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Influence of CEO's Facial Emotions in Interview Videos on Firm Market Value

Short Paper

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Abstract

Facial expressions have been seen as one of the most instinctive and efficient ways in the form of nonverbal communication. The CEO provides important facial information during the interview, which links to the firm's current market situation and future planning. In the literature, few studies have examined the relationship between CEO interview facial expressions and firm performance. This study explores how CEOs' facial emotions impact firm market value by analyzing the interview videos from the YouTube platform. We use the FER, a CNN algorithm-based method, to establish facial emotions and build multiple regression models to predict the firm's market value. Our findings show that CEO's negative emotion has a significant negative impact on market value. A positive emotional swing has a positive impact on the stock price. The high CEO's emotional swing affects investors' confidence in the firm performance and reflects on the stock price.

Keywords: FER, CEO interview video, market value, social media

Introduction

With the massive number of videos produced by people, it becomes more important for researchers to study what is reflected in the videos. A study shows that more than 500 hours of video were uploaded to YouTube every minute in May 2019 (Tankovska 2021). The number of videos has increased dramatically in the last decade.

Chief Executive Officers (CEOs) play an important role in the firm's information disclosure and strategic decision-making. CEO interview videos contain rich information about their personality and their perspective on the company. CEO interview videos usually focus on the policymaker answering questions on a specific theme. The unscripted and authentic videos are an excellent way to know the CEO and provide a personal perspective.

In this study, we use nonverbal information analysis to explore the effects of CEOs' facial emotions during interviews on firm value. Facial expressions have been seen as one of the most instinctive and efficient ways in the form of nonverbal communication (Behera et al. 2020; Sun et al. 2014). Moreover, in psychology studies, researchers have demonstrated that people can infer other's internal states through spontaneous facial expressions (North et al. 2010). Important facial information can be excavated during the interview videos. This first-hand information permits shareholders to make better decisions. Studying CEO interview videos could help us identify critical information, especially regarding its effect on firm performance.

Artificial Intelligence (AI) technology provides researchers with more tools and opportunities to get information from videos. Based on AI technology development, facial expressions have been intensively studied as an automatic recognition tool in recent years. Videos contain text-based transcripts, voices, images, etc. With the massive number of videos uploaded to the Internet every day, it is essential to get essential information from the video.

Many studies have explained the impact of CEO characteristics on firm performance (Naseem et al. 2020; Peni 2014; Saleh et al. 2020). However, although previous research on CEOs has addressed the effects of various CEO characteristics on firm performance, the findings are not yet converged (Naseem et al. 2020). Few studies have examined the relationship between CEO interview personal sentiment and facial expression and firm performance, especially using an automatic machine learning video data analytics framework. Therefore, the main research question is:

How do CEOs' facial emotions impact firm market value?

Most of previous articles analyze video data by using manual coding. Manually annotating video data is labor intensive and expensive, hence limiting the scales of video datasets and the performance of the trained models. Our study deals with these challenges by using a novel video data analytics framework which can automatically analyze unstructured data for quantitative analysis. The CEO interview videos provide the CEOs' facial expressions. We study this type of video to explore the factors that influence firm performance with this novel framework.

We proceed as follows to categorize CEOs' emotions from their facial expression in interviews videos. First, we collect the CEO interview videos from YouTube. Second, we extract video frames for each video and use facial detection and facial recognition to identify if the CEO was speaking. Third, we use the Convolutional Neural Networks (CNNs) based method to detect facial emotions of the CEO. To seek the relationship between facial emotions and firm market value, we collect firm market value related variables from CRSP datasets and use regression models to predict the firm's market value. The contributions of this paper show as follows.

First, this study contributes to the literature on social media analysis and CEOs' facial expression effect on the firm market value. Our study examines the determinants of firm market value and how the CEO's emotions reveal the stock price, which adds the significant and growing literature stream. Our research on the CEO interview videos describes a new approach to finding the relationship between the firm market value and the CEOs' facial expressions and emotions in the videos. Moreover, although there is an increasing interest in applying video graphics data, the previous research focuses on manual coding, and the efficiency of analyzing the snippets of videos is low. These disadvantages give constraints on the development of analyzing the video graphics data. Our study presents a novel video data analytics framework using multiple machine learning methods, including face detection, facial recognition, and facial

emotion detection. Our methodological exposition extends the possibility of using our method to work on a large dataset of videos across various situations. This research is beneficial for analyzing nonquantitative and nonverbal information. It connects with the social psychology that researches the influence of managerial behavior on the stock market's perception of firm market value. The result illustrates the promise of our approach for future study. Future researchers in management information systems, finance, and psychology can keep working in the same line by applying facial expression recognition to other market participants.

The rest of this paper is organized as follows. The second section presents the literature review and hypothesis development. The third section explains the data and methodology, while the fourth section shows the results and discussion. The fifth section presents the conclusions of this study.

Literature Review

CEO's Emotion and Facial Expression

The emotion theory literature shows that emotional responses play an important role in information processing (Bloch 1995). In the previous studies, the information expressed in the CEO's speech and facial expression to the internal and external stakeholders is one of the most important ways to impact firm performance (Yadav et al. 2007). Blankespoor et al. (2017) examine the relationship between cognitive perceptions of management and firm valuation using thirty seconds of content-filtered video clips of initial public offering presentations. However, the length of their video is limited, and the videos are not listed on social media sites, which might not be widely spread. Akansu et al. (2017) study whether CEO's facial emotions provide information relevant to a firm's financial performance. But their research does not include the facial recognition process and their video data analytics only focus on the frames that are the CEO's face. This loses lots of facial data from the frames containing multiple persons. Moreover, few previous studies focus on a large social media dataset to explore the impacts on firm market value using multiple machine learning methods, including face detection, facial recognition, and facial emotion detection. Our study increases the important and growing literature stream on factors of the firm market value using a novel video data analytics framework.

Social Media Analysis

Many researchers study various data from social media, such as text, images, and videos (Li and Xie 2020; Liu et al. 2020a; Liu et al. 2020b; Shin et al. 2020). Shin et al. (2020) conduct two case studies with a large social media dataset from Tumblr to show the effectiveness of their proposed visual data analytics framework which uses deep learning models to enhance social media research. Even though a large number of studies have studied the data from social media, very few researchers have developed models to apply automatic video analysis and extract CEOs' facial emotions to explore firm market value.

Emotion as Social Information

The theory of emotion as social information (EASI) assumes that the observer's perceived appropriateness of the emotional expression and information processing are the dominant on the interpersonal effects by triggering affective reactions and/or inferential processes in observers (Van Kleef 2009). Emotional expressions provide useful information regarding the disposition and intentions of the sender and the features of the underlying situation (Van Kleef 2009; Yin et al. 2021). When different emotions, like anger, sadness, or happiness, appear in the interview videos, the impact on the audience affects their investment behaviors. That is revealed from the stock price and firm market value. Anger is associated with negative outcomes such as aggression and conflict, but it can also serve adaptive and functional purposes (Hess 2014). We propose that negative emotional expressions (such as anger, sadness, etc.) in the CEO interview videos decrease the investors' expectations of the firm performance and firm market value. The CEO's facial emotional expression is variational in the video. The swing of the CEO's facial emotion is also important. When the facial emotion has many changes, this might change from a positive emotion (e.g., happiness) to a negative, or from a negative to a positive emotion. These changes in emotion affect investors' expectations of the firm performance, which is revealed by the stock price. Therefore, our hypotheses are as follows:

H1a: Negative emotions in interview videos are negatively associated with the stock price.

H1b: Positive emotions in interview videos are positively associated with the stock price.

H2a: Negative emotion swing has a negative impact on the stock price.

H2b: Positive emotion swing has a positive impact on the stock price.

Methodology

Data

We select S&P 500 CEO's interview videos from the social media site, YouTube. The S&P 500 is an index of the stock market, to measure the stock's performance using 500 large companies listed on the stock exchanges in the U.S. The S&P 500, as a benchmark of overall market, reports the returns and risks of the 500 biggest companies to show the performance of stock market. We ensure the S&P 500 companies between 2019 to 2020 and the CEOs at the time. Then, we search and download these CEOs' interview videos from YouTube and remove the videos that are repetitive videos, non-interview videos, non-image videos, phone interviews, etc. According to our research purposes, we finally collect a total of 280 videos from 124 companies.

Research Design

We study CEO interview videos to explore the factors that influence firm performance with novel methods. We study CEOs' emotions from their facial expression in three steps. First, we collect the CEO interview videos from YouTube, which is an American online video sharing and social media platform. Then, we capture the static image every ten seconds. Finally, we use the CNN algorithm-based method to establish seven facial emotions.

Facial expression recognition (FER) is a vital and promising technology in the field of computer vision and AI area. It is used as the primary processing tool for non-verbal intentions. FER's image recognition process involves an input using an image and transforming it into a weighted pixel to code the facial expressions. Usually, seven facial emotions would be established across cultures, such as anger, fear, sadness, disgust, happiness, surprise, and neutral. Comparing the training set images and the input images, the weights are generated by minimizing a loss function. The information expressed in facial expressions is critical for the person who saw it. CEOs spend their time communicating with their partners, investors, stakeholders, and customers. The information brought from the videos would also impact the firm's performance. In this paper, we seek what extent of influence of the information from the CEOs' interview videos on the firm's performance. We collected a group of CEOs' interview videos from YouTube.com. We use facial expression recognition to show the information hidden in the videos.

In this study, we use the FER Python package to analyze facial emotions, including seven facial emotions: anger, fear, sadness, disgust, happiness, surprise, and neutral. The sum of the seven emotion scores for each image is equal to 1.

This study focuses on "marginal" information content, which is called as event studies. Our study focuses on the effect of information on the firm market value. The main purpose of an event study is to address whether or not the specific event conveys new information to the marketplace within a short period around the event (Gordon et al. 2010). The research model is a modified version of the model proposed by (Ohlson 1995). It is widely used in the literature shown as equation (1) below:

$$P_{it} = \beta_0 + \beta_1 \times Ave_Emotion_k + \beta_2 \times Var_Emotion_k + \beta_3 \times BVPS_{it} + \beta_4 \times EPS_{it} + \beta_5 \times LnAst_{it} + \beta_6 \times Gender + \beta_7 \times Race + \beta_8 \times Education \quad (1)$$

where

P_{it} = Stock price of firm i for time t (daily price)

$Ave_Emotion_k$ = The average percentage of kth facial emotion from FER

$Var_Emotion_k$ = The variance of kth facial emotion from FER

$BVPS_{it}$ = Book value of equity divided by the number of shares outstanding of firm i for time t (the quarterly)

EPS_{it} = Earnings per share of firm i for time t (the quarterly)

$LnAst_{it}$ = Log of total assets of firm i for time t (the quarterly)

We calculated for each firm on these variables: Stock price (P), earnings per share (EPS), and the book value of equity (BVPS) during the period t (quarter). All these data were gathered from the WRDS CRSP/Compustat merged quarterly database for the year 2019-2020 except stock price. The daily stock price was gathered from the WRDS CRSP/Compustat merged security daily database for the year from 2019 to 2020.

Measurement of Variables

One of the significant factors for firm market value maximization objectives is the stock price (Kumar et al. 2017). Stock prices are the most observable measure that can be used to judge firm performance. The daily prices are constantly updated to reflect new information regarding a firm. The change in daily stock prices and the daily trading volume are two critical metrics for measuring the firm performance because they attract different types of investors and traders. Connecting these two metrics with the CEO interview videos' information would help us examine the relationship between personal sentiment and facial expression from CEO interview videos and firm performance. We select the daily stock open price and close price on the same day or several days from the video release date. The control variables include CEO's gender, race, and education level. The description of the variables is shown in Table 1.

Variable	Description
Open Price	Daily open price
Day-n-Open Price	The daily open price on the n th day after the video release date
Day-n-Open Price_D	The daily open price difference between the video release date and the n th day divided by the open price on the release date.
Ave_Emotion(k)	The average percentage of one facial emotion from FER. k includes seven emotions, angry, disgust, happy, sad, surprise, and neutral. Such as Ave_happy = 0.66, which means the average percentage of happiness in the video is 66%.
Var_Emotion(k)	The variance of one facial emotion from FER. k includes seven emotions, angry, disgust, happy, sad, surprise, and neutral. Such as Var_happy = 0.03, which means the variance of happiness in the video is 0.03.
BVPS	Book value of equity divided by the number of shares outstanding of a firm
EPS	Earnings per share of a firm
LnAst	Log of total assets of a firm
Gender	CEO's gender, Female and Male
Race	CEO's race, White, Black, Hispanic, and Asian
Education level	CEO's education level, Without degree, Bachelor, Master, and Ph.D.
Table 1. Description of the Variables	

Results

Main Findings

The main results of the multiple regression model are presented in Table 2 and Table 3. Table 2 shows the dependent variable is the firm's daily stock price after the interview video release. In total, we analyze six different regression models based on the different days after the release date. The results show that at the release date, the variance of happy emotion has a significantly positive relationship with the open price at

$p < 0.05$. Besides, the variance of happy emotion is significantly positively related to open price in the following five regression models (different days) at $p < 0.05$. For the average percentage of angry emotion, it becomes significantly negatively related to open price on day 3, day 5, day 15, and day 30 at $p < 0.05$. Compared with the Asian CEO, White CEO has a significantly negative relationship with the open price at $p < 0.05$. Compared with the CEO holding a master's degree, the CEO holding a Ph.D. has a significantly negative relationship with the open price at $p < 0.05$. Based on the results, we find that the negative emotion, angry emotion, has a significant effect on the daily stock open price. We can reject the null hypothesis of H1a. There is a negative relationship between negative emotions and stock price. The positive emotion, happy emotion, has no significant relationship with the daily stock price. We cannot reject the null hypothesis of H1b. However, the variance of the positive emotion, the happy emotion, has a significant relationship with the daily open price. We reject the null hypothesis of H2b. Positive emotion swing has a positive impact on the stock price. The results are reasonable. In the interview videos, when the interviewer asks some tough questions, the CEO's facial emotions might be changed from positive emotion to negative emotion, or vice versa. When the variance of the CEO's emotion is high, it affects investors' confidence in the firm performance and reflects on the stock price. But we cannot reject the null hypothesis of H2a.

In table 3, we analyze five regression models. The dependent variable is the daily stock open price difference, which is a percentage value to measure the extent to the price changes. The results show that on day 3, the average percentages of angry emotion, sad emotion, and happy emotion have significantly negative relationships with the open price change at $p < 0.05$. On day 5, the average percentages of angry emotion and happy emotion have significantly negative relationships with the open price change at $p < 0.05$. We can reject the null hypothesis of H1a. Negative emotions in interview videos are negatively associated with the stock price difference, which is consistent with Table 2. However, on other days, all these emotions are not significantly related to open price change. We find that the emotion has significant effects on the stock price change in a short period. When the time period becomes longer, the effect from the video would be no significant. But the variance of the emotion has no significant effects on stock price change.

	(1)	(2)	(3)	(4)	(5)	(6)
	Day1Open Price	Day3Open Price	Day5Open Price	Day10Ope Price	Day15Open Price	Day30Open Price
Ave_Angry	-261.482 (147.644)	-298.76* (148.242)	-301.254* (149.863)	-286.763 (150.158)	-322.494* (152.265)	-332.889* (158.722)
Ave_Fear	-264.926 (228.971)	-304.356 (229.9)	-307.275 (232.413)	-276.488 (232.871)	-312.349 (236.139)	-312.934 (246.152)
Ave_Happy	-198.992 (131.72)	-232.09 (132.254)	-236.024 (133.7)	-219.216 (133.963)	-247.792 (135.843)	-236.655 (141.604)
Ave_Sad	-218.788 (128.178)	-245.254 (128.698)	-251.487 (130.105)	-236.705 (130.361)	-263.45* (132.191)	-253.268 (137.796)
Ave_Neutral	-278.913* (136.886)	-313.63* (137.441)	-317.416* (138.944)	-296.183* (139.218)	-325.783* (141.171)	-312.998* (147.158)
Var_Angry	-9.311 (491.015)	-1.066 (493.005)	-24.128 (498.395)	7.807 (499.377)	-8.701 (506.385)	123.188 (527.858)
Var_Fear	-92.753 (938.389)	-109.479 (942.193)	-104.12 (952.493)	-154.885 (954.369)	-170.187 (967.763)	-131.883 (1008.801)
Var_Happy	370.113* (170.115)	360.127* (170.804)	368.808* (172.671)	373.798* (173.012)	385.69* (175.44)	389.878* (182.879)
Var_Sad	219.903 (399.716)	200.602 (401.336)	204.941 (405.724)	199.929 (406.523)	167.81 (412.228)	168.68 (429.709)
Var_Neutral	703.558 (400.416)	754.485 (402.039)	760.748* (406.434)	735.794 (407.234)	722.582 (412.95)	645.823 (430.461)
BVPS	1.798** (.238)	1.858** (.239)	1.881** (.241)	1.876*** (.242)	1.849** (.245)	1.946*** (.256)
EPS	25.486*** (5.375)	25.741*** (5.397)	25.336*** (5.456)	24.453*** (5.466)	25.468*** (5.543)	30.173*** (5.778)
LnAst	-51.228***	-52.254***	-53.162***	-53.612***	-53.15***	-58.332***

	(12.426)	(12.476)	(12.613)	(12.638)	(12.815)	(13.358)
Gender (Female)	-4.292	-2.194	-4.545	-1.835	-.218	-3.949
	(27.121)	(27.231)	(27.529)	(27.583)	(27.97)	(29.156)
Race (Black)	-63.738	-53.805	-60.617	-58.203	-58.283	-41.301
	(72.26)	(72.553)	(73.346)	(73.491)	(74.522)	(77.682)
Race (Hispanic)	6.804	13.629	10.846	10.449	9.213	14.846
	(68.445)	(68.722)	(69.474)	(69.61)	(70.587)	(73.581)
Race (White)	-55.014**	-50.931**	-54.386**	-54.337**	-54.437**	-50.611*
	(24.832)	(24.932)	(25.205)	(25.255)	(25.609)	(26.695)
Education (BA)	-10.773	-11.622	-11.562	-11.655	-12.899	-14.495
	(12.693)	(12.744)	(12.883)	(12.909)	(13.09)	(13.645)
Education (Ph.D.)	-61.446**	-56.461*	-57.095*	-60.147**	-59.302**	-48.687
	(28.969)	(29.087)	(29.405)	(29.463)	(29.876)	(31.143)
Education (Without degree)	-52.985	-52.014	-51.508	-53.465	-55.044	-55.191
	(44.932)	(45.114)	(45.607)	(45.697)	(46.338)	(48.303)
Intercept	540.044***	570.565***	582.249***	569.02***	597.781***	604.572***
	(143.266)	(143.847)	(145.419)	(145.706)	(147.751)	(154.016)
Observations	280	280	280	280	280	280
R-squared	.475	.482	.48	.473	.47	.486
<i>Standard errors are in parentheses</i>						
*** $p < .001$, ** $p < .01$, * $p < .05$						
Table 2. Multiple Regress Model Results of Open Price						

	(1)	(2)	(3)	(4)	(5)
	Day3Open Price_D	Day5Open Price_D	Day10Open Price_D	Day15Open Price_D	Day30Open Price_D
Ave_Angry	-2.202**	-1.175*	-.078	-.238	-.389
	(.076)	(.08)	(.117)	(.141)	(.199)
Ave_Fear	-.218	-.162	.064	-.086	-.264
	(.118)	(.125)	(.182)	(.219)	(.308)
Ave_Happy	-1.193**	-1.163*	-.046	-.176	-.208
	(.068)	(.072)	(.105)	(.126)	(.177)
Ave_Sad	-1.138*	-.136	.017	-.123	-.222
	(.066)	(.07)	(.102)	(.123)	(.173)
Ave_Neutral	-2.212**	-1.195**	-.033	-.158	-.102
	(.07)	(.074)	(.109)	(.131)	(.184)
Var_Angry	.04	-.091	.038	-.078	.697
	(.252)	(.267)	(.39)	(.469)	(.661)
Var_Fear	-.127	-.183	-.167	-.134	.392
	(.482)	(.51)	(.745)	(.897)	(1.264)
Var_Happy	.047	.012	.15	.116	.041
	(.087)	(.093)	(.135)	(.163)	(.229)
Var_Sad	-.258	-.125	-.512	-.604	-.507
	(.205)	(.217)	(.317)	(.382)	(.538)
Var_Neutral	.399	.43*	.058	.06	-.758
	(.206)	(.218)	(.318)	(.383)	(.539)
BVPS	0***	0***	.001***	0**	0
	(0)	(0)	(0)	(0)	(0)
EPS	-.008***	-.008***	-.018***	-.013**	.007
	(.003)	(.003)	(.004)	(.005)	(.007)
LnAst	-.001	-.004	-.013	-.008	-.03*

	(.006)	(.007)	(.01)	(.012)	(.017)
Gender (Female)	.005	.001	.017	.035	.025
	(.014)	(.015)	(.022)	(.026)	(.037)
Race (Black)	.112***	.036	.062	.054	.239**
	(.037)	(.039)	(.057)	(.069)	(.097)
Race (Hispanic)	.032	.011	.019	.012	.032
	(.035)	(.037)	(.054)	(.065)	(.092)
Race (White)	.021*	-.001	-.003	-.002	.056*
	(.013)	(.014)	(.02)	(.024)	(.033)
Education (BA)	-.011*	-.007	-.004	-.009	-.008
	(.007)	(.007)	(.01)	(.012)	(.017)
Education (Ph.D.)	.022	.036*	.054*	.071*	.106**
	(.015)	(.016)	(.023)	(.028)	(.039)
Education (Without degree)	.016	.027	.011	-.009	.02
	(.023)	(.024)	(.036)	(.043)	(.061)
Intercept	.165*	.181*	.102	.219	.312
	(.074)	(.078)	(.114)	(.137)	(.193)
Observations	280	280	280	280	280
R-squared	.154	.129	.16	.155	.135
<i>Standard errors are in parentheses</i>					
*** $p < .001$, ** $p < .01$, * $p < .05$					
Table 3. Multiple Regress Model Results of Open Price Change					

Conclusion

This study examines how CEOs' facial emotions in their interview videos influence firm market value. A group of 280 CEO interview videos from 2019 to 2020 is selected. We apply facial emotion recognition and multiple regression models in this study. The results support some of our hypotheses. The findings reveal that CEO's negative emotion has a significant negative impact on market value. Positive emotion swing has a positive impact on the stock price. When the variance of the CEO's emotion is high, it affects investors' confidence in the firm performance and reflects on the stock price. We also find that the emotions has significant effects on the stock price in a short period. When the time period becomes longer, this effect from the video is not significant.

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