websites in order to collect a dataset which represents the historic sentiment that rating agencies felt toward certain stocks over a period of time. This dataset will then be compared against the actual share price over the same period of time to see if the rating agencies accurately predicted the performance of the equity.

Data has been collected for 21 publicly traded companies listed in the US. These companies were chosen as their shares operate in very liquid markets and have many ratings issued to them by various ratings agencies. This study aims to discover if the rating agencies are ahead of the market or lag behind the consensus.

This will be achieved by computing the correlation between rating upgrades and downgrades on shares and their actual price movements. Using statistical analysis we can find the true relationship between predictions and future real returns. As a second means of verifying the performance of rating agencies, a tool has been developed which simulates an investor following the advice of a rating agency over the period of time in question, and examines the returns that they would have achieved.
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Chapter 1

Introduction

1.1 Research Motivation

Companies finance themselves through debt (bonds) and equity (shares). When a firm is publically traded their debt and equity are freely traded by consumer and institutional investors. An entire industry surrounding the financial information regarding the ratings of debt and equity now exists to guide investors when purchasing these financial products.

Rating agencies such as Moody's, S&P and Fitch are well known for rating the bonds of states and companies and have developed rating scales, which can be easily understood by investors. These scales are all similar, and can be seen in Figure 1. Ratings can have huge effects on a country's borrowing costs when their sovereign debt rating receives an upgrade or downgrade. As a result bond ratings are of great importance and there has been much academic literature relating to the nature of these ratings.

However, less has been written about the nature of ratings which are assigned to equities. These ratings tend to be less reported on, due to the fact that sovereign states cannot issue equity. This study will concentrate on the effectiveness of these ratings and relationship to price movements.

![Figure 1: Bond Ratings Table](image)

Throughout this report, the terms shares, stocks and equity will be used interchangeably.
On the 1\textsuperscript{st} of March 2013, the value of all public equities in the world is estimated to be $55 Trillion (Bloomberg, 2013).\textsuperscript{ii} In the USA the number of people who own shares has fluctuated greatly in the past ten years, but it still constitutes a majority of the population, as shown by the Gallup poll below.

\textit{Percentage of Americans Investing in Stocks, April of Each Year, 1999-2011}

Do you, personally, or jointly with a spouse, have any money invested in the stock market right now -- either in an individual stock, a stock mutual fund, or in a self-directed 401(k) or IRA?

\begin{figure}
\centering
\includegraphics[width=\textwidth]{gallup_poll.png}
\caption{Gallup Poll\textsuperscript{iii}}
\end{figure}

\begin{footnotesize}
\begin{itemize}
\item 1999: 58% \hspace{1cm} 2000: 62% \hspace{1cm} 2001: 67% \hspace{1cm} 2002: 64% \hspace{1cm} 2003: 61% \hspace{1cm} 2004: 62% \hspace{1cm} 2005: 61% \hspace{1cm} 2006: 65% \hspace{1cm} 2007: 62% \hspace{1cm} 2008: 57% \hspace{1cm} 2009: 56% \hspace{1cm} 2010: 54% \hspace{1cm} 2011: 53%
\end{itemize}
\end{footnotesize}

\textsuperscript{2002 numbers are from June 28-30 polling; \% investing in stocks was also at the 54\% low in May 2000.}

Stocks are a large part of the general population's pensions and investments, but not everyone is fully capable of researching, judging and analysing which companies they should invest in. As a result many rely on financial advisers and the research of others.

Firms such as Morning star, Investopedia and MSN Money publish stock ratings to the public which constitute recommendations on whether someone should buy, hold or sell a stock. However, these agencies do not publish information about their historic ratings, making it very difficult to analyse their past performance without collecting the data independently. The motivation for this study is to investigate if these ratings are accurate indicators of success in equity price prediction.
1.2 Research Objectives

This research is focused on the investigation of equity rating agency performance with regard to how accurate a predictor of share price movement their upgrade and downgrade ratings are. This will involve the design and development of a tool for systematically harvesting and collecting stock ratings from selected rating agencies in addition to actual equity prices over a defined period of time. An analysis of the rating agencies themselves will be conducted by examining the relationship between stock prices and their assigned ratings.

A secondary aim of this research is to design and develop a tool to simulate the average returns an investor would have made had they followed the recommendations of the rating agencies in question over the same period of time. While similar studies have been conducted which analyse bond ratings and prices, this study is original in the sense that it will be analysing equities and equity ratings, which to the best knowledge of the author, has not been conducted before.

1.3 Technical Approach/Methodology

A methodology was chosen in order to collect the required data from selected rating agencies. Screen Scraping (also referred to as Data Scraping) will be used as a technique throughout this study to harvest data from those rating agencies. It important for the reader to have an understanding of this technique, as it will affect the data which can be gathered.

Screen Scraping is defined by PC Magazine as: "Acquiring data displayed on screen by capturing the text manually with the copy command or via software. Web pages are constantly being screen scraped in order to save meaningful data for later use. In order to perform scraping automatically, software must be used that is written to recognize specific data."iv As all of the data which is needed for this study is published online and freely available, and is required to be constantly gathered, Screen Scraping is an applicable way of harvesting the data for this study. Web crawling could have been used, however for this study all that was needed was to download a web document and extract information from it for this purpose Screen Scraping is ideal.

The data needed for this study will be the rating assigned to an individual firm by a rating agency and each rating agency used in this study displays the data needed on their website respective websites. Screen Scraping the data is possible by using a permanently referable URL, which will be the rating's website and a firm's ticker symbol². A more detailed explanation of the technical aspects

² An abbreviation used to uniquely identify publicly traded stocks of a particular stock market. E.G Microsoft’s ticker symbol is MSFT.
of Screen Scraping the data for this study will be found in Section 4.5.3 in the Design and Implementation.

1.4 Overview of Report

In the second chapter the essential background of financial instruments and the industry which rates them will be discussed. The section also discusses the ratings themselves and how their success has been measured in the past. A discussion on financial information and their effect on the prices of investments will also be introduced.

The Problem Overview chapter discusses the justification for many of the decisions which had to be made during the course of this study, including which rating agencies, firms and markets were selected for the experiments conducted.

The Design and Implementation chapter discuss the various requirements and considerations of the system needed to gather the data for the study. It will then outline a high-level design of the entire system from harvesting the data to its analysis, and the development of an investment simulator. Following on from this, the chapter outlines the technologies and tools used to implement the system. Sequence diagrams and detailed explanations, particularly how each rating agency’s information will be screen scraped will be given. Examples will be given of the tools used to change the data which is harvested into statistical information. A detailed explanation of the development and the functionality of the investment simulation will also be provided.

The Analysis and Evaluation chapter will discuss some of the issues tackled during the course of the study which will affect the data which is being harvested by an evaluation of the system used to gather the data for the study. It will then describe what the information gained from the data set tells us about the nature of the rating agencies used in this study and their ability to predict price movements.

Finally the Conclusions chapter will give a brief synopsis of the findings of the study along with future recommendations for further research.
Chapter 2

Background and Related Work

To gain a deeper understanding of the study and why it is of value, it is important to have an understanding of the background of the financial instruments and the agencies which try to rate them. Past methods of measuring the success of these agencies will also be discussed in this chapter.

2.1 Investment Instruments

Both debt and equity are forms of financing for firms and governments. There are differences between stocks and bonds which lead to differing ways of rating each as an investment, but from an investor’s perspective they are both securities through which they wish to make a positive return.

Stocks pay dividends to their owners, while bonds pay interest payments. Unlike dividends, interest payments cannot be reduced or suspended. Those who purchase stocks gain ownership of the business whose shares they hold. In addition, equity holders have claims on the future earnings of the firm. Bondholders do not gain ownership of the business or have any claims to the future profits of the borrower. The borrower’s only obligation is to repay the loan with interest.

Bonds are generally considered to be less risky an investment. Should the company run into trouble, i.e. bankruptcy, bondholders are paid first before other expenses are paid and stockholders are less likely to receive any compensation in this scenario.

A simplified explanation of how to purchase the two investments would be as follows: Stocks are purchased by investors either when a company has an initial public offering (IPO) or they can be traded second hand on stock exchanges. Bonds can also be purchased directly from the corporation or governments that issue them, but when purchasing a bond the investor is technically considered a ‘lender’ to the borrowing entity, which is why he receives interest payments. The rights to these interest payments can also be traded second hand on bond markets.

Usually an investor will purchase either investment using a middle-man, such as a brokerage or a bank. As there are second hand markets for debt and equity where investors can almost instantly buy or sell investments, as long as there is a large volume of trading in the security, it is possible to trade investment instruments in real time.
2.2 The Structure of the Ratings Industry

There are well-established rating agencies that specialise in bonds. As of the beginning of 2013, the bond rating market is dominated by three firms: Standard and Poor's, Moody's and Fitch. They are commonly referred to as the ‘Big Three’.

The equity rating agencies on the other hand are not as well established and do not receive the same media coverage. As mentioned earlier, much of the media concerning ratings is related to the bond ratings of governments. Many firms who issue ratings to stocks describe themselves as ‘investments research firms’, such as Morningstar, MSN Money and Value Line. The equity research industry is not dominated by a small handful of firms, but instead consists of a large number of independent firms.

2.3 Ratings

It is important to make the distinction between bond and stock ratings. Bond ratings are the ratings which are assigned to debt, while stock ratings are assigned to equities.

Bond ratings are usually formulated under a large set of criteria. The exact criteria are not published as this is valuable intellectual property for the rating agencies and they want to keep the exact specific information hidden. However, they do publish general guidelines on how ratings are assigned. Below is an example from Standard and Poor’s of some of their guidelines for assigning a CCC+ rating to a bond.

“CCC+: The issuer is currently vulnerable and is dependent upon favourable business, financial, and economic conditions to meet its financial commitments. The issuer’s financial commitments appear to be unsustainable in the long term, although the issuer may not face a near term (within 12 months) credit or payment crisis.” (Standard and Poor’s, 2012)

As can be seen in the guideline above, rating agencies use qualitative judgement in their analysis and as such, rating agencies can differ in their opinions when rating securities. For example in February 2013 Moody’s credit rating agency downgraded Britain's sovereign debt from AAA (highest rating) to AA1 (second highest rating) stating that “Britain’s debts are too high and the prospect is for a prolonged period of subdued growth.” There are no strict definitions of what exactly too high a debt level or a “prolonged period of subdued growth” means. Only one of the three big credit rating firms downgraded Britain’s debt. Ratings are well informed opinions of analysts who work at the rating firms and each rating agency uses a different set of criteria when evaluating and analysing firms and states, this is true for both bond and stock ratings.
2.4 Analysing Rating Agencies

This research will analyse how an agencies’ ratings have performed by examining price movements of shares that occur when their rating has changed. When analysing the performance of S&P and Moody’s, the House of Representatives in the United States measured the default rate (The rate of borrowers who fail to pay their loans). Table 1 shows the default rates from 1970 to 2006 of each rating class of Municipal and Corporate Bonds issued by Moody’s and Standard and Poor’s.

<table>
<thead>
<tr>
<th>Rating categories</th>
<th>Moody’s Municipal</th>
<th>Moody’s Corporate</th>
<th>S&amp;P Municipal</th>
<th>S&amp;P Corporate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa/AAA</td>
<td>0.00</td>
<td>0.52</td>
<td>0.00</td>
<td>0.60</td>
</tr>
<tr>
<td>Aa/AA</td>
<td>0.06</td>
<td>0.52</td>
<td>0.00</td>
<td>1.50</td>
</tr>
<tr>
<td>A/A</td>
<td>0.03</td>
<td>1.29</td>
<td>0.23</td>
<td>2.91</td>
</tr>
<tr>
<td>Baa/BBB</td>
<td>0.13</td>
<td>4.64</td>
<td>0.32</td>
<td>10.29</td>
</tr>
<tr>
<td>Ba/BB</td>
<td>2.65</td>
<td>19.12</td>
<td>1.74</td>
<td>29.93</td>
</tr>
<tr>
<td>B/B</td>
<td>11.86</td>
<td>43.34</td>
<td>8.48</td>
<td>53.72</td>
</tr>
<tr>
<td>Caa-C/CCC-C</td>
<td>16.58</td>
<td>69.18</td>
<td>44.81</td>
<td>69.19</td>
</tr>
<tr>
<td>Investment Grade</td>
<td>0.07</td>
<td>2.09</td>
<td>0.20</td>
<td>4.14</td>
</tr>
<tr>
<td>Non-Invest Grade</td>
<td>4.29</td>
<td>31.37</td>
<td>7.37</td>
<td>42.35</td>
</tr>
<tr>
<td>All</td>
<td>0.10</td>
<td>9.70</td>
<td>0.29</td>
<td>12.98</td>
</tr>
</tbody>
</table>

Table 1: Cumulative Historic Default Rates (in percent)\(^{viii}\)

As seen above, there are very low default rates for highly rated bonds and vice versa. As the data is taken from a 2008 congressional report, it does not capture the many series of defaults which were associated with the global recession of 2007-2009. However, the research does demonstrate the accuracy of bond ratings. The fact that bond rating agency performance receives congressional attention in the United States also indicates the importance with which they are viewed.

A bondholder’s main concern is that an entity does not default; hence viewing the history of defaults makes sense as a way of analysing a credit rating agency and a clear relationship is found between a bonds credit rating and its default rate. For a stockholder the main concern is the dividends and the
stock’s price. This is why throughout this study, the methodology for analysing a stock ratings performance will be to examine the relationship between a stock rating and the actual market price.

### 2.5 Efficient Markets

An influential theory in finance called the “Efficient Market Hypothesis”, attempts to explain the effect of financial information on security prices. Eugene Fama who conceived the idea stated “\textit{that security prices fully reflect all available information and a market in which prices always fully reflect available information is called efficient.}”

A theory, which the Efficient Market Hypotheses is built upon is that of the random walk. The idea is simple, as news about a security is published, its price will fluctuate as it incorporates the news. Since news about a security is unpredictable and random, so too will the security price be erratic and random. The more efficient a market is, the more random the price changes should be, because investors eliminate quickly any informational advantages and compete away any profits that could be made from any new information. Security prices have no memory in this sense, meaning that yesterday’s prices should not have any bearing on todays.

As market prices hold all information about a security, there is no way for most investors to earn superior returns in the long term.

Security prices also reflect the market sentiment about the future. While a security's current or past price cannot tell us about its future price, it is possible to use the market price as a gauge of the markets opinion of a company. For example if Firm A and Firm B were almost identical but Firm A’s bonds were trading at a lower level, it would be possible to deduce that the market perceives Firm A as the riskier of the two.

The efficient market hypotheses is still a heavily debated issue in the world of finance but if it were true, there should not be any way of predicting share prices, meaning that ratings would be a useless predictor of share price movements. While this research will not be attempting to prove or disprove the efficient markets hypothesis, the hypothesis is important as it demonstrates the impact that financial information has on stock prices.
2.6 Related Work

Ratings themselves are financial information, which can have an effect on the investment that they are describing. It has been proven by Arthur Warga, Professor of Finance and former Dean of the University of Houston and Gailen Hite, a professor at Columbia Business School that a significant relationship exists between bond prices and bond rating changes. By examining over 2,800 bonds issued by about 1,200 firms throughout 1985-95, they discovered that there is a strong negative reaction to a bond’s price when a rating agency lowers its rating below a prime rating (below CCC, CCC+ or Caa1). Another finding of the study was that months before a rating downgrade the prices of bonds would begin to slowly fall. This hinted at the possibility that the bond ratings could be behind the market at times.

Their method of testing the effect of rating changes on prices was to measure the percentage change in bond prices after downgrades and also to compute the correlation between them. Bond ratings have an effect on bond prices and can act as a reliable predictor of the chances of default. This study tries to determine if the same is true for stock ratings and stock prices.

Despite an extensive search, the author was unable to identify any studies which investigate the effect of ratings on stock prices. As a result, this study, where applicable, uses similar methods to those which were used when comparing bond prices and ratings. These methods involve using regression analysis and computing the increases and decreases in prices after rating changes.

This chapter has discussed much of the background of the investment rating industry. It looked specifically at the bond and equity rating agencies and how they operate. The following chapter will discuss the reasoning behind many of the decisions, which are to be made throughout the project.
Chapter 3

Problem Overview

This chapter discusses a number of decisions related to the identification of which data was to be targeted in order to collect a dataset upon which an analysis could be performed. The following sources needed to be identified and selected:

- The market
- The exchanges where the companies would be listed
- The companies within the market
- The rating agencies that would be used

The following sections will describe these selection decisions and provide more detail on each of the choices made.

3.1 Choosing the US Market/Stock Exchanges

The US Market was selected as it is the largest in the world in terms of market capitalisation, as can be see from figure 3 below. This means that its stocks have the most readily available financial information, in the greatest volume, as many investment research firms analyse the shares within this market.

![Figure 3: Top 6 countries in order of countries Market Capitalization of listed companies (2008-2011)](image)

Even though the market is the United States, it does not mean that only US companies can be included in this research, as a company does not need to be listed where it is geographically based. The two largest stock markets in the world in order of trade value are the NYSE and the NASDAQ. All
of the firms that will be selected for use in this study will be listed on either one of these two exchanges. Table 2 shows the trade value and the market capitalisation of the two exchanges.

<table>
<thead>
<tr>
<th>Stock Exchange Name</th>
<th>Headquartered</th>
<th>Market Capitalization</th>
<th>Trade Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYSE</td>
<td>New York City</td>
<td>14,242</td>
<td>20,161</td>
</tr>
<tr>
<td>NASDAQ</td>
<td>New York City</td>
<td>4,687</td>
<td>13,553</td>
</tr>
</tbody>
</table>

Table 2: Stock Exchange Table. Figures based on World Federation of Exchanges xii

3.2 Choosing the Rating Agencies

As the data will be collected using screen scraping, the rating agencies have to publish their ratings online in order for them to be collected. The webpage which displayed the rating needed to be accessed through URL along with the ticker symbol. This will allow for each rating of each firm to be accessed by using the URL of the rating agency’s website and the ticker symbol for the firm which was needed. If it was possible to access a rating this way, it would be possible to develop a script, which could systematically harvest the data automatically by simply changing ticker symbol. The rating agencies which were chosen will be discussed in the following sections.

3.2.1 Morningstar

Morningstar, a Chicago based financial data firm, which has been in operation since 1984 in the Investment Research Industry. Their equity ratings are shown on a scale of stars out of 5 (1 indicating sell and 5 indicating buy). They are considered reputable and a very mature investment research firm and as such it would be interesting to include them in a study of rating agencies.

Their ratings are accessed by the following http request. An example of a 4/5 rating for Apple Inc. and how this rating was accessed are shown in Figure 4, below.


![Apple Inc AAPL | ★★★★](image)
3.2.2 Investopedia

Investopedia is a website started in 1999 devoted to investment education. It allowed its users to vote whether stocks were a buy, sell or hold and then assigned a percentage value as a rating. Even though it is not specifically an investment research firm, it is interesting to include in the study as its ratings reflect the popular opinion of users of the site. Their ratings are given on a percentage scale and were accessed by voting on the stock.

Unfortunately during the duration of the study Investopedia ceased supporting the voting feature on its website and as a result this information could not be included in the study. It could not be replaced by another rating agency as it was too late in the duration of the study when the problem occurred. If another rating agency had been substituted, it wouldn’t have been possible to compare their ratings against the other agencies over a similar time period. There will be a more detailed discussion as to why this was the case in the analysis and evaluation section.

3.2.3 MSN Money Stock Scouter

MSN money is a financial information website, which is associated with Microsoft and NBC. Microsoft describes MSN Money as:

“MSN Money is Located exclusively on MSN, combines the award-winning finance tools and content from Microsoft, the worldwide leader in software, with exclusive investment news and analysis from CNBC, the world’s most popular financial cable news network.” (Microsoft 2010) xiii

MSN Money has a stock scouter feature which has been rating stocks, with ratings from 1 to 10 since 2001. xiv The following is found under the heading “How MSN Stock Scouter Works” on the MSN Money website:

“Stock Scouter rates stocks from 1 to 10, with 10 being the best, using a system of advanced mathematics to determine a stock’s expected risk and return. Ratings are displayed on a bell curve, meaning there will be fewer ratings of 1 and 10 and far more of 4 through 7.” xv

![Figure 5: Distribution of MSN Ratings](image-url)
MSN Money does not elaborate on its "system of advanced mathematics", as mentioned earlier it makes sense for rating agencies not to reveal exactly how the ratings are derived, as it is a unique selling point. It is included in the sample as it would be interesting to test the accuracy of its rating system, as the industry partners such as NBC are quite popular sources of financial news.

To access the ratings a simple HTTP request with the ticker symbol at the end of the request as seen highlighted below is needed.

http://investing.money.msn.com/investments/stock-price/?symbol=AAPL

Below is an example of a 6 out of 10 rating is displayed:

![Stock Scouter Rating Example](image)

**3.4 Time Frame**

The data was collected in 30 minute intervals beginning at 11am GMT on November 9th 2012 and will cease being collected at 1pm on March 17th 2013. This meant that the data will be collected for a period of over four months, which is enough time to gather a significant amount of data.

Within the four month time frame, the anticipation was that many of the firms chosen in the study would make announcements concerning their products and performance. For example, one of the firms chosen in the study, Activision Blizzard’s flagship product Call of Duty: Black Ops 2 was scheduled to be released on November. Its sales figures were also scheduled to be released shortly after. Events like this tend to change analysts’ opinions regarding firms. As the study relies on the ratings to change, four months was intended to be enough time for the rating agencies to factor in many different announcements.

The study was due on the 8th of April, so the decision to end on the 17th of March was in order to afford enough time to the analysis and evaluation.
3.5 Choosing the Sample Firms

In order to avoid the data being skewed by industry-specific or geographic events a mix of companies was chosen in order to represent many different sectors of the economy. For example if the sample consisted of mainly petroleum firms and the price of oil crashed worldwide, most likely all firms in our sample would suffer unexpected losses. In order to mitigate these risks the firms chosen are all firms which operate globally with operations across many continents. Below is a list of the firms that were chosen for the sample:

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Stock Ticker</th>
<th>Stock Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nokia Oyj (ADR)</td>
<td>NOK</td>
<td>NYSE</td>
</tr>
<tr>
<td>Coca-Cola Co</td>
<td>KO</td>
<td>NYSE</td>
</tr>
<tr>
<td>Ryanair Holdings plc (ADR)</td>
<td>RYAAY</td>
<td>NYSE</td>
</tr>
<tr>
<td>General Electric Company</td>
<td>GE</td>
<td>NYSE</td>
</tr>
<tr>
<td>Walt Disney Co</td>
<td>DIS</td>
<td>NYSE</td>
</tr>
<tr>
<td>General Motors Co</td>
<td>GM</td>
<td>NYSE</td>
</tr>
<tr>
<td>Taiwan Semiconductor Mfg. Co. Ltd. (ADR)</td>
<td>TSM</td>
<td>NYSE</td>
</tr>
<tr>
<td>Goldman Sachs Group Inc.</td>
<td>GS</td>
<td>NYSE</td>
</tr>
<tr>
<td>Activision Blizzard Inc.</td>
<td>ATVI</td>
<td>NASDAQ</td>
</tr>
<tr>
<td>Bank of America Corp</td>
<td>BAC</td>
<td>NYSE</td>
</tr>
<tr>
<td>Apple Inc.</td>
<td>AAPL</td>
<td>NASDAQ</td>
</tr>
<tr>
<td>Microsoft Corporation</td>
<td>MSFT</td>
<td>NASDAQ</td>
</tr>
<tr>
<td>Google Inc</td>
<td>GOOG</td>
<td>NASDAQ</td>
</tr>
<tr>
<td>Exxon Mobil Corporation</td>
<td>XOM</td>
<td>NYSE</td>
</tr>
<tr>
<td>Hess Corp.</td>
<td>HES</td>
<td>NYSE</td>
</tr>
<tr>
<td>Wal-Mart Stores Inc.</td>
<td>WMT</td>
<td>NYSE</td>
</tr>
<tr>
<td>BP plc (ADR)</td>
<td>BP</td>
<td>NYSE</td>
</tr>
<tr>
<td>ConocoPhillips</td>
<td>COP</td>
<td>NYSE</td>
</tr>
<tr>
<td>AT&amp;T Inc.</td>
<td>T</td>
<td>NYSE</td>
</tr>
<tr>
<td>Toyota Motor Corporation (ADR)</td>
<td>TM</td>
<td>NYSE</td>
</tr>
<tr>
<td>Hewlett-Packard Company</td>
<td>HPQ</td>
<td>NYSE</td>
</tr>
</tbody>
</table>

Table 3: List of Sample Firms
An American depositary receipt (ADR) represents securities of a non-US company that trade in the US financial markets. Five of the firms are ADR non-US firms, Nokia (Finland), Ryanair (Ireland), TSMC (Taiwan), BP (United Kingdom) and Toyota (Japan). These companies were selected in order to ensure that not only US firms are included in the sample. This is to mitigate the risk of our sample being overly skewed by events that only affect the United States. For example, were regulations negatively affecting only US headquartered companies unexpectedly to come into effect, the non US firms would act as a control group.

It would be expected that rating agencies would not be able to predict any number of unexpected events. The approach to selecting the sample of firms has been to diversify as much possible. This has been the same approach when choosing the rating agencies. It is important to have several rating agencies and several firms as it is possible that screen scraping will fail during the four month period for one of the agencies. The next chapter will outline the design and implementation of the system which harvests the ratings data for each company. The tools that will be used analyse the data will also be discussed.
Chapter 4

Design and Implementation

This chapter aims to identify the core requirements of the system, which will harvest data from the rating agencies’ websites and the tools which will be used to analyse the data. There will also be a small discussion concerning some of the problems associated with developing a system with many technological components and their effects on the design. There will also be an outline of the design of the complete system.

4.1 Requirements

The project requirements were based upon the research question of gathering a data set of prices and ratings to perform analysis in order to find the reliability of the stock rating agencies. The requirements which will dictate the design and implementation are as follows:

- Allow the user to enter a company, which ratings will be tracked.
- Create a method for systematically harvesting these ratings from Investopidea, MSN Money and Morningstar.
- Develop a method for systematically harvesting the price of each of the firms’ shares.
- Create a website which aggregates the most recent ratings allowing for monitoring of the data, which is being harvested.
- Enable the user to convert the raw stock data to processed statistical data, which can then be analysed.
- Enable the user to use the ratings and price data to perform investment simulations to analyse to how differing strategies based on rating changes would have performed.

4.2 Issues affecting design

Some of the issues which will have an effect on the design of the system will be discussed in this section.

As there are no products available that would fulfil the requirements for this system, it is not possible to build upon a state of the art. The whole system instead will be designed from the
beginning with the expectation that many different technologies will be used for separate parts of the project. Throughout the design a ‘best tool for the job’ approach was adopted, mainly using open source software during development, as open source software provides a large freely available support community.

The entire system has to deal with a lot of phases from harvesting to the analyses of the data. The system using an accumulation of many different technologies, could lead to integration problems when moving the data between technologies. As a result constant awareness of the many integration issues will have to be kept while designing the system. By using technologies, which could easily use Comma Separated Values (.CSV) files as inputs and outputs, data could be moved between different parts of the system easily.

4.3 User Model

The software which is being developed for the purposes of harvesting data conducting the study is being designed solely for the purpose of this study. This means usability will not be of great concern, while designing the system. The key concern will be that the system is functional as opposed to user friendly. There will be a discussion on the future development of software tools, for harvesting and analysing data which will be more user friendly in the Analysis and Evaluation section.

4.4 Data Storage

All of the data harvested during this study will have to be gathered in a database order to run analysis once all the information is harvested. There will be a database table storing each firm's name, ticker and exchange which will act a company list that will show which firms are in the system.

Each firm will have a corresponding database table, which will store all of the data about the firm. This will mean that each table will be named after a firm and will include fields with the various rating agencies rating's and their price at the time of capture. With all of the rating data of the firms organised by firm, it will be easier to implement the programs which will need to use the data.
4.5 Complete System Overview

With all of the requirements and issues taken into consideration, the following system which is shown in Figure 7 was designed. The next section will discuss the various technological components of the system while referring to the labels given to each component in Figure 7.
Next the implementation of the designed system will be discussed. Throughout this section it is important to use the diagram of the complete system overview in Figure 7 as a visual guide through the entire system, as each section in this chapter will correspond to the labels in the diagram. Each section will discuss each component of the diagram and give a detailed account of the technologies used when implementing the system.

4.5.1 Linux Virtual Machine (VM)

The Python scripts for harvesting the data, the MySQL database for storing the data and the website for viewing the data will be hosted on a Linux Virtual Machine in the Knowledge and Data Engineering Group at Trinity College Dublin.

Linux was used as it is a free open source server software and compatible with many of the technologies that were required for the development of the system. Such as Python 2.7 and the following libraries that would be needed: LXML, MySQLdb, URLlib, BeautifulSoup, Regex, JSON, Time. All of these libraries made it possible to download the websites of the rating agencies, parse the rating, add a time stamp, and insert the information into a database.

The Linux VM also comes enabled with Cron, which allows for time based scheduled tasks. This would be vital as this meant that the python scripts could be called upon automatically to harvest the data automatically.

4.5.2 MySQL Database

MySQL, an open source database was installed on the VM along with phpMyAdmin to allow for simple utilization of the database. PhpMyAdmin allows for simple exporting of the contents of the database in .CSV, meaning that the other parts of the system needed to be able to parse and handle .CSV files in order to to use the data from the database.

The database would host all of the data needed by the study. As mentioned in Section 4.4 the database will contain a table holding general information about each company and a separate table for each firm to hold all of the ratings data.

---

All of the technologies in bold are further explained in the Appendix
4.5.2.1 The Company List Table

The Company List table held the basic information of each of the company’s names, exchanges and ticker symbols. This table would be used with the AddCompany.py script, which will be discussed further in Section 4.5.3. The structure of the Company List table can be seen in Figure 8.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Collation</th>
<th>Attributes</th>
<th>Null</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>ticker</td>
<td>varchar(10)</td>
<td>utf8_general_ci</td>
<td>No</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>name</td>
<td>varchar(50)</td>
<td>utf8_general_ci</td>
<td>No</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>exchange</td>
<td>varchar(10)</td>
<td>utf8_general_ci</td>
<td>No</td>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8, Structure Company List Table

4.5.2.1 The Stock Data Tables

The ratings and price information about each company would each be held in a separate table. Each table would be named after their ticker symbol. These tables would be used during the AddCompany.py and Refresh.py scripts, which will be discussed below. Figure 9 shows the structure of a Stock Data table.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Collation</th>
<th>Attributes</th>
<th>Null</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int(9)</td>
<td></td>
<td>No</td>
<td>None</td>
<td></td>
<td>auto_increment</td>
</tr>
<tr>
<td>morningstar</td>
<td>int(5)</td>
<td></td>
<td>Yes</td>
<td>NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>investapedia</td>
<td>int(5)</td>
<td></td>
<td>Yes</td>
<td>NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>msnstockscouter</td>
<td>int(5)</td>
<td></td>
<td>Yes</td>
<td>NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>float</td>
<td></td>
<td>No</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time</td>
<td>int(20)</td>
<td></td>
<td>Yes</td>
<td>NULL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 9: Structure of a Stock Data Table

4.5.3 Add Company Python Script

As it was required that a user could enter in a ticker name to see if it was already being harvested by the system, a Python script was developed which allowed a user to enter a ticker name and check if it was already within the system. The script will check if the ticker already exists in the database to avoid duplicate tickers. The python script will then screen scrape the exchange and full company name from the Google Finance Website. By calling the following web address (the ticker inserted where indicated in red):

http://www.google.com/finance?q=ticker
The information would then be inserted it in the Company List table, an example of which can be seen in Figure 10. A Stock Data table will then be created for the company. Figure 11 shows a Sequence Diagram of the entire process. This script was developed as it allowed for a simple way to populate the database with sample companies.

<table>
<thead>
<tr>
<th>ticker</th>
<th>name</th>
<th>exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAPL</td>
<td>Apple Inc.</td>
<td>NASDAQ</td>
</tr>
</tbody>
</table>

Figure 10: Example firm added to Company List Table

![Sequence Diagram: AddCompany.py](image)

Figure 11: Sequence Diagram: AddCompany.py

### 4.5.4 Refresh Python Script

As equity ratings and prices were required to be harvested over a period of time so that they could be analysed, a python script was developed which would screen scrape the ratings for each stock from the three stock rating websites. The price would be retrieved using the Google API. Using a Cron (Scheduled Task) the Refresh.py Script would automatically run and collect the data every 30 minutes, which would systematically capture both the ratings and the price of each of the shares on every hour and half hour. A timestamp would then be generated and all of this information will be inserted in the firm’s stock table.
Figure 12 is a sequence diagram describing an overview of how the process is carried out and Figure 13 shows a sample of the information which is collected from the sites and inserted into a Stock Data table. A more in depth explanation of the collection of the information will be found in the proceeding pages.

Figure 12: Sequence Diagram: Refresh.py

<table>
<thead>
<tr>
<th>Id</th>
<th>morningstar</th>
<th>investapedia</th>
<th>msnstockscouter</th>
<th>price</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3367</td>
<td>4</td>
<td>88</td>
<td></td>
<td>452.99</td>
<td>1363627043</td>
</tr>
<tr>
<td>3366</td>
<td>4</td>
<td>88</td>
<td></td>
<td>451.4</td>
<td>1363624278</td>
</tr>
</tbody>
</table>

Figure 13: Example of information Refresh.py gathers and inserts into a stock data table
4.5.4.1 Screen Scraping the Morning Star Rating

Figure 14 below screenshot shows the Morningstar webpage for Apple Inc. and its page source, which needs to be parsed to get the rating.

The GetMorningStar() method downloads the entire page. As we can see the attribute “r_star4” is what holds the numeric rating, which is needed. By navigating to the element where “r_star” is we can parse the numeric rating using regex. By using the ticker “AAPL” and the Morningstar URL it is possible to screen scrape the ratings from the Morningstar website.
4.5.4.2 Screen Scraping the MSN Money Rating

Figure 15 is the MSN Money web page for a stocks rating. The same method as was used for Screen Scraping the rating of MSN Morning Star rating will be used with a few minor alterations. Again the example is Apple Inc.

![Msn Money Webpage](image)

We navigate to where class ="tck" and then take the string, which in this case = “6 out of 10” and the first number is parsed to get the numeric rating, which in this case would be 6.

4.5.4.3 Screen Scraping the Investopidea Rating

As mentioned earlier the Investopidea website stopped issuing ratings during the project. However when scraping their website one had to vote on a stock in order to view the ratings. It was possible to mimic this voting by using the URLLIB library, allowing to send a HTTP POST request which would let the script mimic voting by including in the request “currentvote=1”.

The rating will have to be parsed from an XML element for example currentvote="88%", by removing the percentage sign. The rating would then be converted from a string to an integer.
4.5.4.4 Retrieving the Price using the Google Finance API

Using the Google Finance API it was possible to simply request all current information on a firm and retrieve the price. Once the price and all three ratings would be gathered, a UNIX timestamp would be created and all of the information would be inserted in the respective companies table.

4.5.5 Website for visual demonstration of current ratings

As screen scraping is an inherently risky method of collecting data a website will be created to have a quick way of viewing the ratings in aggregate. The website was made using HTML, CSS and PHP to pull the information from the database. The webpage could be accessed on the TCD computer science network through the URL: "kdeg-vm-38.scss.tcd.ie/al/index.php". The user could simply type in the ratings they wanted to view and this was mainly used as a way of ensuring that the scripts were working as intended. Figure 16 shows a screen shot of the website viewing Microsoft.

Figure 16: Screenshot of webpage displaying ratings
4.5.6 Exporting Comma Separated Values (.CSV) Raw Data Files

**PhpMyAdmin** allows for a simple way to export the data through a .CSV file. This file type is the preferred method for analysing the data in this case for the following reasons:

- There was a restriction on the KDEG VM from using MySQL commands from outside the VM, which made it impossible to develop a client side application that could fetch records straight from the database.
- Excel is compatible with .CSV files.
- Using R is preferable with .CSV files when performing statistical analysis.
- Java has excellent methods for importing data from excel files, especially as the user can specify how the data is modelled within phpMyAdmin before it is exported.

The Raw data would be extracted from the database and would hold all the rating and price data. This data would be used when running the investment simulation and will be further processed using R. Figure 17 shows an example of the raw stock data for one firm.

```
<table>
<thead>
<tr>
<th>Id</th>
<th>morningstar</th>
<th>investopedia</th>
<th>msnstock:price</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352497236</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352471417</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352475014</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352478627</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352482218</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352485823</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352489419</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352493022</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352496614</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352500216</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352503819</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>88</td>
<td>5</td>
<td>1352507422</td>
</tr>
<tr>
<td>13</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352511029</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352514015</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352518215</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352521814</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352525415</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352529016</td>
</tr>
<tr>
<td>19</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352532615</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352536216</td>
</tr>
<tr>
<td>21</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352539814</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352543415</td>
</tr>
<tr>
<td>23</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352547019</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>88</td>
<td>4</td>
<td>1352550814</td>
</tr>
</tbody>
</table>
```

Figure 17: Sample Raw Data
4.5.7 R for Statistical Analysis

The R stats package allowed for analysis of the .CSV files. R was chosen as it is especially useful when determining statistical significance and running/analysing linear regressions. In order to assess statistically the relationship of the prices and the ratings many, statistical techniques could be performed using R.

This would allow the running of regressions and correlations between each companies prices and ratings data sets. It was also required to run each calculation with lag times of 30, 60 and 90 minutes as this will show if there was a lag time between the rating change and the price change.

For example, the user could input: “Price as a function of MSN Rating”, the R Script will take all the price and MSN rating data from the 21 firms and apply statistical techniques and output the results into a CSV file. An example of can be seen in Figure 18, which shows the output for Nokia.

To summarise, the R script uses the tens of thousands of records from the raw data and provides the user with the relevant statistical data needed to perform analysis, the results of which will be discussed in the analysis and evaluation chapter.

4.5.8 .CSV Processed Data

The processed data which the R script provides can be seen in Figure 18, this will be done for each rating agencies ratings against each firms share price. It is important to move the processed data from R to Excel as it can then be viewed and graphed.
Excel allowed for simple ways of manipulating the data and analysing the processed output from R. Excel was also chosen as it allows for tools for visually graphing data. Using Excel it was easy to calculate averages for each of the statistical equation. Figure 21 shows the averages statistical data over all 21 firms for MSN ratings as a function of price. These figures will be discussed in further detail in the Analysis and Evaluation chapter.

**4.5.9 Excel for Statistical Analysis**

Excel allowed for simple ways of manipulating the data and analysing the processed output from R. Excel was also chosen as it allows for tools for visually graphing data. Using Excel it was easy to calculate averages for each of the statistical equation. Figure 21 shows the averages statistical data over all 21 firms for MSN ratings as a function of price. These figures will be discussed in further detail in the Analysis and Evaluation chapter.
4.5.10 Java Investment Simulation

The Java application will allow the user to see how much of a return one would have made depending on which stocks he or she had invested in and at what rating levels the investor had bought/sold. This is important as, R and Excel would allow for the statistical analysis of the data, while the Java program will allow a user to test differing investment strategies based upon ratings.

The program allows for the user to enter the following inputs:

<table>
<thead>
<tr>
<th>MSN Buy Price</th>
<th>MSN Sell Rating</th>
<th>Morningstar Buy Rating</th>
<th>Morningstar Sell Rating</th>
<th>Lag time</th>
<th>Stock Name</th>
</tr>
</thead>
</table>

The program will then calculate the amount per share and percentage return, depending on the inputs.

The main algorithm loops through the rows of data, one by one, and if the rating changes to the level, which the user has indicated to buy at, one share will be bought at the current price. Then if the rating falls to the sell level it will sell it at the price at the time. The program will calculate the profit in both absolute and percentage terms. There is an example on the following page.
Figure 20: MSFT Investment Simulation Example

Figure 20 shows the MSN rating to scale, with the price for the data collected for Microsoft running through all of the data which has been captured. In this example the MSN rating has been multiplied by 5 in order to have in the same scale as the price, this is purely for display purposes. “Sell” Rating is set at 20 indicated by the red line, the “Buy” rating is set at 30 indicated by the green line, The MSN Rating is the yellow line and the price is the blue line.

When the Msn rating rises above the yellow line the simulation program developed by this research buys a share at the current price, and if it falls below the red line it sells a share at the current price. At the end of the series it will determine the profit or loss in absolute and percentage values.

The program essentially allows for a user to historically play out different investment strategies to see how much return would have been made had investments taken place. Results produced by this program will be used, in conjunction with the statistical analysis, to evaluate the performance of the rating agencies in question.

This chapter outlined the design and implementation of the system to gather the ratings and price data and some of the tools which will be used to analyse the data. The next chapter discuss the results from the analysis the data set.
Chapter 5
Analysis & Evaluation
The implementation of the system described in the previous chapter and the data that it
gathered worked mostly as planned and designed. However throughout the project there were
obstacles which affected the data that could be harvested and results which could be acquired.
This chapter will follow a discussion and analysis, firstly of some of the problems acquiring the
dataset and then the results from the dataset.

5.1 The Final Data Set
The final dataset which is to be analysed consisted of 21 firms and two rating agencies,
Morningstar and MSN Money. Investopedia.com unfortunately had to be removed from the
study, as they stopped issuing ratings during the observation period. 5 of the 21 companies also
had to be excluded as their ratings in Morningstar remained static throughout the period of
observation. Below, will be brief discussion of how these issues arose.

5.1.1 Issues with Screen Scraping
Harvesting data from webpages via scripts ran the risk of one the rating agencies changing their
website causing knock on effects to the data which was being captured. In fact, this issue was
encountered during the study as Investopedia.com stopped issuing ratings and redesigned their
website. It was felt that the risk of such an issue going undetected was minimised by creating a
website to monitor the ratings issued in real-time. However, monitoring the ratings regularly in
order to check that the system was functioning was not without its problems, as the issues with
Investopidea.com demonstrate.

The fact that Investopidea had stopped issuing ratings was not noticed when viewing the
website because the python script harvested a rating of “88%” each time, which seemed to be a
normal rating. In fact, the script was harvesting the “88%” rating from a redirected “404: Page
Not Found Page” on the website. This was not noticed until it was too late in the study to switch
to another website to harvest ratings. Harvesting data from multiple rating agencies, somewhat
reduced the impact of this problem as there remained a full collection of data for two agencies
for which a comparison could be performed.
5.1.2 Static Ratings

Throughout the project five of the firms' Morningstar ratings did not change. As the project is trying to determine the relationship between rating changes and prices, having no rating changes would have implications on the analysis of the results. This meant that the standard deviation of these ratings would be equal to zero. As a result much of the regression analysis could not be carried out. The investment simulation would also be rendered useless for these five firms using Morningstar's ratings as the algorithm depends on rating changes as an indicator of price.

There was a risk that, the four month period would be too short a time to for some ratings to change. This risk was mitigated by including large firms in our sample that would display much activity during the period so hopefully their ratings would change. Using a large pool of sample firms and multiple rating agencies also insured that there would be enough rating changes to analyse.

Figure 21 shows the standard deviations of each firm rating from each agency. MSN Money had on average twice the standard deviation of the Morningstar firms. This would be expected as the MSN rating system covers ratings from 1 to 10, while Morningstar has ratings from 1 to 5. A bar was included which shows Morningstar’s average if it were multiplied by two to account for having half the interval ratings.

We can see that after the zero values were excluded and Morningstar’s average was multiplied by two, both rating agencies had similar average rating standard deviations. This is important as the spread of ratings shows that the few firms who experienced static ratings were the exception and not the rule.
5.2 Regression Analysis to Determine an Investment Strategy

The ideal rating system would assign high ratings when the price is low and set to rise and low ratings when the price is high and set to fall.

Correlation acts as measure of how successful rating agencies ratings can be. Correlation and anti-correlation can measure how well ratings can predict if a stock is overvalued or undervalued. A value of -1 is a perfect anti-correlation: when x goes up, y goes down in an linear manner. The perfect rating system should have a correlation as close to -1 because when price moves towards its peak, it would be the worst time to buy hence the rating should be low, and conversely when the price is at its lowest the shares are undervalued and the ratings should be high to indicate this. Using examples of two firms: one with a negative correlation and one with a positive correlation between prices and rating an explanation on the effect on investment can be determined.

The R squared is the proportion of variability in a data set that is accounted for by the statistical model. It provides a measure of how well future outcomes are likely to be predicted by the model. This means that the high R squared companies fit the linear model best and when a firm’s ratings and prices fit a linear model with an anti-correlation, it means that the ratings

![Standard Deviations of Ratings](image-url)
have been a good predictor of prices. With this logic a linear regression was tested, to measure if the ratings act were a good predictor of prices.

MSN money's ratings of Goldman Sachs and Morningstar's ratings of Hewlett-Packard were chosen as their R Squared values were some of the highest in the sample.

The investment simulation, described in chapter x, is used to determine how much profit or loss an investor would have made on investing in the two stocks using different strategies. It is important to note that MSN issues ratings on scale from 1-10 and Morningstar on a scale from 1-5.

The following examples will demonstrate in detail how different correlations effect investing strategies using regression analysis and the investment simulation.
5.2.1 The effect of a positive correlation between prices and ratings

Figure 22 displays the price against the MSN rating for Goldman Sachs with the line of best fit and Figure 23 shows the stats from the output which was processed using R for Goldman Sachs.

The P value determines if the results are statistical significance. As we can see the P value was so small in all cases it was rounded down to zero. So it can be determined that the correlations and regressions are statistically significant. As it may not be possible to buy or sell a share immediately as the rating changes lag times of 30, 60 and 90 minutes were added to the results the see if lag times effected the results.

The R Squared with a lag of 90 minutes is 0.595. The confidence intervals are based on a 95% confidence level.

Table 4 shows the profit or loss in percentage terms of different investment strategies. Had an investor used a strategy where he/she had bought at different ratings; these were produced using the investment simulation. As we can see buying at higher ratings would have caused the investor to buy at the higher prices and selling at the lower ratings would have caused them to sell at the lower prices. This effectively would have caused the investor to buy high and sell low, which explains the many loss making outcomes of the investment strategies. The only strategy which resulted in a profit was the buy at 10 and sell at 7. This would make sense, if we look at Figure 1; the price levels at rating 7 are higher at times then at 10. This leads to the possibility of

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4 The exact P value is 2e-16 or 0.00000000000000022; however Excel rounds this figure to 0.
buying at the lower price and selling at a higher price. It is only possibly though to make a profit using the ratings appropriately as price deviates so widely from the regression line at rating 7.

However if the higher prices are found at the higher ratings then it is an indication that the shares are overvalued when the rating agencies are assigning the top ratings to the stock. We can see that using a strategy of buying when the rating is low and selling when the rating is high produces very high returns. As can be seen in table 1 that buying at 6 and selling at 10 would have produced over a 22% return for the four month period under observation, meaning that the highest profit would have been made by trading against the ratings.

<table>
<thead>
<tr>
<th>GS Investment Simulation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buy</strong></td>
<td><strong>Sell</strong></td>
</tr>
<tr>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

*Table 4: Results of Investment simulation for GS*
5.2.2 The effect of a negative correlation between prices and ratings

As a positive correlation leads to lower returns, it is reasonable to expect that a negative correlation will lead to higher returns if a strategy using the ratings is used. The following example uses Hewlett-Packard (HPQ) price and Morningstar's ratings to prove this case.

![Figure 25: HPQ Price as a function of Morningstar ratings with a lag of 90 minutes](image)

As we can see in Figure 25 the relationship between Morningstar's rating of HPQ and its price has a high negative correlation of -.804 and a relatively high R Squared of 0.646. The P Values are virtually 0 in all cases meaning that the results are statistically significant.

<table>
<thead>
<tr>
<th>HPQ</th>
<th>Investment Simulation using Morningstar's Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Buy</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 5: Results of Investment simulation for GS
Table 5 shows the outcome of the investment simulation for HPQ using different buy and sell Morningstar ratings. As we can see, buying at high ratings and selling at lower ratings leads to high returns in this case. Trading against the ratings in this case i.e. buying at 3 and selling at 4 would have led to a negative return.

As we can see in Table 5 at buying at 4 or 3 and selling at 2 gives the same return of 60.43%. The reason is the return is the same is due to the fact that the rating of 3 means buy at rating 3 or higher in the investment simulation. Figure 5 displays the ratings as series and shows that the simulation essentially bought the share as soon as the simulation began and sold at the very end of the simulation when the rating fell to 2.

![Morningstar Rating Of HPQ](image)

Figure 26: Morningstar Rating of HPQ series
5.3 Analysing the Rating Agencies using Regression Analysis

It would seem that when a linear relationship exists the correlation can be a very effective tool at analysing the performance of the ratings. The R squared can be used to determine the intensity of the relationship and the correlation or R can be used to determine the strength of the relationship.

Essentially we can determine a how well a rating agency performed by looking at their average R squared and correlation.

<table>
<thead>
<tr>
<th>Average Price as a function of Morningstar Ratings</th>
<th>Average Price as a function of MSN Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td></td>
</tr>
<tr>
<td>Slope</td>
<td>-0.00129</td>
</tr>
<tr>
<td>R Squared</td>
<td>0.295382</td>
</tr>
<tr>
<td>Intercept</td>
<td>140.617</td>
</tr>
<tr>
<td>P Value</td>
<td>0.000237</td>
</tr>
<tr>
<td>Correlation</td>
<td>-0.43948</td>
</tr>
<tr>
<td>P Value</td>
<td>0.000237</td>
</tr>
<tr>
<td>First Confidence Interval</td>
<td>-0.46464</td>
</tr>
<tr>
<td>Last Confidence Interval</td>
<td>-0.41394</td>
</tr>
</tbody>
</table>

Figure 27: The Averages for the 21 MSN firms and the 16 Morning Star firms

As we can see in Figure 27, with a lag time of 90 minutes, the average correlation for the 21 MSN Money firms is 0.197 and the r squared is 0.214. Contrasted to Morningstar’s average correlation of -0.434 and an R Squared of 0.290, means that Morningstar would be the better of the rating agencies at identifying when stock prices were set to rise and fall. In fact a strategy where one traded inversely to MSN Money would have led to a higher chance of profitable trades.

5.4 Discussion

It is important to note that a weak relationship exists on average for all firms. However, for a number of specific firms a very strong relationship measured by the correlation exists between the ratings and the prices. There could be many explanations to determine why this is the case which are beyond the scope of this project to fully explore, however, a few possible explanations will be discussed below.

A possible explanation could be that Morningstar’s analysis is superior to that of MSN Money and simply they are better at detecting undervalued and overvalued stocks. Figure 28 shows all the firm’s correlation coefficients, it is clear that investing using Morningstar’s ratings would
lead the investor to buy at lower prices and sell at higher prices. While using MSN Ratings would have had the opposite effect.

Figure 28: Correlation Coefficient by firm

Figure 29 shows the R squared of each firm by both rating agencies. There is a lot of variation, of which firms’ price movements the rating agencies can accurately predict. It is interesting that 5 out of the 21 firms (24%) whose ratings were harvested for from Morningstar had static ratings. A possible explanation for the rating changing rarely is that as Morningstar has fewer ratings they naturally do not shift as much. It could also indicate something of the methodology by which both rating agencies rate each stock. As the rating agencies themselves do not publish how the ratings are compiled, one can only speculate on the methods used by each agency. It is interesting to note that the standard deviation of MSN Money's ratings of Microsoft were the highest of any firm, while Morningstar did not change their rating once, displaying the variation in the methods used by the rating agencies use when analysing stocks.
The United States stock markets also performed very well on average during the time of the study. Figure 30 shows the NYSE Composite Index between late October 2012 and beginning of April 2013 and Figure 31 shows the NASDAQ Composite Index for the same period.

The index’s measures the performance of all common stocks listed on the NASDAQ and NYSE, including ADRs and the all of the firms in the sample were listed on either exchange. Between November 9th 2012 and March 19th 2013 the index rose 12.34% and the NASDAQ rose in the same period 11.45%. This would be considered very large growth for a four-month period and would not be considered by any means ‘normal’ growth. It could be that Morningstar performs better in these market conditions, while MSN Money performs worse. However there were short downfalls in the composite index so the data does capture both scenarios of positive and negative average market growth.
This chapter discussed the analysis of the results using the investment simulation and statistical analysis and many of the issues which affected the gathering of the data. The next chapter will discuss some of the ways in which further study can improve on the methodologies presented in this study.
Chapter 6

Conclusions

The final chapter restates the objectives of the project and the achievements of the design and implementation and the conclusions which can be drawn from the analysis. Some of the possibilities for further research will also be discussed.

6.1 Software Evaluation

The objectives of this project were to build a system that was capable of systematically harvesting the data from rating agencies websites for a sustained period allowing for astute analysis of rating agencies in terms of their ability to predict share price returns.

The resulting system allowed for the objectives to be met; however there are inherent risks with the unstable nature of using Python scripts for screen scraping. These risks meant that when problems such as the rating agencies performing website redesigns or rating agency simply ceasing to issue ratings online, alterations had to be made to ensure the appropriate data would be gathered. These alterations meant that the final data set of the rating agencies fell from three to two, but this did not severely affect the completion of the study. But constant monitoring of the results was needed in order to make sure the system was functioning as intended. For future studies of this nature it would be very helpful to build safeguards into the program to detect faults such as static ratings or changing locations of the resources.

More sophisticated techniques of harvesting data could be utilised if it were necessary to increase the scale of the project. If one was willing to purchase a proprietary software services as 80 legs to crawl websites. Web crawling could replace screen scraping as a more reliable method of collecting the ratings data for firms. 80 legs allows for 10,000 free URL crawls, however for this study there were over 20,000 scrapes performed when harvesting the data, so it was out the scope for this study. Instead of relying on third party software, it was also preferable to have more control over the storage and harvesting of the data, which developing python scripts provided.

The analysis was performed using three separate programs: A Java program which allowed for the investment simulation, R to transform the raw data into statistical data and perform regression analysis and excel for high-level statistical analysis and graphing. These three
programs were each appropriate and the best fit for each job, however going forward, consolidating the functionality of the three technologies into one application would make analysing the results much less complex from a user perspective.

6.2 Evaluations of the Results
The aim of the analysis was to use the results to draw conclusions about the nature of the rating agencies and measuring their ability to predict prices. This was achieved by using a combination of the investment simulation to historically play out different investment strategies and using linear regression and correlation. The study found that the larger the negative correlation the more likely one was to be successful using the ratings as a guide to trading shares.

A secondary aim of this research was to design and develop a tool to simulate the average returns an investor would have made had they followed the recommendations of the rating agencies in question over the same period of time. The Java Investment Simulation achieves this aim

The study also concluded that by the measure of correlation based on the twenty one firms in the sample, over the four month period, Morningstar’s ratings would have been a far superior predictor of price movements to that of MSN Money’s.

The method of using correlation to test the success of rating agencies could be useful when determining historically the success of rating agencies. If an investor choose to trade using the ratings, the information of past ratings could be useful when trying to determine which rating agency’s guidance to follow. However one must always be wary about the uncertainties when using the past to predict the future.

A popular theory in finance developed in the 1930’s named the Elliott Wave Principle proposed that financial markets moved in cycles. If an investor could figure out which part of the cycle he/she was in, it would be possible to predict where the market would move by viewing past patterns and making sure they were correlated. The late 1980’s stock market had .90 correlation to that of the late 1920’s and this led some to believe that they were truly in the same cycle and the stock market crash of the 1929 along with the great depression were surely going to repeat itself in the late 1980’s. Of course the great depression did not repeat itself in the 1980’s, but many investors believed it would happen and as a result they bet the wrong way. It is not in exact science to use history to predict the future and similarly using rating agencies past ranking to check the validity of their future rankings carries the same risks as the Elliot Wave Principle.
6.3 Further Research

It would be interesting to run the test again for a longer time frame. Four months is a considerably long time in the stock market, however testing only one four month period in isolation could make the results of this study open to influence by other factors. If the data could be collected for a longer time, it would be possible to compare different periods against each other under different market conditions.

Another consideration for future work would be to add a larger and more varied sample of firms and Rating Agencies. This study was focused mainly on Rating Agencies and firms from the United States, so it could be worthwhile collecting the data from much smaller markets and from a much larger variety of countries.
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Appendix

MySQL: Open source relational database management system that runs as a server providing multi-user access to a number of databases.

Cron: Enables Linux users to schedule jobs to run periodically at certain times or dates.

PhpMyAdmin: Free and open source tool written in PHP intended to handle the administration of MySQL.

Python Libraries:

MySQLdb: An open source library allowing python to communicate with a MySQL database.

Time: An open source library, which allows for the generation of UNIX time stamps.

LXML: An open source library for the navigation of XML documents.

URLLib: An open source library, which allows for python to make http GET and POST requests.

BeautifulSoup: Allows for the less obscured display of page sources from web pages.

Regex: Enables efficient string parsing using Python.

JSON: Allows for the conversion of Unicode objects to JavaScript objects.
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