ACM40960: Projects in Maths Modelling

Literature Review

Social Media Sentiment Analysis to Understand Market Dynamics

Soujanya Hassan Prabhakar
22202225

Hrishita Bapuram
22204557

MSc. Data & Computational Science

Supervisor: Dr Sarp Akcay

UCD School of Mathematics & Statistics
University College Dublin

June 16, 2023

Table of Contents

1 Introduction 2

2 Social Media as a source of Market Sentiment 2

3 Sentiment Analysis in Financial Markets 3

4 Relationship between Market Sentiment, Volatility and Expected Returns: Methodical Approaches 4

5 Implications for Risk Management and Investment Strategies 5

6 Conclusion 6

1 Introduction

In recent years, Sentiment Analysis has emerged as a popular tool to gauge public opinion. In the advent of rampant social media communication across wide ranging platforms, it has allowed for a vast amount of subjective textual data, of which Twitter and Reddit are popular due to its real-time and vast user-generated content. Under proper analysis, it can be an invaluable new source of information. In the context of this project, we explore the application of sentiment analysis in evaluating the movement of popular stocks.

In market analysis, the ability to accurately predict market returns is important to gain an edge to maximise profits as well as mitigate risk. The purpose of this literature review is to examine existing research on using Sentiment Analysis from tweets to estimate market volatility and thereby future returns.

2 Social Media as a source of Market Sentiment

In the financial sector, Social Media has become a valuable source of data for sentiment research. A number of researches [1] have concentrated on using analysing headlines, captions and tweets to gauge market sentiment. In order to determine the sentiment polarity (positive, negative, or neutral), researchers have created sentiment classifiers trained on financial and non-financial tweets. These studies have produced encouraging findings, demonstrating the value of Social Media data in determining market mood.

3 Sentiment Analysis in Financial Markets

Analysis of Stock market returns has been an eon-old field of research, with multiple approaches evolving over time to accurately guess market-returns. Some of these include Fundamental and Technical Analysis, Time Series and Forecasting using traditional methods and machine learning approaches. [2] The use of Sentiment Analysis is a relatively new approach that uses unstructured textual data to extract public opinion. The idea vests in the understanding that public opinion drives market dynamics and a "negative" or "positive" sentiment could trigger a bearish or a bullish trend, as illustrated in the graphic below [3]

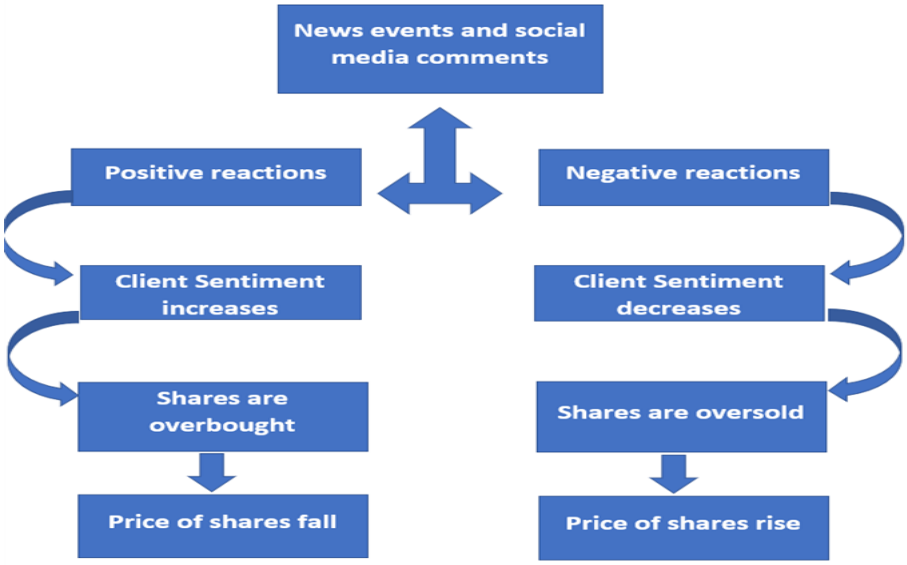

Figure 1: Source: DailyFX

Sentiment and Lexicon based analyses thus provide a novel, more direct approach to obtaining data that truly represents individual opinions. In light of this, there have been many case studies of use cases [2] as well as public data repositories on platforms like Kaggle and GitHub that have made clean and well-organised data more accessible for everyone to contribute to creating a more sophisticated model. [4] Additionally, there have also been approaches that enable a spectrum of sentiments [1] to be analysed as opposed to the more traditional positive and negative labels, enabling a more personalised model creation and thereby allowing for higher accuracy in predictions.

4 Relationship between Market Sentiment, Volatility and Expected Returns: Methodical Approaches

As established above, Sentiment Analysis can be an invaluable tool to quantify previously uncertain aspects of market dynamics with increased accuracy. As discussed previously, positive sentiment is typically linked to lower market volatility and better-anticipated returns, while negative sentiment is typically linked to higher volatility and poorer returns. A general model structure with different approaches has been adopted by previous studies, built around a common 3 step procedure [[5], fig. 1], as illustrated in the image below:

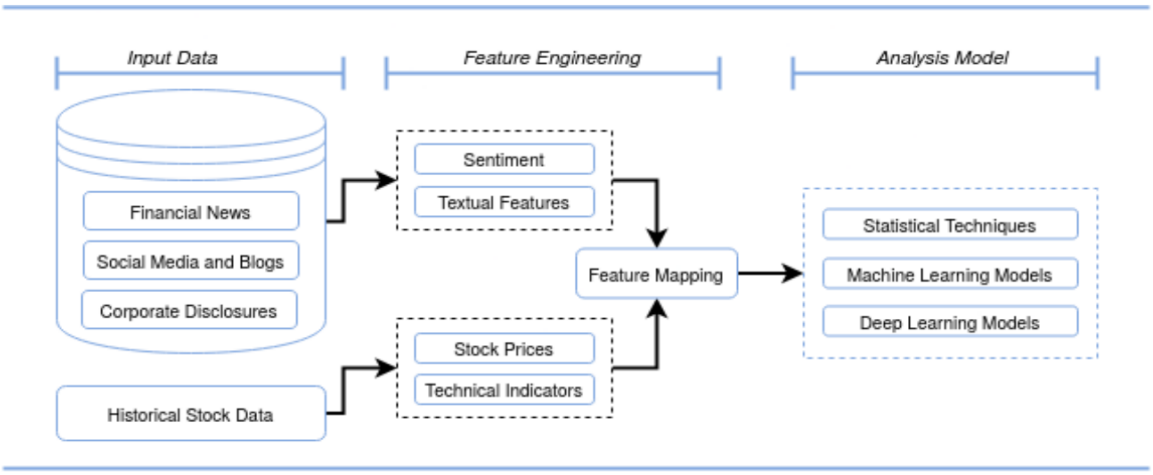

Figure 2: Source: arxiv.org

Additionally, Mehta et al. [6] explore the various algorithms employed at the analysis stage that involve the algorithm that considers public sentiment, opinions, news, and historical stock prices to forecast future stock prices using Support Vector Machines (SVMs), Multinomial Naive Bayes, Linear Regression as well as Recurrent Neural Networks using LSTM. Deveikyte et al [7] make the case for quantifying market volatility using Sentiment Analysis. In a model based on correlation analysis, VADER found that for the sentiment found in Twitter comments, there was a correlation coefficient of –0.7 ($p < 0.05$), which indicates a strong negative correlation between the negative sentiment captured from the tweets on a given day and the volatility observed the next day. The same model achieved a prediction accuracy of 63%.

Numerous analytical techniques are covered in the literature for analysing sentiment from Twitter data and news headlines, and their effects on market outcomes. To extract sentiment and look into its predictive power, researchers have used statistical models, sentiment lexicons, and machine learning algorithms. The necessity for precise sentiment labelling, data noise, and the dynamic nature of sentiment are still major problems. Furthermore, careful evaluation is required due to the biases in online comment channels and the low generalizability of results across other markets and time periods.

5 Implications for Risk Management and Investment Strategies

The ability to accurately evaluate public sentiment has significant implications for Risk and Portfolio management as well as for developing Investment strategies. Analysis of how sensitive a particular publicly traded stock is by itself or in a portfolio can be useful in stress-testing scenarios where the company or fund manager can devise ways to combat potential vulnerabilities to minimise risk. Additionally, preempting market behaviour can enable overall preparedness among investors, bankers, and other stakeholders, thereby avoiding the creation of bubbles that may potentially lead to financial disasters akin to those in 2001 and 2008.

An investor's ability to make informed judgments, control portfolio risk, and create trading strategies can all be aided by the timely detection of sentiment changes. Sentiment analysis can be incorporated into risk models and trading algorithms to improve performance and seize market opportunities.

6 Conclusion

This literature review highlights the growing interest in applying sentiment analysis from Twitter tweets (and news headlines) to assess market sentiment, forecast market volatility, and estimate expected returns. The papers under consideration show how sentiment analysis can be used to understand market dynamics and the consequences for risk management and investment plans. Even if there are still issues and limitations, more research in this area can help us comprehend the connections between investor behaviour, market results, and sentiment better.

Our project is structured around a similar idea and aims to construct a model with the following tentative structure:

- **Sentiment Analysis**: To derive for a given day in the studied time duration, the polarity of public sentiment (either in 2 classes or more) using data from a suitable social media platform (Either Twitter or Reddit)
- **Analysing recurrent patterns in the relationship between market sentiment and stock movement**: To evaluate if the highs and lows of stock movement can be attributed to a sequence/pattern of market sentiment outcomes
- **Constructing a prediction model for predicting stock returns/ prices**: Ideally using a Recurrent Neural Network with sentiment data and stock prices for the given time duration
- **Explore expansion of model into a stress testing simulator**: Pending viability, to construct a primitive stress-testing model to simulate various market sentiment scenarios and evaluate the sensitivity of the stock price to the volatility of the same.

References

1. Bollen, J., Mao, H. & Zeng, X. Twitter mood predicts the stock market. *Journal of Computational Science* **2,** 1–8. ISSN: 1877-7503. https://www.sciencedirect.com/science/article/pii/S187775031100007X (2011).
2. Carosia, A. E. O., Coelho, G. P. & Silva, A. E. A. Analyzing the Brazilian Financial Market through Portuguese Sentiment Analysis in Social Media. *Applied Artificial Intelligence* **34,** 1–19. eprint: https://doi.org/10.1080/08839514.2019.1673037. https://doi.org/10.1080/08839514.2019.1673037 (2020).
3. Costa, T. D. *Using sentiment analysis to examine stocks* 2020. https://www.dailyfx.com/education/understanding-the-stock-market/stock-market-sentiment-analysis.html.
4. https://www.kaggle.com/datasets?search=sentiment+analysis.
5. Fataliyev, K., Chivukula, A., Prasad, M. & Liu, W. *Stock Market Analysis with Text Data: A Review* 2021. arXiv: 2106.12985 [q-fin.ST].
6. *Harvesting social media sentiment analysis to enhance stock market prediction using deep learning* https://peerj.com/articles/cs-476/.
7. Deveikyte, J., Geman, H., Piccari, C. & Provetti, A. A sentiment analysis approach to the prediction of market volatility. *Frontiers in Artificial Intelligence* **5.** ISSN: 2624-8212. https://www.frontiersin.org/articles/10.3389/frai.2022.836809 (2022).