

# THE IMPACT OF ECONOMIC AGENTS PERCEPTIONS ON STOCK PRICE VOLATILITY

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## Abstract

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This paper studies perceptions of economic subjects and its impact on stock prices. Perceptions are represented by stock market indexes and Facebook activity. The contribution of this paper is twofold. In the first place, this paper analyzes the unique data of Facebook activity and proposes the methodology for employment of social networks as a proxy variable which represents the perceptions of information in society related to the specific company. The second contribution is the proposal of potential link between social network principles and theories of behavioral economics. Overall, the author finds the negative impact of Facebook activity on stock prices and the positive impact of stock market indices. The author points the implications of findings to protection of company reputation and to investment strategy based on the existence of undervalued stocks.

Keywords: perceptions of economic subjects, Facebook activity, social networks, overreaction on negative news

## INTRODUCTION

The research in the field of stock price volatility generally agrees that the primary determinants of stock movements are news and information. Source, type and content of information is important with significant impact on advanced (Suk-Joong *et al.*, 2003) and emerging (Andritzky *et al.*, 2007) markets. Nikkinen & Sahlstrom (2003) show the differences in the impact of foreign news, especially from US economy in comparison with the domestic news. The impact of information and news changes in different levels of business cycle (McQueen & Roley, 1993) or in periods of crisis (Schwert, 2002, 2011). The qualitative content of information is significant as well. The impact of positive and negative news is analyzed by Hanousek *et al.* (2008) or Ěgert & Kočenda (2012). Capital markets and stocks reflect information and news in prices. The mainstream economic theory based on assumptions of neoclassic and new macroeconomic theory, such as the existence of “*Homo economicus*” with rational expectations brought a hypothesis of efficient markets. According to this theory, stock

prices reflect all available information (Fama, 1970, 1991) and volatility of stock prices can be described by random walk behavior because formation of news is random and unexpected (Malkiel, 2003). However, the empirical observations of stock prices show excess volatility and anomalies like herding behavior or “fashion movements” (Shiller, 1984, 1995) together with existence of short term comovements in capital markets (Lo & MacKinley, 1999; Malkiel, 2003). These observations are not explained by the efficient market hypothesis successfully. In this situation, behavioral economics and finance argue with the idea of economic subject who possess bounded rationality (Stanovich & West, 2000), employs heuristic (Kahneman & Tversky, 1974; Kahneman, 2002) and emotions (Damasio, 1998; Leowenstein *et al.*, 2001) in decision making at risk and uncertainty. The existence of human being and not the rational individual can explain the “irrationality” in the short term behavior of capital markets. However, this research is largely theoretical and subjective because the objective research in the area of perceptions of economic agents is data costly.

Previous research shows “macro” analysis of society’s behavior and its impact on stock prices based on the data of stock market indices. Benjamin King (1966) shows that stock prices reflect 50% of S&P 500 volatility and similar results are shown by Meyers (1972) or Roll (1992). This paper employs stock market indices as well because they can be considered as the indicator of current market and economy conditions. The novelty of this paper is the employment of social media data as a proxy for perceptions of economic subjects. Due to technological progress, there is a new phenomenon in our society called social media or web communities like Facebook and Twitter. These networks can be considered as databases of human behavior. The author sees web social communities as a “mirror” of society. The employment of social media data can be beneficial. Nofsinger (2005) defines the economy as a complex social system of human interactions. Humans are not “*Homo economicus*” who always maximize utility individually, but they are part of the social system where behavior of others can be very influential (Nofsinger, 2005). According to the “*Socionomic hypothesis*” there is a relationship between social mood and behavior of society (Prechter, 1999, 2003). The current emotions and mood wide-spread in population can have economic consequences and impact on capital markets or stock prices (Nofsinger, 2005). The existence of social networks brings great opportunity to study perceptions of news and information in society and its impact on stock price volatility. This paper studies behavior of economic subjects proxied by data of US stock indexes (Nasdaq, NYSE, Dow Jones, S&P 500) and by Facebook activity (likes and comments of users). A similar study was accomplished by Bollen *et al.* (2011) who study social mood collected on Twitter as a predictive tool for the Dow Jones index. In addition, Sprenger & Welp (2011) hypothesize about the Twitter stock forums as a source of information for retail investors. Both studies show the positive relationship. Twitter mood can improve the prediction of Dow Jones index and good news lead to stock price growth. The main contribution of this paper is the empirical and quantitative Facebook data analysis. Author proposes the methodology, data transformation and econometric methods necessary for the identification of the relationship between perceptions of news and stock prices. The results of empirical analysis are directed to investment strategy and to the protection of a company’s image. The contribution in economic theory is the proposal of the link between social network theories and behavioral economics.

## MATERIAL AND METHODS

### Data

This paper quantifies a relationship between stock prices of 14 companies<sup>1</sup> and perceptions of economic subjects tracked by US stock indexes and Facebook activity during the period from 25<sup>th</sup> of February till 13<sup>th</sup> of December 2013. The dependent variable *Stock* represents a time series of stock prices expressed in daily, closed values in US dollars for 14 companies. Facebook activity is represented by variable *Like* and *Talking about* (*Talk*). Both variables are expressed in units described as the cumulated sum for last 7 days to specific date. For example, the present value of *Like* or *Talk* is the cumulated sum of users’ activity during the last 7 days from today. Facebook data were collected from each company’s Facebook profile by algorithm. It is important to keep in mind that the time series of variables *Like* and *Talk* represents only the quantity of users’ activity nor the quality. However, in the reality variable *Like* express a positive preference of users and variable *Talk* can represent a positive or negative comment of users. Variables of stock indices are Dow Jones Industrial Average (*Dow*), New York Stock Exchange (*Nyse*), Nasdaq Composite (*Nasdaq*) and S&P 500 (*S&P*) expressed in daily closed values (basis points). The model also includes 43 dummy variables ( $D_1, \dots, D_{43}$ ) because studied period has 43 weeks. Time dummies represent the unobserved time effects. Original data are expressed in different time units. Homogenous time structure was accomplished by the following steps. The author adjusted time structure of stocks and stock indices variable according to the variables of Facebook activity. Missing observations for stocks and stock indices during weekends and holiday were calculated by linear interpolation. Further, daily, closed values of stocks and stock indices were modified as 7 days cumulations with regard to specific day. All variables are in the form of first differences. Standard data modifications as seasonality or inflation adjustments were not considered because of analysis in the short run time period, approximately 10 months.

## METHODOLOGY

The first part of the methodology is devoted to the basic relationship between variables. It is estimated with a linear model expressed in the panel structure with fixed effects. Fixed effects model has been applied due to analysis of individual companies in time. The general model can be presented as:

$$Y_{it} = \alpha_i + \beta X'_{it} + \varepsilon_{it};$$

$$i = 1, \dots, N; t = 1, \dots, T; \varepsilon_{it} \sim i.i.d. (0; \sigma^2_{\varepsilon});$$

1 Amazon, Apple, At&t, Bank of America, Citi Bank, Coca-Cola, General Electric, Google, Hewlett Packard, Intel, Johnson & Johnson, McDonald’s, Walmart, Toyota

where

$Y_{it}$ .... dependent variable defined for individual  $i$  in time  $t$ ,

$\alpha_i$ .... a random variable which represents unobserved heterogeneity (fixed effects) for observation  $i$ ,

$\beta$ .....estimated vector of coefficients in  $1 \times K$  dimension,

$X'_{it}$ ....regressor  $i$  in time  $t$  and

$\varepsilon_{it}$ .....an error term expressed as unobserved random variable uncorrelated with observed regressor  $X'$  with identical normal distribution (Cameron & Trivedi, 2005).

The second model in the paper estimates the impact of Facebook activity during states of growth and decrease in Facebook activity. The model of Markow switching regimes is employed for that objective (Hamilton, 1994). The simple Markow switching model can be presented as:

$$y_t = \mu_1 + \varepsilon_t \quad \varepsilon_t \sim (0; \sigma_1^2) \text{ State 1;}$$

$$y_t = \mu_2 + \varepsilon_t \quad \varepsilon_t \sim (0; \sigma_2^2) \text{ State 2.}$$

This representation clearly implies the existence of two different processes for the dependent variable  $y$ . When the state of the world for the time  $t$  is 1 (2) then the expectation of the dependent variable is  $\mu_1$  ( $\mu_2$ ) and the volatility is  $\sigma_1^2$  ( $\sigma_2^2$ ) (Perlin, 2012, p. 5). This paper works with the existence of deterministic transition of states. States of growth and decrease are observed because they are captured by dummy variable. The application of dummy variable in the model can be generally defined as:

$$y_t = D_t(\mu_1 + \varepsilon_{1,t}) + (1 - D_t)(\mu_2 + \varepsilon_{2,t}).$$

State 1 is true ( $D_t = 1$ ) for time  $t$  when the exogenous variable is positive<sup>2</sup> and State 2 ( $D_t = 0$ ) otherwise.

## RESULTS

### Basic Model

The basic model represents the results of within regression. Results in Tab. I. include only statistically significant variables.

Tab. I indicates the negative impact ( $p = 0.028$ ) of Facebook activity expressed in comments of users on stock prices. Variable *Talking about (Talk)* represents the quantity nor the quality of users' activity. Therefore, one can assume that with increasing activity of users, comments are predominantly negative or negative comments have a bolder impact. This result is supported by widespread research in behavioral economics and finance based on the prospect theory and loss aversion which show an overreaction on negative news or feelings in comparison with the positive ones (Kahneman & Tversky, 1979, 1991; Bondt & Thaler, 1985; Chan, 2003; Soroka, 2006). The relationship between stocks and stock indices Nasdaq ( $p = 0.000$ ) and Dow Jones ( $p = 0.000$ ) is according to the model positive and more significant in comparison to Facebook activity. This situation can be explained by standard models of finance like CAPM where stock index represents the market and its impact is dominant. Another argumentation is based on the existence of unconventional monetary policy like quantitative easing during the studied period where new liquidity and lower systematic risk cause the increasing investments in stock markets (Joyce

#### I: Within regression

$$Stock_{it} = f(Like_{it} + Talk_{it} + Nasdaq_{it} + Dow_{it} + Nyse_{it} + S \& P_{it} + D_1 + \dots + D_{43})$$

Number of observation = 4129

Number of groups = 14

$R^2 = 0.20$

$F(12.4103) = 86.56$ ; Prob > F = 0.000\*\*\*

Stock	Coef.	SE	t-test	p-value	95% interval	
Talk	-0.001	0.001	-2.19	0.028**	-0.002	-0.000
Nasdaq	0.415	0.045	9.22	0.000***	0.327	0.504
Dow	0.467	0.052	8.83	0.000***	0.363	0.504
D2	0.001	0.001	2.84	0.005***	2.17e	-0.000
D3	0.001	0.001	1.97	0.049***	0.000	0.504
D4	0.001	0.001	2.56	0.010**	0.000	0.571
D9	0.001	0.001	2.73	0.006***	0.000	0.002
D13	0.001	0.001	2.16	0.031**	0.001	0.002
D35	0.002	0.001	3.39	0.001***	0.000	0.002
D36	0.001	0.001	6.46	0.000***	0.000	0.003
D37	0.001	0.001	2.76	0.006***	0.000	0.002
D38	0.001	0.001	2.01	0.044**	0.000	0.001
cons	-0.001	0.001	-2.05	0.041**	-0.001	-6.25e

2 Facebook activity increases

*et al.*, 2010; Blinder, 2010; Fawley & Neely, 2013). Dummy variables express the positive impacts of events in specific weeks during the analyzed period. Especially during the end of February and the beginning of March and later at the end of the analyzed period during the November and December. The short investigation at blogs related to financial markets shows the existence of positive news about historical maximums of indices Nasdaq, Dow Jones, S & P 500 during these months. (BBC, 2014; Reuters, 2014; Zacks, 2014). These results can be explained by *Socionomic hypothesis* (Prechter, 1999, 2003) and spillovers of positive mood from capital markets to society.

### Markow Switching Model

The estimates of the Markow switching model are presented in Tab. II. and Fig. 1.

According to the model probabilities, the model suggests that State 1  $p(s_t = 1/s_{t-1} = 1) = 0.96$  is slightly more persistent than State 2  $p(s_t = 2/s_{t-1} = 2) = 0.91$ . Probabilities expressed in the average duration of each state shows the duration for State 1 is 27.21 time period and duration for State 2 is 11.53 time period, respectively. The State 2 is shorter, but variance ( $p = 0.00$ ) and impact ( $p = 0.00$ ) is greater in comparison with State 1. This result indicates the overreaction on negative news and higher stock price volatility in case of decrease in Facebook activity.

### DISCUSSION

The author estimated the impact of economic subject perceptions tracked by stock market indices and Facebook activity on stock prices. The positive impact (an existence of positive mood)

II: Estimates of Markow switching model

State		Coef.	SE	p-value
State 1	$\mu_1$	0.0008	0.0004	0.06*
	$\mu_2$	-0.0012	0.0019	0.52
	$\sigma_1$	0.0006	0.0000	0.00***
State 2	$\mu_1$	0.0008	0.0007	0.23
	$\mu_2$	-0.0077	0.0026	0.00***
	$\sigma_2$	0.0048	0.0000	0.00***
		State 1	State 2	
State 1		0.96	0.09	
State 2		0.04	0.91	

The expected duration of State 1: 27.21

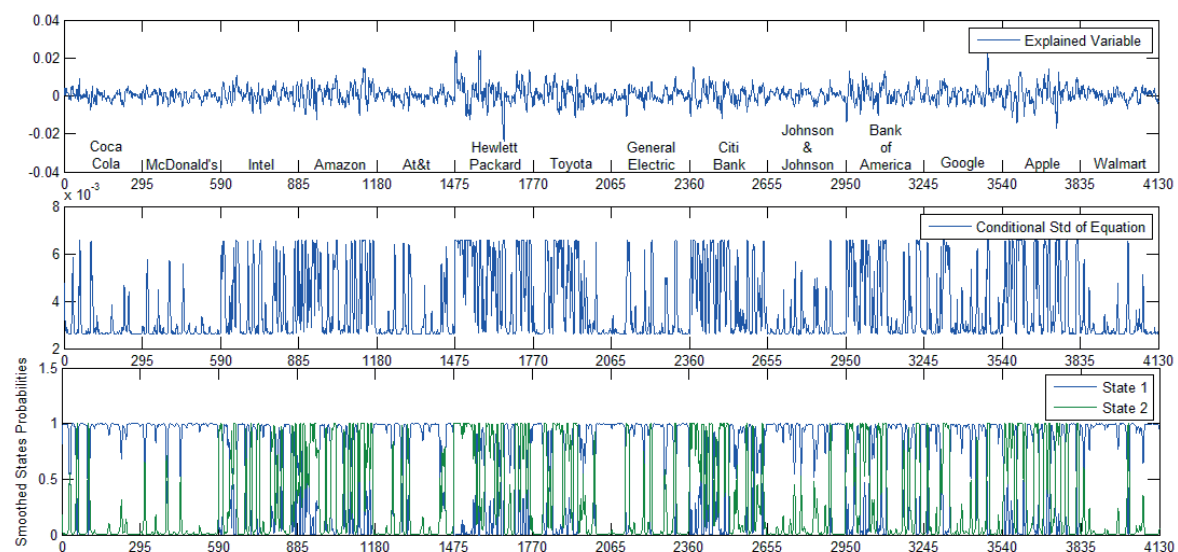
The expected duration of State 2: 11.53

AIC: -3.4837e + 004

BIC: -3.4786e + 004

Log Likelihood: 17 426.40

Note: Significance level 1% (\*\*\*), 10% (\*)



1: Estimates of Markow switching model – Graphical presentation



of stock markets on stock prices is consistent with models like CAPM or studies about the positive effects of quantitative easing in the balance sheet channel of monetary policy, where one part of the channel is the stock market. Spillovers of positive mood from stock markets to society can be explained also by dummy variables. Web sites related to stock markets are full of positive news about growth of stock indices. The incentive for the further research in the area of stock indices is a current taper in quantitative easing. This situation raises the question if perceptions of economic subjects are negative because of higher systemic risk or positive because of better conditions in the economy. The negative impact of Facebook activity is in the contrast with two most similar studies of Bollen *et al.* (2011) and Sprenger & Welp (2011) which indicate the positive impact of news tracked by Twitter on stock prices and stock markets. The impact of negative news indicated by this paper is supported by rich research, but author analyzed only quantity of comments. Therefore, this is the incentive for further research to analyze quality (positive, negative activity). The negative impact of

Facebook activity presents important implications for a company's image. In such a case, marketing department should act deliberately and decrease the impact of negative posts which can lead to drop in stock price. However, this objective can be difficult to accomplish. The negative perceptions of specific information do not need to be rational, users can behave emotionally and negative comment of one user can later become the opinion of the crowd. Shiller (1995) indicates the irrationality of herding behavior and Granovetter (1978) or Burt (1985) propose the model of collective behavior in social systems. On the other side, stock price decrease caused by an overreaction of investors on negative news can be an interesting investment opportunity for purchase of undervalued stocks with the potential for further growth. The investment recommendation is a move to a long position in case of short-term undervalued stocks with potential for long term stock price growth. Similar results were brought by DeBondt and Thaler (1985) where a short term portfolio of "losers" stocks in long run overcomes the profits of the market.

## CONCLUSION

This paper analyzes the impact of economic agents perceptions on stock price volatility. The short term influential factors as perceptions or sentiment of economic subjects are tracked by stock market indices and social network Facebook but the primary objective of the paper is Facebook data analysis. The basic relationship between variables is studied by linear panel regression with fixed effects. In addition, this paper employs the application of Markov switching regimes with intense focus to analyze the difference in growth and decrease of Facebook activity. The general conclusion of the paper is the negative impact of Facebook activity, specifically negative information has a bolder impact with consequences in higher volatility and decrease in stock prices.

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