



Full length article

## Diurnal rhythms in investor sentiment

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### ABSTRACT

I use data from a large social network to assess the diurnal stability of investors' collective valuation of financial assets. Employing user-assigned valuation indicators attached to time-stamped messages, I show that investors' sentiment towards assets, which is fairly constant during most of the day, dips markedly and regularly in the morning. When looking at messages posted by different subsamples of users, I find that both level and variability of investor sentiment decrease with trading experience. Not only are more experienced investors as a group less optimistic than novice investors, their valuations are also substantially less variable over the course of the day. The findings provide empirical support for assumptions and results that feature prominently in theoretical and empirical descriptions of investor behavior.

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## 1. Introduction

When asked for the value of a financial asset at different times of the day, investors should – unless new information arrives – provide the same response. A firm's prospects in the morning are, *ceteris paribus*, of course, very much the same as in the evening. The results in this paper indicate that investors as a collective seem to disagree. Instead, I find that the average valuation of financial assets varies substantially and systematically with the time of the day. In addition, I find that the magnitude of this variation interacts strongly with investor characteristics deemed relevant in theoretical work on investor sentiment.

Beliefs and preferences play central parts in asset pricing models. Yet, empirical research questions the stability of both constructs as well as their invariance to seemingly irrelevant external factors. For one, the extensive literature on investor sentiment suggests that much of the variation in beliefs is “not justified by the facts at hand” (Baker and Wurgler, 2007, p. 129). Instead, beliefs seem to respond to events with little to no economic relevance like

the weather (Saunders, 1993; Hirshleifer and Shumway, 2003; Kamstra et al., 2003; Kaplanski et al., 2014) or sports results (Edmans et al., 2007). What is more, recent research suggests that the instability in beliefs is to some degree systematic and indicative of variation in decision processes (Drerup et al., 2014). Second, findings in psychology suggest that the perception of risk responds to variation in emotional states (Johnson and Tversky, 1983). Happy and unhappy people, for example, seem to perceive risky situations differently. Finally, emotional states, i.e., the factors that seem to cause much of the instability in beliefs and preferences, tend to follow diurnal rhythms. Mood in particular, arguably a major determinant of variation in investor sentiment (Nofsinger, 2005), varies predictably throughout the day (Stone et al., 1996, 2006).

In this paper, I take these observations as my point of departure to establish whether similar patterns exist in collective investor sentiment. To this end, I work with messages posted in a large social network with exclusive focus on financial markets. Two features make the network ideally suited for my analyses. First, users can flag their messages as “bullish” or “bearish”. This allows me to construct a simple and unambiguous sentiment indicator. Second, the dataset covers more than 7.5 million time-stamped

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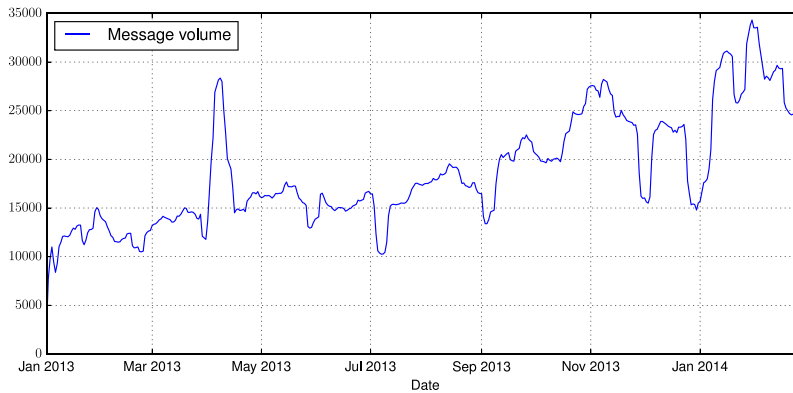


Fig. 1. Daily message volume (7 day moving average).

messages over a 14-month period, enabling me to paint a fine-grained picture of collective sentiment over the course of the day. I find that investor sentiment is fairly stable during about three quarters of the day. Each day, however, the collective sentiment deteriorates substantially for several hours in the morning, suggesting that sentiment indeed exhibits regular diurnal patterns.

Theoretical work on sentiment often invokes one investor group whose valuations are comparably volatile. Typically, this group comprises less sophisticated investors (e.g., De Long et al., 1990). The data I work with allows me to shed some light on the empirical validity of this assumption. A large fraction of the users in the dataset provides a self-description that includes among other things the own level of trading experience. I find that investors who report larger levels of trading experience are less optimistic than novice investors and, supporting the above narrative, at the same time their collective sentiment is far less variable in time.

Section 2 presents data, method, and descriptive statistics. Section 3 provides the main results, including a set of robustness checks and additional findings. I conclude and discuss the findings in Section 4.

## 2. Data

### 2.1. Data source—StockTwits.com

I work with data from StockTwits.com, a free social network that exclusively focuses on financial markets.<sup>1</sup> StockTwits was founded in 2008 and has grown to more than 300,000 investors. The platform derives its modus operandi and name from Twitter. Its users communicate by posting messages no more than 140 characters in length to discuss a range of financial topics, from issues pertaining to specific firms to the stock market as a whole. My dataset comprises approximately 7.5 million messages posted by more than 50,000 distinct users between January 2013 and

February 2014.<sup>2</sup> Fig. 1 gives an impression of the growth in the average daily message volume during my sample period. Throughout, I restrict my analyses to messages posted on workdays and relegate an analysis of weekends to Appendix A.1.

My analyses use several data points associated with each message. The following shows a stylized example of a hypothetical message posted on StockTwits.com:

Date	12/04/2013
Time	12 : 30 : 21
UserID	8219
UserExperience	Professional
Message	Plenty of upside. Day will end strong.
Sentiment	Bullish
....	

Each observation contains the date and time on which the message was posted, exact to the second and expressed in Eastern time. In addition, I know who posted a message as well as how the user describes her or his own trading experience (“Novice”, “Intermediate”, or “Professional”). Further, I know the full text of the message. Finally and most importantly, I know whether a user classified a message as an optimistic, pessimistic, or neutral opinion (“Bullish”, “Bearish”, or neither). This facilitates my analysis immensely as it frees me from the burden of having to classify messages by their content. As part of my results, I show that using simple word counts based on the text within a message performs poorly at capturing the users’ own sentiment classifications. While I do have access to a number of further data points, the previous variables form the basis of my main analyses. In case I make use of additional variables, I introduce them along the way.

### 2.2. Variable construction

To construct my main variable, I employ a two-fold aggregation procedure. The first step of this procedure aggregates all messages into equally spaced 1-h intervals.

<sup>1</sup> Data from StockTwits.com has been used in a variety of research settings, typically employing it as a means to assess market sentiment (e.g., Oliveira et al., 2013; Giannini et al., 2015a,b). At stocktwits.com/developers/docs/research, StockTwits maintains a list of papers working with its data.

<sup>2</sup> I also have messages dating back to September 2009. However, since the feature I rely on most was introduced in mid 2012 only, I discarded these messages.

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