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Does the Impact of Sentiment on Firm Financial Performance Transmit in Supply Chain?

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ABSTRACT

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Public's sentiment in social media changes firms' stock prices by affecting investors' perceptions and their investment decision-making. Recent literatures in supply chain management identify the connection between firms' financial performance and their suppliers' financial performance. Based on the linkage of financial performance among partners in supply chain, this paper explores whether the impact of public's sentiment in social media on firms' financial performance transmits in supply chain. By analyzing 21-month daily stock data of 67 IT firms that listed in the U.S and the top 5 suppliers and customers of these companies, this paper validates the linkage of the financial performance among members in supply chain. Furthermore, this paper proves that public's sentiment in social media about firms positively impacts their financial performance. Although such impact transmits in supply chain, the sentiment negatively affects the financial performance of the firms' suppliers and customers.

KEYWORDS: Sentiment, Social media, Financial performance, Supply chain

INTRODUCTION

Social media is "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content" (Kaplan & Haenlein, 2010, p61). In recent years, it has been widely used by firms to influence consumers' opinions and purchase intentions (Algesheimer, Dholakia, & Herrmann, 2005), to increase marketing communication effectiveness (Dholakia & Durham, 2010; Kozinets, de Valck, Wojnicki, & Wilner, 2010; Trusov, Bucklin, & Pauwels, 2009), to interact with customers and manage customer relationship (Boyd & Ellison, 2008), to monitor a marketplace (Berinato & Clark, 2010), and to gain competitive advantages (Cook, 2008). On one hand, social media provides firms a new platform to communicate with customers. On the other hand, social media offers users the control of discovering, producing, sharing, and distributing information (Solis & Carroll, 2008; Thackeray, Neiger, Hanson, & McKenzie, 2008). Specifically, social media allows consumers share experiences and opinions toward certain firms with progressively larger audiences in the format of electronic word-of-mouth (Thackeray, Neiger, Hanson, & McKenzie, 2008; Okazaki & Taylor, 2013). Consumers' sentiment expressed in these opinions, such as attitudes and emotions, is proved to be an indicator of firm equity value (Luo, Zhang, & Duan, 2013; Oh, & Sheng, 2011; Yu, Duan, & Cao, 2013). Recent finance literature has proved that sentiment changes firms' stock prices by affecting investors' perceptions and their investment decision-making (e.g. Brown & Cliff, 2005; Chun, Hung, & Yeh, 2012; Merrin, Hoffmann, & Pennings, 2013; Stambaugh, Yu, & Yuan, 2012).

Porter (1980) notes that vertical linkages exist between a firm's value chain and the value chains of its suppliers and customers. Optimizing vertical linkages should engender superior performance in supply chain (Frohlich & Westbrook, 2001; Tan, Kannan, & Handfield, 1998; Vickery, Jayaram, Droge, & Calantone, 2003). Recent literatures in supply chain management identify the connection between firms' financial performance and their suppliers' financial performance. For instance, Shin, Collier, and Wilson (2000) find that buyer cost performance is positively associated with supplier performance, and that suppliers and buyers have better financial performance when buyers have a higher level of supply management orientation. Babich, Burnetas, and Ritchken (2007) find that the change of suppliers' stock price affects buyers' purchasing and investment policies.

Given the linkage between firms' financial performance and their suppliers' financial performance, does the impact of sentiment in social media on firms' financial performance expand to affect their suppliers' and customers' financial performance? The answer remains unknown. Accordingly, this paper explores whether sentiment in social media about firms influence their suppliers' (upstream) and customers' (downstream) financial performance. In addition, this paper further investigates whether sentiment in social media about firms' suppliers and customers influence the firms' financial performance. A regression is conducted based on daily financial data of 67 information technology firms listed in the U.S stock market and their top 5 suppliers and customers for 21 months extracted from Bloomberg. The results validates the linkage of the financial performance among members in supply chain. Furthermore, the results prove that public's sentiment in social media about firms positively impacts their financial performance. Although such impact transmits in supply chain, the sentiment negatively affects the financial performance of the firms' suppliers and customers.

This paper makes several contributions to supply chain management literature. First, the results of the regression validates the linkage of financial performance between firms and their suppliers based on the daily data from Bloomberg. Second, this paper extends the linkage and proves that the financial performance of firms and their customers are connected as well. Third, this paper proves that the impact of sentiment on firm financial performance transmits in supply chain.

The remainder of this paper is organized as follows: Section 2 provides a literature review and develops hypotheses. Sections 3 discusses the data and methodology. The results of the regression analysis are provided in Section 4. At the end, Section 5 concludes the paper.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Sentiment in Social Media and Firm Performance

The main characters of social media are participation, interaction, collaboration, sharing, and relationship (Kaplan & Haenlein, 2010). The easiness of discussion in social media brings users together and they have the control of discovering, producing, and distributing information (Solis & Carroll, 2008; Thackeray, Neiger, Hanson, & McKenzie, 2008). In Twitter, for example, users are both consumers of tweets (followers) and producers of tweets (followed) (Fischer & Reuber, 2011).

Social media users express their opinions and attitudes by posting blogs or sending out tweets. The contents of the blogs and tweets are unstructured texts (Pang & Lee, 2008). Sentiment

analysis is the computational detection and study of people's opinions, appraisals, attitudes, emotions, and subjectivities toward entities, individuals, issues, events, topics and their attributes in texts (Li & Wu, 2010; Liu, 2010; Liu & Zhang, 2012; Pang & Lee, 2004). As a special application of text mining, sentiment analysis seeks to identify the viewpoint (s) underlying a text span by extracting positive, negative, or neutral opinions from the text (Pang & Lee, 2004; Thelwall, Buckley, & Paltoglou, 2012).

Financial performance is perceived by firms as a result of reaching their economic goals. Some traditional indicators are applied in prior research to measure firms' financial performance, such as return on investment (ROI), return on sales (ROS), return on assets (ROA), growth in sales, revenue, and market share, the number of new customers, cost management, working capital, productivity, efficiency, (Carr, & Smeltzer, 2000; Corsten & Felde, 2005; Droge & Germain, 2000; Petersen, Handfield, & Ragatz, 2005; Venkatraman & Ramanujam, 1986). Chen, Liu, and Zhang (2012), however, adopt equity value to measure firm financial performance. They argue that equity value can be monitored and recorded at a higher frequency than daily or even hourly level, so the respond of stock market to the information transmitted through social media is caught by equity value timely and precisely.

A growing body of sentiment analyses in the field of finance proves that sentiment affects firm short-term and long-term financial performance (Brown & Cliff, 2005; Chung et al., 2012; Luo, Zhang, & Duan, 2013; Merrin, Hoffmann, & Pennings, 2013; Oh, & Sheng, 2011; Stambaugh, Yu, & Yuan, 2012; Yu, Duan, & Cao, 2013). For instance, Sprenger Tumasjan, Sandner, and Welpe (2014) find a consistent correlation between Twitter sentiment and stock market returns by analyzing tweets about the top 100 stocks in the Standard & Poor's index (S&P 100). Luo, Zhang, and Duan (2013) point out that positive blog posts can improve trust and advocacy of the consumers or investors and result in higher firm value, whereas negative blog posts can damage corporate reputations and impair firm performances. Yu, Duan, and Cao (2013) find that social media has a strong relationship with firm stock performance, but the impact of sentiments on firm stock performance varies across social media. They point out that blog sentiment affects firm stock performance positively, whereas forum sentiment affects firm stock performance negatively. Luo, Zhang, and Duan (2013) find that positive blog posts can improve trust and advocacy of the consumers or investors and thus result in higher firm value, while negative blogs can damage corporate reputations and impair firm performances. Baker and Baker & Wurgler (2006) explore how investor sentiment affects the cross-section of stock returns. They conclude that a wave of investor sentiment has larger effects on securities whose valuations are highly subjective and difficult to arbitrage. In terms of why sentiment affects firm financial performance, scholars agree that investor optimistic or pessimistic beliefs in various sentiment states cause stock price variations (Baker & Wurgler, 2006; Berger & Turtle, 2012; Bergman & Roychowdhury, 2008; Chung, Hung, & Yeh, 2012; Garcia, 2013).

Given the impact of sentiments on firm financial performance, sentiments can be analyzed to predict firms' market adjusted returns (Oh, & Sheng, 2011). For example, Bollen, Mao, and Zeng (2011) analyze Twitter messages on a given day and find that the mood of the Twitter population is able to predict the movement of the Dow Jones Industrial Average (DJIA) on the following day with a claimed accuracy of 87.6%. In addition, firms manage their reputation by analyzing sentiments (Gundecha & Liu, 2012; Swain & Cao; 2014).

Financial Performance Linkage in Supply Chain

Firms do not operation individually. Instead, vertical linkages exist between a firm's value chain and the value chains of its suppliers and customers (Porter, 1980). In recent decades, suppliers and customers are inextricably linked throughout the entire supply chain through different value adding activities (Spekman, Kamauff Jr, & Myhr, 1998). As Ahern and Harford (2014) point out, customers and suppliers in the supply chain are community of interests, and any shock to one firm has a resulting effect on its linked partners. Therefore, Vickery, Jayaram, Droge, and Calantone (2003) note that the improvement in financial performance requires firms to optimize their business management across in supply chain.

Recent literatures prove that there is certain financial linkage between customers and suppliers in supply chain. For instance, Shin, Collier, and Wilson (2000) find that buyer cost performance is positively associated with supplier performance, and that suppliers and buyers have better financial performance when buyers have a higher level of supply management orientation. Frohlich and Westbrook (2001) examine upstream and downstream integration in supply chain and find that both suppliers and customers have strong association with performance improvement. Babich, Burnetas, and Ritchken (2007) find that the change of suppliers' stock price affects buyers' purchasing and investment policies. Carr and Kaynak (2007) find that enhanced supplier performance can help buyers improve product quality and reduce costs. Hertzel, Li, Officer, and Rodgers (2008) examine how financial distress and bankruptcy affect a firm's customers and suppliers and conclude that distress related to bankruptcy filings is associated with negative and significant stock price effects for suppliers and customers. Krause, Vachon, and Klassen (2009) note that firm's performance is closely related with its suppliers and customers.

Although financial linkage between customers and suppliers in supply chain is proved in prior research, the correlation among the equity values of firms, their suppliers (upstream), and their customers (downstream) has not been identified clearly yet. Thus, this leads to the following two hypotheses:

H1a. The stock return of a firm's suppliers is positively related to this firm's stock return.
H1b. The stock return of a firm's customers is positively related to this firm's stock return.

Because sentiment affects firm financial performance, which is connected with the financial performance of their customers and suppliers, the impact is conjectured to transmit across supply chain upwards and downwards. This leads to the following hypotheses:

H2a. The sentiment in social media about a firm positively influences its stock return.
H2b. The sentiment in social media about a firm positively influences its suppliers' stock return.
H2c. The sentiment in social media about a firm positively influences its customers' stock return.

DATA AND METHODOLOGY

Data Collection
Publicly traded IT firms in the U.S. are selected in this study. The IT industry is chosen because firms in this field are more likely to be affected by information transmitted in social media. In principle, however, the analysis presented in this study can easily be extended to any industry or sector of the stock market. Altogether, 67 IT firms are selected from Bloomberg as the focal firms. Furthermore, the top 5 customers and the top 5 suppliers of each selected firm are

chosen from the supply chain database inside Bloomberg. The focal firms represent the point of entry in this study, whereas their upstream and downstream trading partners in their supply chain. Daily stock prices of the focal firms and their trading partners are collected from January 1, 2015 to September 30, 2016, because stock return changes is more compatible with the diffusion of social media (Chen, Liu, & Zhang, 2012).

As it is not easy to measure sentiment directly (Baker & Wurgler, 2007), recent studies on sentiment adopt proxy variables first, and then relate these proxies to firms' equity returns (Edelen, Marcus, & Tehranian, 2010). Bloomberg offers social sentiment analytics using algorithms that incorporate statistical models and years of Twitter history and are developed by a team of Ph.D. students, product managers, and R&D professionals. In fact, Bloomberg has integrated Twitter messages into its terminals and NASDAQ has launched a mobile application that prominently incorporates content from Stock Twits. Therefore, sentiment is assessed based on the data directly from Bloomberg in this study.

Methodology

Daily stock return
Daily stock return is defined in Equation 1.

$$R_i = c_i - c_{i-1} / c_{i-1} \qquad (1)$$

where R_i is the daily stock return for the i-th day and C_i is the stock price for the i-th day. Daily return for day i is essentially the *percent* change in closing price from day (i-1) to day i.

Stock return for suppliers and customers
To eliminate the impact of internal relationships among suppliers and among customers, weighted average method is applied to calculate the stock return of suppliers and customers.

$$R_s = 1/5 \times \sum_{i=1}^{5} R_{s,I} K_i \qquad (2)$$

Where R_s is the daily average stock return of the five suppliers. $R_{s,i}$ is the daily stock return of the i-th supplier. K_i is the weight of the i-th supplier in the five suppliers.

$$R_c = 1/5 \times \sum_{i=1}^{5} R_{c,I} K_i \qquad (3)$$

Where R_c is the daily average stock return of the five customers. Rc,i is the daily stock return of the i-th customer. Ki is the weight of the i-th customer in the five customers.

The weights are calculated based on the capital size of each firm.

The linkage between the stock return of focal firms and the stock return of their partners in supply chain

Multiple linear regression analysis is applied to develop a set of two models for predicting the relationship of stock return for members in supply chain. Model 1 is for the relationship between stock return of focal firms and that of their suppliers. Model 2 is for the relationship between stock return of focal firms and that of their customers. The following financial indexes are chosen as control variables: market premium, market to book ratio, the ratio of debt/total equity, current market capital (firm size), the ratio of price/earnings, and return on assets.

The regression equations are defined as below:

Modle 1: $R_{it} = \alpha + \beta_1(R_s - R_{MKT}) + \beta_2 R_{MKT-RF} + \beta_3 MTB + \beta_4 D/E + \beta_5 CMC + \beta_6 P/E + \beta_7 ROA + \varepsilon$ (4)

Modle 2: $R_{it} = \alpha + \beta_1(R_c - R_{MKT}) + \beta_2 R_{MKT-RF} + \beta_3 MTB + \beta_4 D/E + \beta_5 CMC + \beta_6 P/E + \beta_7 ROA + \varepsilon$ (5)

where R_{it} is the daily stock return of the focal firms and RMKT is the Fama-French (1993) risk factors. RMKT-RF is the market premium. MTB is market to book ratio. D/E is the ratio of debt/total equity. CMC is current market capital (firm size). P/E is the ratio of price/earnings. ROA is return on assets.

The relationship between sentiment and stock return of focal firms

$$\text{Model 3: } R_{it} = \alpha + \beta_1 Senti + \varepsilon \tag{6}$$

where R_{it} is the daily stock return of focal firms and Senti is the sentiment of the focal firms.

Sentiment and stock returns in supply chain

$$\text{Model 4a: } R_s = \alpha + \beta_1 R_{it} + \beta_2 Senti + \varepsilon \tag{7}$$
$$\text{Model 4b: } R_s = \alpha + \beta_1 R_{it} + \beta_2 Senti + \beta_3 R_{it} * Senti + \varepsilon \tag{8}$$
$$\text{Model 5a: } R_c = \alpha + \beta_1 R_{it} + \beta_2 Senti + \varepsilon \tag{9}$$
$$\text{Model 5b: } R_s = \alpha + \beta_1 R_{it} + \beta_2 Senti + \beta_3 R_{it} * Senti + \varepsilon \tag{10}$$

Where R_s is the daily average stock return of the five suppliers. R_{it} is the daily stock return of the focal firms. Senti is the sentiment of the focal firms. R_c is the daily average stock return of the five customers.

RESULTS

The standardized beta coefficients give a measure of the contribution of each variable to Model 1 and Model 2. A large value indicates that a unit change in this predictor variable has a large effect on the criterion variable. The values of t and Sig (p) give a rough indication of the impact of each predictor variable. A big absolute t value and small p value suggests that a predictor variable is having a large impact on the criterion variable. The results shown in Table 1 indicate that Model 1 and Model 2 (suppliers with $\beta_1 = 0.087$, t = 2.402 and customers with $\beta_1 = 0.082$, t = 2.276) are significant at 5% level. Therefore, H1a and H1b are supported.

Table 1.
The result of relationship of stock returns in supply chain members

Independent Variables	Model1	Model2
Intercept	0	0
	(0.672)	(0.672)
Market to Book Ratio	0.021***	0.021***
	(3.415)	(3.417)
D/T Ratio	-0.01*	-0.01*
	(-1.669)	(-1.671)
Firm Size	0.005	0.005
	(1.08)	(1.08)
P/E Ratio	0.002	0.002
	(0.447)	(0.447)
ROA	-0.014**	-0.014**
	(-2.416)	(-2.416)
Market Premium	0.675****	0.671****
	(18.673)	(18.521)
Rs	0.087**	
	(2.402)	
Rc		0.082**
		(2.276)

Note: T-statustucs in parentheses below coefficients.
* denotes significance at the 10% level,**significance at the 5% level, ***
significance at the 1% level, and **** significance at the 0.1% level.

The results of Model 3, Model 4, and Model 5 are shown in Table 2. In Model 1 and Model 2, R_{it} is the dependent variable, whereas R_s and R_c are the independent variables. The results indicate that R_{it} is positively related with R_s and R_c. In contrast, R_{it} becomes the independent variable and R_s and R_c become the dependent variables in Model 3, Model 4, and Model 5. Table 2 indicates that R_s and R_c are positively related with R_{it} (at 0.1% level). Specifically, the sentiment of IT firms positively impacts their stock return ($\beta_1 = 0.045$, t = 7.505, and p = 0.01). Thus, H2a is supported. However, β_2 in Model 4a, Model 4b, Model 5a and Model 5b are all negative, -0.012, -0.009, -0.014, and -0.011 respectively. Furthermore, β_3 is -0.099 and t is -14.693 (p<0.001) in Model 4b. Therefore, H2b is not supported. This means that the sentiment in social media about a firm negatively influences its suppliers' stock return. Similarly, β_3 is -0.105 and t is -15.029 (p<0.001) in Model 5b. Thus, H2c is not supported. This means that the sentiment in social media about a firm negatively influences its customers' stock return. Moreover, the negative impact on customers' stock return is stronger than that on suppliers' stock return.

The results in Table 1 and Table 2 show that firms' stock return is positively related with the stock return of their partners in supply chain, that the sentiment in social media about a firm positively impacts its stock return, and that the impact of sentiment on firm stock return does transmit in supply chain. However, the positive impact on firms' stock return negatively affect the stock return of their suppliers and customers. In other words, sentiment and emotions of firms appear only as noise to their suppliers and customers.

Table2. The results of the sentiment analysis

Independent Variables	Model3	Model4a	Model4b	Model5a	Model5b
Intercept	0	0****	0****	0****	0****
	(-0.738)	(4.879)		(3.831)	(3.971)
Rit		0.392****	0.452****	0.394****	0.458****
		(72.839)	(67.021)	(70.577)	(65.447)
Senti	0.045****	-0.012**	-0.009*	-0.014**	-0.011*
	(7.505)	(-2.284)	(-1.746)	(-2.492)	(-1.943)
Rit*Senti			-0.099****		-0.105****
			(-14.693)		(-15.029)

Note: T-statustucs in parentheses below coefficients.
* denotes significance at the 10% level,**significance at the 5% level,*** significance at the 1% level, and **** significance at the 0.1% level.

To investigate whether the influence of sentiment on the stock returns of firms and their partners in supply chain is persistent over time, a robust test of Model1 and Model 2 is performed by lagging the stock return of firms for three days and one week. The results of the robust test are shown in Table 3. It can be seen from the results that the impact of sentiment on firms' stock return transmits across supply chain not only in real time, but also continuously.

Table 3. the robust test results

Independent Variables	3days		1week	
	Model1	Model2	Model1	Model2
Intercept	0	0	0	0
	(0.653)	(0.653)	(0.647)	(0.631)
Market to Book Ratio	0.021***	0.021***	0.021***	0.021***
	(3.401)	(3.401)	(3.362)	(3.311)
D/T Ratio	-0.01*	-0.01*	-0.01	-0.01
	(-1.649)	(-1.649)	(-1.643)	(-1.623)
Firm Size	0.005	0.005	0.005	0.005
	(1.049)	(1.049)	(1.046)	(1.03)
P/E Ratio	0.002	0.002	0.002	0.002
	(0.461)	(0.461)	(0.451)	(0.441)
ROA	-0.014**	-0.014**	-0.013**	-0.013**
	(-2.378)	(-2.378)	(-2.348)	(-2.301)
Market Premium	0.588****	0.588****	0.587****	0.587****
	(120.212)	(120.213)	(119.458)	(117.163)
Rs	0.011**		0.011**	
	(2.157)		(2.259)	
Rc		0.011**		0.012**
		(2.163)		(2.369)

Note: T-statustucs in parentheses below coefficients.
* denotes significance at the 10% level,**significance at the 5% level,*** significance at the 1% level, and **** significance at the 0.1% level.

DISCUSSION AND CONCLUSIONS

Public's sentiment in social media about firms affect investors' perceptions, which play a key role in their investment decision-making. Accordingly, firms' financial performance is found to be impacted by such sentiment. Recent literature in supply chain management find that the financial performance of members in supply chain is connected. Given the impact of sentiment and the linkage of financial performance among members in supply chain, this paper explores

whether the impact of sentiment on firms' financial performance transmits in supply chain. By analyzing 21-month daily stock data of 67 IT firms that listed in the U.S and the top 5 suppliers (upstream) and customers (downstream) of these companies, this paper validates the linkage of the financial performance among members in supply chain. Furthermore, this paper proves that public's sentiment in social media about firms positively impacts their financial performance. Although such impact transmits in supply chain, the sentiment negatively affects the financial performance of the firms' suppliers and customers.

The insights derived from this study can not only help academicians understand how sentiment of the focal firms can influence the stock return of supply chain members, but also guide practitioners to adjust their supply chain strategies to achieve a sustainable competitive advantage. Managers should realize that sentiment data usage is a form of social interaction and they should consider the advantages of using this networking to identify and to track the relevant information from the sentiment data for developing appropriate supply chain strategies. Furthermore, this study reports a significant negative relationship between sentiment of the focal firms and the stock return of their supply chain members. This relationship can be used to develop a predictive model for stock market reaction in supply. The model might extend the investment decisions and provide some reference to the investors.

One limitation of this study is that only IT firms from a population of publicly traded companies in the U.S. are selected. Future studies with sample from a wide range of firms and their supply chain members would increase the generalizability of the findings. As such, supply chain management will benefit from a thorough understanding of sentiment effecting on the stock market reaction of the supply chain.

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