Research Report

Investor Attention and Algorithmic Decision Making in Financial Markets

ALGORITHMIC DECISION MAKING PLAYS AN IMPORTANT ROLE IN FINANCIAL MARKETS. ONE SOURCE OF INFORMATION FOR SUCH ALGORITHMS IS THE SENTIMENT OF SOCIAL MEDIA MESSAGES AND NEWS ARTICLES CONCERNING A LISTED COMPANY. YET, CURRENT TOOLS DO NOT DISTINGUISH BETWEEN POPULAR AND LESS POPULAR NEWS AND IT IS UNCLEAR WHETHER METHODOLOGIES BASED ON DATA ANALYTICS CAN BE APPLIED ON SMALL DATASETS OF LESS POPULAR COMPANIES. THEREFORE, WE ANALYZE WHETHER THE IMPACT OF MEDIA SENTIMENT ON FINANCIAL MARKETS IS INFLUENCED BY TWO LEVELS OF INVESTOR ATTENTION AND WHETHER THIS IMPACTS ALGORITHMIC DECISION MAKING.

Benjamin Clapham Michael Siering

Peter Gomber

Introduction

Due to the massive data volumes generated in today's high-frequent financial markets, algorithmic decision making and decision support systems (DSS) have become indispensable in this business domain. Market participants process new information within very short periods of time and immediately trade on this information. For that purpose, investors and traders employ tools to automatically analyze comprehensive data sources to reach favorable investment decisions.

In particular, the sentiment expressed within financial news and within social media, such as Twitter, has been investigated concerning its relationship to capital market reactions and, consequently, concerning its applicability as an input variable for financial decision support systems (Tetlock, 2007; Bollen et al., 2011). However, one prerequisite for the impact of sentiment expressed in any type of message is that the communicated message itself has to be noticed by a large enough number of market participants, i.e., investor attention is required (Barber and Odean, 2008).

Investor attention is caused by two reasons: First, sentiment can be expressed within a popular news item, which is shared and commented intensively in social media and referred to by various traditional websites. Second, the respective message or news item can relate to a large, well-known company that is targeted by a larger number of analysts, investors, and traders.

Previous studies proposing DSS have mainly analyzed blue chip companies or media sentiment regarding news items for larger companies (e.g., Schumaker and Chen, 2009). Therefore, until now, it is unknown whether related methodologies as well as the derived trading strategies can also be applied in data settings with fewer observations and less popular news items and companies.

We investigate whether these two levels of investor attention influence the impact of sentiment on financial markets and whether they should be incorporated within algorithmic trading strategies. Furthermore, we investigate whether our proposed algorithmic trading strategies outperform a baseline strategy and, consequently, whether a respective DSS can also be applied in case of smaller companies with lower media coverage and less investor attention.

Research Model

We hypothesize, test, and confirm that sentiment information based on social and traditional online media has an impact on stock returns as several academic studies have already shown (Bollen et al., 2011). Moreover, research on investor attention suggests that investors mainly react to prominent news and that they especially trade on important information. Previous studies on media sentiment have not accounted for this. Therefore, we enrich the sentiment score of a social media message or news item with its popularity score.

The popularity of a news item is based on the number of reactions that it generates. It approximates investor attention since a higher number of user interactions in social media and more references on other websites increase the reach of the sentiment conveyed by a message. Consequently, more investors are aware of that particular news item and may trade on its sentiment leading to a stock market reaction. Therefore, we hypothesize that investor attention measured by news popularity has a moderating effect on the influence of news sentiment on stock returns, which holds for both social media (*H1a*) and traditional online media (*H1b*). This means that the sentiment of messages and news which are highly popular, i.e., are shared and commented intensively and, thus, achieve high investor attention, has a stronger impact on stock returns than sentiment expressed in less popular and, thus, less relevant news items.

Moreover, larger corporations tend to be better known to investors and financial analysts publish more news articles related to these companies than articles related to smaller firms. Drawing again on investor attention

theory, sentiment information related to small firms, which are accompanied by lower media coverage and, thus, tend to be less known to a broader investor audience, should have a lower impact on stock returns than the sentiment of messages and news concerning large firms. Consequently, we hypothesize that investor attention on a corporate level has a moderating effect on the impact of social (*H2a*) and traditional online media (*H2b*) sentiment on stock returns, and should, thus, be taken into account in DSS design (see Figure 1).

Additionally, we perform a trading simulation and test trading strategies considering sentiment and investor attention against a simple buy-and-hold strategy. Since we propose that investor attention regarding company-related traditional online news and social media messages moderates the impact of sentiment on stock market reactions, automated investment decisions based on sentiment and news popularity information should outperform trading strategies that only trade on sentiment information. Specifically, strategies following both variables should only trade on relevant information, thereby, leading to higher returns compared to basic sentiment strategies.

Empirical Results

Our analysis (Clapham et al., 2019) is based on 58,517 company-related messages in total (online financial news and social media messages from Twitter and Facebook) as well as stock market parameters gathered from July 1st, 2014, to June 30th, 2015, for 40 listed German companies. These companies are randomly selected from different size categories according to market capitalization in order to cover companies with differing popularity.

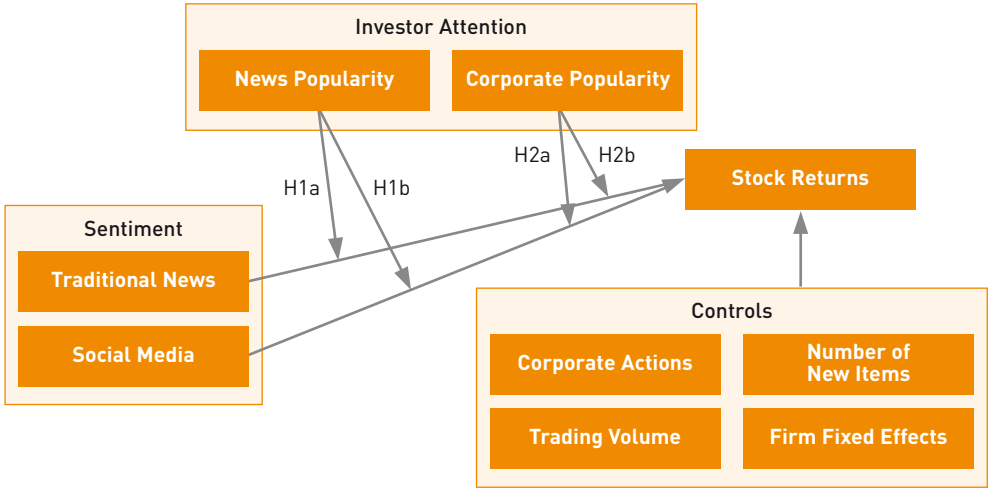

Figure 1: Research Model: Impact of Sentiment and Investor Attention on Stock Returns

For the whole sample, social and traditional online media sentiment as well as the corresponding news popularity representing investor attention can be used to explain abnormal daily returns. Thus, they should not be neglected within algorithmic decision-making strategies. Specifically, the interaction term of sentiment and news popularity, which accounts for the moderating effect of news popularity, is significant for the whole sample. The sentiment variable alone, however, is not significant. Therefore, hypotheses *H1a* and *H1b* are confirmed as this effect prevails both for social media messages and news items on traditional news websites.

To investigate whether the results also prevail for companies with low investor attention, we repeat the analysis on the subsets of the largest and smallest ten companies in our sample as measured by market capitalization. For large companies, sentiment expressed in popular messages and news items in social as well as traditional online media is significantly related to abnormal stock returns. In case of small companies, however, the interaction term of sentiment and popularity is only significant for social media and not for traditional news websites.

Therefore, algorithmic decision-making based on sentiment and investor attention measured by news popularity needs a careful configuration to the respective context as the variables to be taken into account depend on the size of a company and the accompanying media coverage. Consequently, low investor attention on a corporate level leads to a lower impact of social and traditional online media sentiment on stock returns, which supports hypotheses *H2a* and *H2b*.

DSS Configuration and Trading Simulation

In order to assess the economic relevance of considering investor attention measured by news popularity for algorithms that trade on media sentiment, we propose a DSS configuration. We apply a trading simulation to evaluate the developed prototype incorporating media sentiment and popularity information. We develop three different trading strategies, test them against a simple buy-and-hold strategy, and vary the critical thresholds of sentiment and popularity that trigger actual investment decisions in a sensitivity analysis.

The three trading strategies are defined as follows: In the *basic news trading strategy*, investment decisions are based solely on sentiment information. The two *advanced news trading strategies* also consider the change in investor attention, i.e., the change in popularity regarding the news about a specific company on a given day. Strategy *advanced news trading I* considers news popularity for opening a position whereas the *advanced news trading II* strategy applies popularity thresholds besides sentiment information for both opening and closing a position.

Trading Strategy	Return (in %) (improvement to buy-and-hold)	Holding Period (in days)	Transactions (thereof short)
Buy-and-Hold	**-1.23** (n.a.)	**251**	**40** (0)
Basic News Trading	**-0.19** (1.04)	**1.2**	**485** (145)
Advanced News Trading I	**1.14** (2.37)	**1.2**	**215** (71)
Advanced News Trading II	**4.12** (5.35)	**6.0**	**186** (62)

Table 1: Results of the Trading Simulation

Our results show that all three news trading strategies based on media sentiment outperform the simple buy-and-hold strategy (see Table 1). Moreover, the *advanced news trading* strategies, which also consider news popularity besides sentiment information and, thus, account for investor attention, achieve higher abnormal returns than the *basic news trading* strategy. Particularly the advanced news trading II strategy, which considers news popularity for both opening and closing a position, achieves the highest return. Consequently, considering both sentiment and popularity for DSS trading on news and social media messages is economically valuable. This result also holds when varying the critical thresholds of sentiment and popularity for buying or selling a stock.

However, when differentiating between large and small companies, the positive results of our trading strategies based on sentiment and popularity are less distinct. While the strategies lead to high abnormal daily returns in case of small companies, relying on daily returns is not fast enough in case of large, well-known companies. When trading these companies, algorithms have to react considerably faster, i.e., during the trading day, to generate abnormal returns based on media sentiment. For smaller companies with lower investor attention, investors can benefit from day-to-day decisions drawing on media sentiment and news popularity as shown with our proposed DSS.

Conclusion

DSS are subject to intensive investigations in finance and information systems research and play an important role in today's financial markets. Many studies have shown that the sentiment of news articles and social media messages influences the stock prices of companies mentioned in these posts. Moreover, algorithmic trading engines already make use of this information to improve their trading decisions. Yet, the impact of investor attention on the influence of media sentiment on stock returns remains unclear.

Our study shows that configurations of trading algorithms should account for both the popularity of news items and the popularity of the respective companies to control for investor attention. Specifically, advanced news trading strategies that determine investment decisions based on sentiment and investor attention measured by news popularity generate significantly higher returns than benchmark strategies.

We show that investor attention has an influence on the impact of sentiment on financial markets on two levels: First, we find that, at a news item level, the impact of sentiment on stock returns is stronger for popular news items, i.e., news with high investor attention.

Second, at a corporate level, the impact of sentiment in case of larger companies with high investor attention is stronger. Nevertheless, our trading simulation – that analyses daily returns – also shows that this impact can be rather exploited in case of smaller companies as a comparably lower number of investors targets these companies so that stock prices react slower to news announcements.

References

Barber, B. M.; Odean, T.:
All That Glitters: The Effect of Attention and News on the Buying Behavior of Individual and Institutional Investors.
In: Review of Financial Studies, 21 (2008) 2, pp. 785–818.

Bollen, J.; Mao, H.; Zeng, X.:
Twitter Mood Predicts the Stock Market.
In: Journal of Computational Science, 2 (2011) 1, pp. 1–8.

Clapham, B.; Siering, M.; Gomber, P.:
Popular News Are Relevant News! How Investor Attention Affects Algorithmic Decision-Making and Decision Support in Financial Markets.
Forthcoming in: Information Systems Frontiers (2019).

Schumaker, R. P.; Chen, H.:
Textual Analysis of Stock Market Prediction Using Breaking Financial News.
In: ACM Transactions on Information Systems, 27 (2009) 2, pp. 1–19.

Tetlock, P. C.:
Giving Content to Investor Sentiment: The Role of Media in the Stock Market.
In: The Journal of Finance, 62 (2007) 3, pp. 1139–1168.