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Title: The Impact of Firms' Social Media Initiatives on Operational Efficiency and Innovativeness

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1. Introduction

Marching beyond personal or individual usage, social media have been increasingly adopted for organizational purposes such as operations and innovation management (Kiron et al., 2012). For instance, Starbucks has launched a social media platform called My Starbucks Idea to enable customers to participate in developing new drinks and flavors (Gallaugher and Ransbotham, 2010), and Caterpillar has adopted the Spredfast social media platform to facilitate coordination and collaboration across its internal departments and extended dealer network (PR Newswire, 2012). Recently, Kane et al. (2014) reported that 87% of maturing companies used social media to spur innovation while 60% integrated social media into their operations.

In fact, making strategic use of social media is at the top of the agenda for many organizations. Firms are now considering social media as an approach to amplify the word of mouth of their products, a channel to keep customers in contact, and a chance for direct sales and marketing (Gamboa and Gonçalves, 2014). While the importance of listening to customers has been well recognized, especially under the quality management principle, the rapid-developing social media technologies empower customers, strengthen firm-customer connection, and provide opportunities for operational improvement. For example, it was reported that large banks such as the Bank of America actively turned “online rants into compliments” and used social media to “reach out to clients or employees to head off problems” (Epstein, 2011, p. P9). Tapping text analytic methods to search for customer feedback, social media technologies enabled Wendy’s to “report on customer experiences down to the store level within minutes” (Henschen, 2010). Social media have also changed the way in which individuals contact and learn about firms’ offerings (Rishika et al., 2013). A firm’s capability in facilitating information flow quickly through customer feedback and interaction is increasingly critical for business success.

Social media provide a platform for experience sharing, knowledge accumulation, and organizational learning (Nguyen et al., 2015). Corporate discussion forums (CDS) of organizations enable firms to gather a particular group of customers and other stakeholders with diverse backgrounds to discuss organization-specific issues, work collaboratively, and create new ideas. The

term “open innovation” refers to a system whereby innovation is not primarily undertaken by a specific research unit, but rather is developed publicly (Martini et al., 2014). By allowing ideas to generate dynamically through social networks and clusters, firms enjoy collective inventions characterized by fast knowledge accumulation and rapid product development rates.

Social media also enhance knowledge sharing *within organizations* through social networking of internal staff members (Cao et al., 2015). Internal social media platforms enhance effective organizational communication by providing employees across geographical locations with a forum for posting job updates, asking questions, and sharing best practices. Intra-organizational communication facilitates information exchange and knowledge assimilation, improving cross-functional coordination and management. For example, GE relied on Colab, its internal social media platform, to connect its 60,000 knowledge workers worldwide, enabling them to get “together to solve problems and share best practices” (Goulart, 2012, p. 14). Facilitating information flow across organizations, social media also allows business partners to have unprecedented access to vast volumes of external knowledge sources, improving business intelligence across organizations and supply chain networks.

Although anecdotal evidence suggests that firms can benefit from their social media efforts in terms of operational efficiency and innovativeness improvement (Cecere, 2010; Kane et al., 2014), some practitioners worry about the potential drawbacks of adopting social media in organizations. For instance, too much social interaction on social media may disrupt work and distract employees from work-related communication, resulting in lower productivity (Leonardi et al., 2013); outflow of firms’ information and knowledge to external social networks via social media may lead to leakage of confidential information and trade secrets, hurting firms’ intellectual property and innovativeness (Molok et al., 2010). On the other hand, while the emerging social media phenomenon has attracted much research attention in recent years (Aral et al., 2013; Fader and Winer, 2012), little empirical evidence is documented in the literature about the impact of firms’ social media initiatives on operational efficiency and innovativeness. Our research fills this research gap.

We argue that social media facilitate firms’ information flow and knowledge sharing across internal and external social networks, which enhance internal and external collaboration, and allow

firms to be more customer-oriented, contributing to operational efficiency and innovativeness improvement. By strategically enhancing information flow and knowledge acquisition, firms are likely to improve their capability in new product/service development and idea generation, leading to enhancement in both efficiency and creativity (Li et al., 2014). To test our hypotheses, we collected longitudinal performance data from 2006 to 2012 and examined firms' social media initiatives in 281 organizations between 2006 and 2011 (Section 3 provides the details). Using system generalized method of moments (GMM) estimation to analyze the data, we show that social media initiatives improve firms' operational efficiency and innovativeness.

2. Theoretical background and hypothesis development

2.1. Social media initiatives

Social media are “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 and Haenlein, 2010, p. 61). With a view to capitalizing on the content generated by their stakeholders (particularly existing and potential customers), firms increasingly adopt social media for various organizational purposes such as marketing, operations, and innovation management (Kiron et al., 2012), which we refer to as social media initiatives in this research. With reference to prior studies (e.g., Kiron et al., 2013; Kane et al., 2014), we classify firms' social media initiatives into six categories based on their different business objectives as follows: 1) Employee collaboration and internal communication, 2) Interfirm cooperation and supply chain management, 3) New product development and idea generation, 4) Public relations and corporate social responsibility, 5) Customer service and customer relationship management, and 6) Sales and marketing. Table 1 lists some examples in each category extracted from our sample.

--- Table 1 about here ---

Although researchers have been paying increasing attention to the emerging social media phenomenon in recent years, the existing research focuses on studying the effects of social media users' actions (Aral et al., 2013), rather than the outcomes of firms' strategic use of social media (i.e., social media initiatives). For instance, Forman et al. (2008) investigated the impact of

consumer-generated product reviews in an online community on firms' product sale. Luo et al. (2013) studied the ability of consumers' online ratings and blog posts to predict firms' equity value. Even though some researchers have begun to examine firms' social media initiatives directly (Gu and Ye, 2014; Rishika et al., 2013; Wu, 2013), they focus on the consequences of firms' social media initiatives at the individual user level, rather than their impacts at the firm level. For instance, Wu (2013) analyzed how a firm's adoption of social networking tool affects the work performance and job security of individual employees. Gu and Ye (2014) examined how a firm's responses to customer comments on social media affect the satisfaction of individual customers. Our research is an initial attempt to investigate the impact of social media initiatives at the firm level.

2.2. Social media initiatives, information capability and competitive advantage

In a rapid-changing and fast-moving business environment, the traditional static approach of knowledge-warehouse deployment has undergone a paradigm shift towards a dynamic capability in capturing knowledge through high-velocity, high-volume information flow (Kankanhalli et al., 2005). Organizations that are able to make use of external and internal information movements and big data are likely to have knowledge-based advantage over their competitors. Social media, which empower multi-way communication between organizations and their stakeholders in an efficient and cost-effective manner (Chua and Banerjee, 2013), is considered as a strategic approach to foster knowledge exchange among individuals and organizations, advancing organizational learning and knowledge management, thus yielding a competitive edge (Thomas and Akdere, 2013).

More generally, the impact of social media initiatives on firm performance can be understood through the resource-based view (RBV) of a firm's information capability. RBV suggests that firms are able to create competitive advantage through a complex, bundled set of resources that are rare, valuable, inimitable, and non-substitutable (Barney, 1991; Hitt et al., 2016b). Hitt et al (2016b) argued that RBV has become more important for OM research as OM researchers are increasingly focused on a collective of organizational routines within and across firms that reinforce each other to create competitive advantage. Although information technology by itself rarely contributes directly to a firm's sustained competitive advantage, it forms part of the firm's operationally complex routines and

capabilities (Wade and Hulland, 2004). Barney's (1991) seminal research considered a firm's strategic resources as a package of assets, attributes, information, and knowledge that can be sophisticatedly deployed to conceive of and implement organizational strategy, leading to competitive advantage.

A number of OM researchers have shown that interpersonal and interfirm relationships developed through information technology and online information capability enhance a firm's operational capabilities (Johnson et al., 2007; Vaidyanathan and Devaraj, 2008). In particular, relation-specific assets and knowledge-sharing routines are idiosyncratic, and socially and operationally complex (Johnson et al., 2007), contributing directly to competitive advantage. Wade and Hulland (2004) delineated that a firm's information capacity contributes to competitive edge creation through *outside-in* capabilities and *spanning* capabilities. Outside-in capabilities refer to the development of externally-oriented business intelligence and relationships, placing an emphasis on anticipating market trends, responding to customer requirements, and understanding competitive landscapes. Spanning capabilities refer to information alignments internally and externally, spanning the traditional knowledge gaps that exist between departments, across firms, and along the supply chain.

Social network theory suggests that information-rich social networks that bridge distinct parties and span "structural holes" are critical to organizations (Aral et al., 2012). Informal communication networks through social media are critical to knowledge flow between individuals (Wu, 2013). Research in information systems (Dou et al., 2013; Wu, 2013) and organization science (Dahlander and Frederiksen, 2012; Tuertscher et al., 2014) shows that social media technologies can supplement an established social structure, leading to a new, information-rich system for knowledge brokerage and dissemination (Leonardi, 2007). Ample evidence suggests that employees who are positioned in an information-rich social network and serve as an information broker for diversified groups of contacts from distinct parts of organizational networks are likely to be both more productive and innovative (Aral et al., 2012; Wu, 2013).

In fact, the strategic importance of information flow and knowledge sharing to competitive advantage is well recognized in various business disciplines (see, e.g., Cousins and Menguc, 2006;

Tsai, 2001; Tanriverdi, 2005). Through social media initiatives, a firm's information capability is enhanced through personal and organizational social networks (Leonardi, 2007). Informational processing theory asserts that a firm's major task is to handle, gather, and act on data as they emerge (Hult et al., 2004), and the best organizational structure is to follow the information processing requirements (Leonardi, 2007). Nevertheless, organizations are traditionally structured according to functional units. Such a "silo" organizational structure often impedes communication across geographically dispersed business entities. Social media technologies strengthen the information flow through the traditional organizational structure, promoting the formation of a powerful information-sharing channel and advice-seeking network.

2.3. The impact of social media on operational efficiency and innovativeness

A firm's social media initiatives are likely to positively influence its operational efficiency. A firm's relative performance in operational efficiency depends on its resources, routines, and capabilities. Resources refer to productive assets that are both tangible and intangible, routines are organizational processes that utilize a complex set of resources, and capabilities are the proficiency in deploying a dynamic bundle of routines (Peng et al., 2008). Both routines and capabilities are socially complex and operationally sophisticated. They are embedded in dynamic interfaces of multiple vibrant knowledge sources within and outside organizations. As a result, a firm's capability in achieving efficient operations is established through dynamic information and knowledge exchange among individuals, with customers, and across institutions (Kusunoki et al., 1998; Peng et al., 2008).

The traditional learning curve model in OM research suggests that knowledge is developed through individual and collective experience accumulation (Yli-Renko et al., 2001). Networks of knowledge sharing among organizations or organizational units accelerate individual and organizational learning. A firm's internal social networks enable faster information flow and sharing among employees, accelerating the diffusion of new knowledge or best practices across different departments and geographically separated offices (Molina et al., 2007; Szulanski, 1996). The information and knowledge being shared via social media is visible to different parties, reducing information asymmetry, avoiding knowledge duplication, and enabling management to make more

informed decisions in a timely manner (Leonardi, 2014; Sanders, 2007). Social media also enable employees in different workplaces to work and collaborate virtually, overcoming geographic boundaries, reducing costs, and improving efficiency. For example, through an internal social media platform named connect.BASF, BASF enabled its 112,000 global employees across 88 business units to work and collaborate, increasing project efficiency by up to 25% (Kane et al., 2014). Wu (2013) showed that information workers in the knowledge-based society are especially valued for their ability to access pertinent information. Timely access to the information related to the tasks on hand directly improves the quality of work, while the ability to reach diverse information provided by distinct actors exposes new opportunities and resources.

Organizational knowledge is developed through interactions between organizations and their customers (Yli-Renko et al, 2001). Traditionally it is challenging for firms to gather information and knowledge from external customers, who are often physically dispersed. Although contemporary communications technologies such as email and instant messaging are able to overcome the geographical constraint, they usually enable information and knowledge exchange between a dyad or among a few group members, rather than across a firm's entire social networks (Leonardi, 2014). Social media provide a firm with an open and accessible resource that enables it to become closer to its customers. Customers can freely express their requirements and preferences regarding the firm's products and services. In fact, social media contain a wide range of perspectives from different reviewers and thus is considered as a superior choice to understand customer requirements (Li et al., 2014), enabling the firm to improve quality management and enhance customer satisfaction.

Customer services and public relations management through social media also directly enhance service efficiency, reduce transaction costs, and improve firm image. For instance, by monitoring customer conversations on social networks closely, T-Mobile was able to identify at-risk customers and engage them specifically, which reduced customer attrition by 50% in only 90 days (Kane et al., 2014). Through social media, company information (e.g., new product information) can be distributed to and shared among customers in a timely manner, enhancing responsiveness and time-based efficiency (Eng and Quaia, 2009; Thomas and Akdere, 2013). For example, fast fashion retailer Zara

leveraged Facebook, a popular social media platform, to gain customer feedback and increase customer responsiveness, perceived value, and commitment, thus enhancing customer satisfaction (Gamboa and Gonçalves, 2014). Positive experience shared by customers on social media can increase firms' reputation, decreasing sales and general administration costs (Chevalier and Mayzlin, 2006). In short, social media initiatives enable faster information flow and better knowledge sharing across firms' internal and external social networks, resulting in operational efficiency improvement.

H1. Social media initiatives improve firms' operational efficiency.

In addition to operational efficiency improvement, the social interaction facilitated by firms' social media initiatives is likely to stimulate new ideas and improve organizations' intellectual capacity. Social media technologies represent a paradigm shift that enable firms to secure faster information flow and better knowledge sharing across their internal and external social networks (Qualman, 2010; Treem and Leonardi, 2012). Social media facilitate external information flow, allowing firms to renew their knowledge and generate new ideas (Oettl and Agrawal, 2008). In particular, to simulate new ideas, firms must expose themselves to uncharted domains of information in evolving marketing and technological environments. Many social networking tools have sophisticated functions for searching and extending networks, allowing firms to access particular expertise and exposing them to different ideas (Piskorski, 2011; Wu, 2013).

According to social network theory, information-rich social networks that are low in cohesion and structural equivalence, but rich in structural holes are particularly helpful for organizational success (Burt, 2004). Structural holes created by social media enhance a firm's ability to access and gather information from non-redundant social groups (Wu, 2013). Subramaniam and Youndt (2005) noted that in Silicon Valley, frequent and informal personal contact between individuals is widely observed and commonly considered as a critical factor for fast technology developments. Levin and Cross (2004) revealed that scientists and researchers are much more likely to obtain useful information through dynamic interaction between people rather than impersonal sources such as a database or file cabinet. Lesser and Prusak (2000) reported that higher-performing faculty members have frequent interaction (though in shorter durations) in a wider range of non-typical office settings than do

lower-performing faculty (Lesser and Prusak, 2000; Dahl and Pedersen, 2004; Becker, 2007). Product and service innovation requires a willingness to explore a wide range of new ideas from obscure and unrelated sources of information through different people and channels.

With fast-developing social media technologies, consumer networks, communities, and groups are increasingly seen as firms' strategic resources. Generating word-of-mouth through communication, consumers are regarded as active co-producers of products and services. Customer co-creation is defined as "an approach to innovation via which customers take an active part in designing new offerings" (Martini et al., 2014, p. 425). OM researchers traditionally regard customers as a strategic resource for quality improvement and innovativeness. Cassiman and Veugelers (2006) maintained that the knowledge acquired from external environments can complement internal R&D activities for innovation purposes. Through social media, firms might proactively include customers in new product development (Cao et al., 2015). For instance, Starbucks' My Starbucks Idea and Dell's IdeaStorm social media platforms enable customers to participate in developing new products and submit innovative ideas to the firms directly (Bayus, 2013; Gallagher and Ransbotham, 2010). Past studies have shown that customer involvement in new product development improves innovativeness (Koufteros et al., 2005).

The interaction facilitated by social media among employees from different geographic areas with different cultures may help generate creative ideas. Gassmann (2001) suggested that a project team with high cultural diversity "can lead to totally unexpected impulses of creativity and innovation" (p. 94). Employees from different departments such as R&D, manufacturing, and marketing may view the same problems from different perspectives and their interaction via social media may help generate innovative solutions (Kahn, 2001). We develop the second hypothesis as follows:

H2. Social media initiatives improve firms' innovativeness.

Figure 1 provides the conceptual framework of this research.

--- Figure 1 about here ---

3. Methods

3.1. Data collection

We study the impact of firms' social media initiatives on their operational efficiency and innovativeness in this research. As a result, our sample was constrained by the availability of data on these two performance measures. We obtained the measures on operational efficiency and innovativeness from Compustat and *Fortune* databases, respectively (please refer to the next section for the details). We searched these two databases over the period from 2006 to 2012, and found that there were a total of 281 firms that had at least one piece of "consecutive two-year data" for both performance measures. We needed a minimum of one piece of consecutive two-year data for each observation because our Dynamic Panel Data (DPD) models (explained below) technically required one-year lagged performance measure for analysis (please refer to equations (5) and (6)). As mentioned above, we obtained the performance data from 2006 to 2012 (seven years), meaning that we had a maximum of six (and a minimum of one) pairs of consecutive two-year performance data for each sample firm. With 281 firms, the maximum number of firm-years available for analysis was 1,686 (i.e., 281 firms x 6 consecutive years). However, as mentioned above, not all the firms had the full six-year consecutive data in the two performance measures (but at least one set of consecutive data in both). We had both operational efficiency and innovativeness measures in 1,108 firm-years, operational efficiency measures only in 51 firm-years and innovativeness measures only in 17 firm-years. In 510 firm-years we had missing data on both measures and thus could not perform any analysis. We thus had 1,159 (i.e., 1,108 + 51) and 1,125 (i.e., 1,108 + 17) firm-years for the analysis of operational efficiency and innovativeness, respectively. These two figures (i.e., 1,159 and 1,125) were considered as *effective firm-years* for our subsequent analysis of the two performance measures.

As our dependent variables covered the period 2006 to 2012 and we also needed a one-year lag between the dependent and independent variables, we collected data related to social media initiatives covering the period 2006 to 2011 and obtained 841 announcements. There were 150 out of the 281 firms (53%) that had at least one social media initiative over the six-year period 2006 to 2011, which is consistent with the finding of recent practitioner reports (e.g., Burson-Marsteller, 2011; Harvard Business Review Analytic Services, 2010).

However, not all these announcements were useful because some of these social media initiatives

fell in the firm-years in which we had no performance data at all (i.e., the 510 firm-years). We had 730 and 690 usable announcements of social media initiatives in these 1,159 and 1,125 *effective firm-years*. The average numbers of announcements per firm per year were 0.629 and 0.613 for the analysis of operational efficiency and innovativeness, respectively. The ranges were from 0 to 30. We had at least one announcement in 320 (27.61%) and 310 (27.55%) firm-years out of these 1,159 and 1,125 effective firm-years, respectively. Table 2 provides a summary. Note that the 1,159 and 1,125 firm-years (in 281 firms) are considered as *effective observations* (and unit of analysis), whether or not they have social media initiatives. Our DPD models, in the simplest sense, is to longitudinally study the relative yearly performance changes for firms at various levels of social media initiatives, including firms with no initiatives at all. Note that the actual analysis is based on the relative numbers of social media initiatives in different industries (i.e., industry standardized scores instead of the actual number from 0 to 30). It is a longitudinal analysis of relative performance changes, comparing within firms across different years and in the same year across different firms.

--- Table 2 about here ---

These 281 firms represent 37 different industries based on the 2-digit SIC codes. The top 20 industries of our sample firms are presented in Panel A of Table 3. It shows that the sample contains firms from a very wide range of industries in both the manufacturing and service sectors. The top five sectors based on 2-digit SIC codes are 1) electronics & other electric equipment, 2) business services, 3) chemical & allied products, 4) chemical & allied products manufacturing, and 5) transportation equipment, representing 41.9% of the total sample. Interestingly, four out of the top five sectors are in the manufacturing industries. We also show the characteristics of the sample firms in terms of sales, total assets, operating income, number of employees, cost of goods sold, capital expenditure, return on assets, age, R&D expense, and advertising expense in Panel B of Table 3.

--- Table 3 about here ---

3.2. *Measurements*

Operational Efficiency. We measured firms' operational efficiency based on the Stochastic Frontier Estimation (SFE) methodology (Dutta et al., 2005; Li et al., 2010). Compared with conventional

efficiency measures using a single financial indicator such as labor productivity and inventory turnover, SFE provides a more comprehensive measure of a firm's overall operational efficiency. The SFE approach models a firm's efficiency in transforming various operational resources (e.g., number of employees, cost of goods sold, capital expenditure etc) into operational output (Li et al., 2010) and is better able to capture the idea of operational efficiency defined from the traditional OM perspective (i.e., relative efficiency in transforming input to output). While the conventional efficiency measures are criticized for their inability to account for industry heterogeneity (Eroglu and Hofer, 2011), SFE indeed measures a firm's relative efficiency in its industry (Dutta et al., 2005), thus making the results comparable across industries. In addition, SFE explicitly incorporates the random error term into its estimation, so it can more accurately capture the efficiency variations beyond that caused by random shocks (Vandaie and Zaheer, 2014).

To implement SFE, we first constructed a stochastic production function to model the relationship between a firm's operational resources (i.e., number of employees, cost of goods sold, and capital expenditure) and its operational output (i.e., operating income) as follows:

$$\begin{aligned} \ln(\text{Operating Income})_{ijt} = & \beta_0 + \beta_1 \ln(\text{Number of Employees})_{ijt} \\ & + \beta_2 \ln(\text{Cost of Goods Sold})_{ijt} \\ & + \beta_3 \ln(\text{Capital Expenditure})_{ijt} + \varepsilon_{ijt} - \eta_{ijt}, \end{aligned} \quad (1)$$

where ε_{ijt} is the stochastic random error term and η_{ijt} represents the technical *inefficiency* of firm i in industry j (2-digit SIC codes) in year t . η_{ijt} ranges from 0 to 1, with 0 indicating no technical *inefficiency* (i.e., the frontier at which the firm is technically efficient). Therefore, η_{ijt} is a relative measure of how *inefficient* a firm is when compared with the corresponding frontier in the same industry within the same year. Therefore, we calculated the operational efficiency of firm i in industry j in year t as follows:

$$\text{Operational Efficiency}_{ijt} = 1 - \widehat{\eta}_{ijt}. \quad (2)$$

Innovativeness. We relied on the innovation ratings published by *Fortune* annually to measure firms' innovativeness. Innovation rating is one of nine criteria used by *Fortune* to pick the Most Admired Companies (MAC) from the *Fortune* 1,000 companies annually. This rating has been widely used in

prior studies (e.g., Cho and Pucik, 2005; Cui and O'Connor, 2012; Staw and Epstein, 2000) as a measure of innovativeness at the firm level. For instance, using the innovation ratings from *Fortune*, Cui and O'Connor (2012) investigated how firms' alliance portfolios affect their innovation performance, while Staw and Epstein (2000) studied whether popular management techniques make firms more innovative. The reliability and validity of this measure have been verified by Cho and Pucik (2004). Consistent with our measurement of operational efficiency, we are interested in the relative innovativeness of a firm compared with its industry peers in order to account for any inter-industry differences. Therefore, we standardized the innovation rating of a firm within its industry as defined by *Fortune*. Moreover, in view of the one-year lag between the survey and publication of the innovation ratings, we computed the innovativeness of firm i in industry j in year t as follows:

$$Innovativeness_{ijt} = \frac{Innovation\ rating_{ij(t+1)} - Mean\ of\ innovation\ rating_{j(t+1)}}{Standard\ deviation\ of\ innovation\ rating_{j(t+1)}}. \quad (3)$$

Social Media Initiatives. We searched for the announcements of social media initiatives in Factiva and counted the numbers to quantify firms' social media efforts. We chose Factiva instead of other possible sources for several reasons. First, Factiva contains news articles from top media outlets such as *The Wall Street Journal*, *The New York Times*, as well as hundreds of other sources (Gnyawali et al., 2010). Factiva thus is more likely to cover firms' announcements of social media initiatives than any single media source. Second, although it is possible to collect data about firms' social media initiatives directly from public social media platforms such as Facebook and Twitter, some social media initiatives are deployed on private or internal social media platforms that are not publicly accessible (e.g., Bills, 2007). Factiva, on the other hand, covers the announcements of social media initiatives deployed on both public and private social media platforms, thus using Factiva avoids the possible bias arising from focusing on public social media platforms only.

Collecting data from Factiva was a labor-intensive task due to the huge amount of information it contains. We recruited 12 student assistants to carry out this task. To ensure quality and consistency across different student assistants, we developed a standard data collection procedure for them to

follow. We also ensured their understanding by conducting a test on them. The student assistants needed to demonstrate they were able to identify the same set of announcements for particular firms in the test. We provided additional training in case of inconsistency. All the samples obtained were further verified by our research team.

We followed prior studies in collecting announcements from Factiva (e.g., Dehning et al., 2007; Zhang and Xia, 2013). First, we searched news articles in Factiva with a combination of our sample firms' names and some general social media terms such as social media, social network, social software, and Web 2.0. We limited our searches to the six-year period 2006 to 2011. For all the news articles obtained from Factiva, we then read through the text to identify the social media initiatives of our sample firms. We thus excluded announcements concerning the social media initiatives of other firms or non-social media initiatives (e.g., senior executive appointments, mergers and acquisitions related to social media) of our sample firms. We also dropped repeated reports of the same social media initiative by different publication sources to avoid double counting. As an example, we show in the Appendix a news article extracted from Factiva reporting the social media initiative of one of our sample firms, Honeywell, to enable employees to locate, manage, and share information and knowledge.

In line with our measurements of operational efficiency and innovativeness, we standardized the social media initiatives of a firm within its industry (2-digit SIC codes) to account for any inter-industry differences as follows:

$$\begin{aligned} & \textit{Social Media Initiatives}_{ijt} \\ &= \frac{\textit{Number of social media initiatives}_{ijt} - \textit{Mean of number of social media initiatives}_{jt}}{\textit{Standard deviation of number of social media initiatives}_{jt}}, \end{aligned} \quad (4)$$

where i, j , and t are firm, industry, and year indices, respectively.

Control Variables. We included five control variables, namely firm size, firm profitability, firm age, firm R&D intensity, and firm advertising expense in our research as they may be related to firms' operational efficiency and innovativeness (Bellamy et al., 2014; Cohen and Levinthal, 1990; Kortmann et al., 2014; Kwong and Norton, 2007; Wu et al., 2010). We measured firm size as the

natural logarithm of a firm's sales (Bardhan et al., 2013, Hendricks et al., 2009), firm profitability as a firm's return on assets (Chizema et al., 2015; Mukherji et al., 2011), firm age as the natural logarithm of the number of years since a firm's founding (Bellamy et al., 2014; Vandaie and Zaheer, 2014), firm R&D intensity as a firm's R&D expenditures over sales (Ba et al., 2013; Bardhan et al., 2013), and firm advertising expense as the natural logarithm of a firm's spending on advertising (Lou, 2014; Pirinsky and Wang, 2006). We also included year (2006-2011) and industry (two-digit SIC codes) dummies in our research to control for any unobservable time- and industry-specific effects.

3.3. *Sample verifications*

A major concern about our measure based on firms' announcements is whether firms actually implement the social media initiatives they have announced in Factiva. To address this concern, we randomly selected 15% (110) of the 730 announcements we collected from Factiva. We read through each of these 110 announcements to identify the social media platforms deployed by firms. We found that among these 110 announcements, 88 involved publicly accessible social media platforms such as Facebook, Twitter, and firms' own websites (e.g., Dell's IdeaStorm). For these 88 announcements, we were able to access the corresponding social media platforms directly or via Internet Archive's Wayback Machine (<http://archive.org/web/web.php>), thus confirming their actual implementation. However, for the remaining 22 announcements that involved internal or private social media platforms, we could not access these platforms directly to verify their implementation. Nevertheless, we were able to verify 19 of these 22 announcements based on third-party sources such as books, magazines, and reports. For instance, although we could not access the Bank of New York Mellon's internal social media platform that was designed for employee collaboration (Bills, 2007), a case study conducted by Carter (2012, p. 112) confirmed the deployment of this internal platform. Overall, we were able to verify 107 (97.3%) of the 110 randomly-selected announcements, thus showing the consistency between the announcements and implementation of firms' social media initiatives.

To further verify our measurement of social media initiatives based on announcements from Factiva, we obtained the total impressions served across social media of 30 firms from January to August 2012 provided by comScore. An *impression* is an actual count of responses in billions from a

web server to user browser in social media. comScore’s measure is regarded as “the best proxy for overall economic activity” of a firm on social media (Edwards, 2012). We measured the social media initiatives of these 30 firms over the same period (i.e., January to August 2012) based on our searches in Factiva. We then compared our measure with that of comScore. The significant correlation between the two measures ($b = 0.45$, $p < 0.05$) provides support for our approach to measuring firms’ social media initiatives based on announcements from Factiva.

3.4. Dynamic panel data (DPD) models

We constructed two dynamic panel data (DPD) models to test our hypotheses as follows:

$$\begin{aligned}
 & \text{Operational Efficiency}_{i(t+1)} \\
 &= \alpha_0 + \alpha_1 \text{Operational Efficiency}_{it} + \alpha_2 \text{Social Media Initiatives}_{it} + \alpha_3 \text{Firm Size}_{it} \\
 &+ \alpha_4 \text{Firm Profitability}_{it} + \alpha_5 \text{Firm Age}_{it} + \alpha_6 \text{Firm R\&D Intensity}_{it} \\
 &+ \alpha_7 \text{Firm Advertising Expense}_{it} + \varepsilon_{it} .
 \end{aligned} \tag{5}$$

$$\begin{aligned}
 & \text{Innovativeness}_{i(t+1)} \\
 &= \beta_0 + \beta_1 \text{Innovativeness}_{it} + \beta_2 \text{Social Media Initiatives}_{it} + \beta_3 \text{Firm Size}_{it} \\
 &+ \beta_4 \text{Firm Profitability}_{it} + \beta_5 \text{Firm Age}_{it} + \beta_6 \text{Firm R\&D Intensity}_{it} \\
 &+ \beta_7 \text{Firm Advertising Expense}_{it} + \varepsilon_{it} .
 \end{aligned} \tag{6}$$

We included lagged dependent variables as regressors in the two models because firm performance such as operational efficiency and innovativeness could be path dependent and persistent over time (Mukherji et al., 2011; Vandaie and Zaheer, 2014). The inclusion of lagged dependent variables made our models “dynamic” in nature, versus traditional “static” panel data models without considering the persistent influence of past performance. Consistent with prior DPD studies (e.g., Mukherji et al., 2011; Vandaie and Zaheer, 2014), we included a one-year lag of the dependent variables as a regressor in the two models¹. We also maintained a one-year lag between the dependent and hypothesized variables. Finally, we included all the five control variables, namely firm size, firm profitability, firm age, firm R&D intensity, and firm advertising expense in the two models.

¹ Our results remained consistent when a two-year lag of the dependent variables was included.

3.5. *System generalized method of moments (GMM) estimation*

Our research context gives rise to several challenges for testing our proposed hypotheses. First, although we included lagged dependent variables in the models to account for the persistent influence of past performance, the lagged dependent variables are correlated with the fixed effects in the error term (i.e., ε_{it}) by construction, leading to dynamic panel bias. While Kiviet (1995) suggested that the least squares dummy variables (LSDV) estimator is able to handle the dynamic panel bias, it works only for balanced panels (Roodman, 2009) and is unsuitable for our unbalanced sample with some firms having more observations than the others. Moreover, although we maintained a one-year lag between the dependent and hypothesized variables in the two models, we could not completely rule out the possibility of endogeneity. In particular, it is possible that firms' strategies and performance co-determine each other (Bardhan et al., 2013; Wintoki et al., 2012). On the one hand, firms' strategies such as pursuing social media initiatives may affect firms' performance such as operational efficiency and innovativeness as we have elaborated above. On the other hand, firms' operational efficiency and innovativeness may also affect firms' decisions to adopt social media, leading to the possibility of two-way causality. Therefore, without taking this possible reverse causation into account, the impact of social media initiatives on operational efficiency and innovativeness could be overstated. Another potential source of endogeneity is the unobservable firm-specific heterogeneity (Wintoki et al., 2012). In other words, some unobservable factors such as managerial ability and corporate culture may affect firms' use of social media and organizational consequences such as operational efficiency and innovativeness simultaneously, making the relationships between social media initiatives and these organizational outcomes biased. Mathematically, the endogeneity concern implies that the independent variables in equations (5) and (6) are correlated with the corresponding error term (i.e., ε_{it}). Although the conventional instrumental variables (IV) techniques that use external variables as instruments can address the endogeneity concern, it is difficult to obtain such strictly exogenous instruments externally as pointed out by prior studies (see e.g., Bardhan et al., 2013; Wintoki et al., 2012).

Considering the challenges discussed above, we followed recent DPD studies (e.g., Bardhan et al.,

2013; Chizema et al., 2015; Wintoki et al., 2012) by employing generalized method of moments (GMM) estimation to test our hypotheses. Specifically, we adopted the System GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998) in this research. The System GMM estimator offers several important advantages for our research. First, the System GMM estimator addresses the dynamic panel bias directly by instrumenting the lagged dependent variables with variables uncorrelated with the fixed effects in the error term (Roodman, 2009). Moreover, the System GMM estimator is suitable for our data with unbalanced panels. An extensive comparison of different DPD techniques conducted by Flannery and Hankins (2013) suggests that the System GMM estimator appears to be one of “the most robust methodologies for unbalanced panels with endogenous variables” (p. 13). Finally, although the System GMM estimator also employs the IV techniques to deal with the endogeneity issue, it does not rely on external variables that are outside the immediate dataset to construct instruments. Instead, the System GMM estimator constructs instruments internally with the transformation of existing variables, overcoming the difficulty in obtaining exogenous instruments externally (Roodman, 2009; Wintoki et al., 2012).

To implement the System GMM estimator, we first transformed the DPD models expressed in equations (5) and (6) into their first difference forms as follows:

$$\begin{aligned}
& \Delta \text{Operational Efficiency}_{i(t+1)} \\
&= \alpha_1 \Delta \text{Operational Efficiency}_{it} + \alpha_2 \Delta \text{Social Media Initiatives}_{it} + \alpha_3 \Delta \text{Firm Size}_{it} \\
&+ \alpha_4 \Delta \text{Firm Profitability}_{it} + \alpha_5 \Delta \text{Firm Age}_{it} + \alpha_6 \Delta \text{Firm R\&D Intensity}_{it} \\
&+ \alpha_7 \Delta \text{Firm Advertising Expense}_{it} + \Delta \varepsilon_{it} .
\end{aligned} \tag{7}$$

$$\begin{aligned}
& \Delta \text{Innovativeness}_{i(t+1)} \\
&= \beta_1 \Delta \text{Innovativeness}_{it} + \beta_2 \Delta \text{Social Media Initiatives}_{it} + \beta_3 \Delta \text{Firm Size}_{it} \\
&+ \beta_4 \Delta \text{Firm Profitability}_{it} + \beta_5 \Delta \text{Firm Age}_{it} + \beta_6 \Delta \text{Firm R\&D Intensity}_{it} \\
&+ \beta_7 \Delta \text{Firm Advertising Expense}_{it} + \Delta \varepsilon_{it} .
\end{aligned} \tag{8}$$

For each variable X in equations (7) and (8), $\Delta X_{i(t+1)}$ represents $X_{i(t+1)} - X_{it}$ and ΔX_{it} represents $X_{it} - X_{i(t-1)}$. The transformation process removes the time-invariant fixed effects in the

error term (i.e., the unobservable firm-specific heterogeneity) in the original equations (5) and (6). Moreover, instead of using exogenous instruments outside the immediate dataset, Arellano and Bond (1991) proposed a GMM estimator that uses the lagged values of the endogenous regressors as instruments for the variables in the difference equations (i.e., equations (7) and (8)), which is commonly known as the Difference GMM estimator (Bapna et al., 2013). Valid instruments, by definition, should be highly correlated with the variables to be instrumented but orthogonal to the error term in order to address the endogeneity concern (Chizema et al., 2015). These requirements result in a set of “moment conditions” that enables the Difference GMM estimator to select the suitable lagged values as valid instruments for the difference equations. Although the Difference GMM estimator has been widely adopted in prior DPD studies (e.g., Dezsö et al., 2012; Sodero et al., 2013), Blundell and Bond (1998) showed that the instruments used in the Difference GMM estimator could be weak if the autoregressive process becomes too persistent over time, as is possible in our study involving firm performance.

To address this weak instruments concern, Arellano and Bover (1995), and Blundell and Bond (1998) developed a new GMM estimator with additional moment conditions in which the lagged differences of the endogenous regressors are used as instruments for the original-level equations. This new GMM estimator is usually referred to as the System GMM estimator (Bapna et al., 2013; Bardhan et al., 2013) as it estimates a system of two equations simultaneously, i.e., the original-level equation and the transformed difference equation. However, as the fixed effects are still present in the error term of the original-level equations, an additional assumption is required in order to implement the System GMM estimator. Nevertheless, although the endogenous variables are correlated with the fixed effects in the error term by construction, it is assumed that the correlation is constant over time (i.e., time-invariant) (Arellano and Bover, 1995; Blundell and Bond, 1998). This is a reasonable assumption for the data over a relatively short time period such as ours with a maximum of six years from 2006 to 2011 (Wintoki et al., 2012). This assumption allows the System GMM estimator to develop differences as instruments to make them exogenous to the fixed effects in the error term and address the endogeneity concern (Roodman, 2009). Therefore, the System GMM estimator uses

lagged differences as instruments for the original-level equations, in addition to the use of lagged levels as instruments for the transformed difference equations. The introduction of more instruments enables the System GMM estimator to address the concern of weak instruments in the Difference GMM estimator and improve the estimation efficiency dramatically (Roodman, 2009). We implemented the two-step System GMM estimator in our research as it is efficient and robust to any pattern of heteroskedasticity (Roodman, 2009).

4. Results

Table 4 reports the correlations among all the variables included in this research. The results show that each of the two dependent variables is highly correlated with their lagged values ($b = 0.799$ for operational efficiency and $b = 0.798$ for innovativeness), providing support for controlling the lagged dependent variables in the regression models. Tables 5 and 6 report the test results on the impacts of social media initiatives on operational efficiency and innovativeness, respectively. For all the models shown in Tables 5 and 6, the lagged dependent variables are positive and significant ($p < 0.05$), providing strong support for the persistent influence of past performance in terms of operational efficiency and innovativeness.

--- Table 4 about here ---

--- Table 5 about here ---

--- Table 6 about here ---

We conducted two tests to verify the suitability of applying the System GMM estimator in our research. The first one is the Sargan test, which is used to check the orthogonality of the instrumental variables to the error term (Chizema et al., 2015). The Sargan statistic is not significant ($p > 0.05$)² in both Tables 5 and 6, failing to reject the null hypothesis that the specific instrumental variables are uncorrelated with the error term. Therefore, the instruments used in this research could be viewed as exogenous and appropriate. The second test is to check the autocorrelation in the idiosyncratic

² A more conservative threshold of p -value suggested by Roodman (2009) is 0.25 and he also warned that this p -value should not be too close to 1. The p -values of our Sargan statistic in Tables 5 and 6 are higher than 0.25 and lower than 0.5, satisfying Roodman's (2009) conservative requirements.

disturbances (those apart from the fixed effects). As this test is applied to the residuals in differences, the first-order autocorrelation (AR1) should be significant by construction³, as shown in Tables 5 and 6 ($p < 0.05$). Therefore, we needed to rely on the second-order autocorrelation in differences (AR2) to determine the first-order autocorrelation in levels (Roodman, 2009). The statistically insignificant AR2 ($p > 0.05$) in Tables 5 and 6 suggests that we fail to reject the null hypothesis that there is no serial correlation in the idiosyncratic disturbances. As a result, there is no evidence that our System GMM models are misspecified.

In addition to the results based on the System GMM estimation, we also include the OLS results in the two tables for comparison. Both the System GMM and OLS models in the two tables are significant ($p < 0.05$) based on the Wald Chi-square and F statistics, respectively. However, the coefficients and significance levels of the lagged dependent variables are much higher in the OLS models than in the System GMM models. This may be due to the inability of the OLS estimator to handle the high correlations between the lagged dependent variables and the fixed effects in the error term. Such an upward-biased estimation for the lagged dependent variables in the OLS models is consistent with the findings of prior DPD studies (e.g., Bapna et al., 2013; Flannery and Hankins, 2013; Roodman, 2009).

Two control variables, namely firm profitability and firm size, remain positively significant ($p < 0.05$) in all the models in Tables 5 and 6, respectively, suggesting that while more profitable firms appear to be more efficient, larger firms seem to be more innovative. The coefficients of social media initiatives are also positive and significant ($p < 0.05$) across all the models in Tables 5 and 6. The results show that social media initiatives improve firms' operational efficiency and innovativeness, thus supporting H1 and H2.

We further employed an alternative matching method and the difference-in-difference approach to check the robustness of our findings regarding the effects of social media initiatives on operational efficiency and innovativeness. Specifically, we first matched firms that adopt social media in year t

³ Let v_{it} be the idiosyncratic disturbance term. Δv_{it} (i.e., $v_{it} - v_{i(t-1)}$) should be correlated with $\Delta v_{i(t-1)}$ (i.e., $v_{i(t-1)} - v_{i(t-2)}$) via the shared $v_{i(t-1)}$ term.

with their industry peers (2-digit SIC codes) that do not adopt social media. We then computed the changes in performance (i.e., operational efficiency and innovativeness) from year t to year $t+1$ for both social media adopters and their matched non-social media adopters. Finally, we calculated the difference-in-difference as the differences in changes between the social media adopters and the matched non-social media adopters. Table 7 reports the difference-in-difference results, which are positive and statistically significant for both operational efficiency ($b = 0.005, p < 0.05$) and innovativeness ($b = 0.120, p < 0.01$). The results thus suggest that social media adoption helps firms improve operational efficiency and innovativeness, consistent with our System GMM and OLS results.

--- Table 7 about here ---

5. Discussions and conclusion

Organizations across the globe are increasingly adopting social media for customer relationships management, employee collaboration, and business intelligence (Bharati et al., 2015). Although social media have fundamentally changed the way in which people “communicate, collaborate, consume and create” (Aral et al., 2013, p. 3), the real impact of social media initiatives by firms has remained largely unexplored, particularly from the OM perspective. Social media initiatives facilitate information flow and knowledge sharing within and across organizations, which in turn improves firms’ effectiveness and innovativeness in a dynamic, knowledge-based business environment. By keeping in touch with distinctive members in different parts of the world within and outside the organization, employees can access knowledge residing in different experts. In fact, previous research showed that social media adoption supports the idea of knowledge management by allowing unrestricted sharing of knowledge, information, and data among various stakeholders (Alberghini et al., 2014). Using secondary data in a longitudinal setting, we showed that social media can be strategically deployed by firms to improve organizational performance.

Social media represent “one of the most transformative impacts of information technology on business, both within and outside the firm boundaries” (Aral et al., 2013, p. 3). Through social media, companies can improve and transform their processes in virtually every organizational function, from

public relationships to marketing, and to internal operations and product innovations (Luo et al., 2013). As shown in Table 1, organizations adopt social media for a wide-range of organizational purposes, including sales and promotion, customer services, internal and external collaboration, and open innovation and idea sourcing. Yet, burgeoning research in this area is predominately directed to marketing and consumer online behaviors at the individual level, rather than considering social media initiatives aggregately at the firm level. Our research takes a strategic OM perspective, exploring the possibility that informal, relationship-oriented online systems like social media can be tactically deployed by firms to produce positive effects on productivity and innovativeness.

Traditional OM research focuses on the transactional benefits of information technology, showing how information technology improves scheduling and coordination, and reduces time between placing orders and delivery. The traditional perspective of information technology adoption emphasizes seamless integration of data flow (e.g., Rabinovich et al., 2003), particularly in the supply chain context. More recently, OM researchers have also stressed the importance of building trust and relationships through the adoption of e-business technologies, reducing both operational risks and transaction costs (Johnson et al., 2007). Our research departs from this stream of research in that we do not consider information technology simply as a tool for improving process integration and transactional efficiency. Compared with other organizational information systems (e.g., ERP) and e-business (e.g., CPFR), the information flow through social media is often informal, unstructured, and less organized. In fact, social media were originally developed not for organizational purposes. Instead, it is for connecting people, interpersonal communication, and maintaining relationships. Unlike e-business technologies, seamless data flow and process automation is unlikely to be the primary benefit for firms' social media initiatives. In contrast, social media strengthen social communication, increase information diversity, and supplement knowledge flow through traditional organizational structures (Aral et al., 2013). Facilitating business transformation in terms of managing customer relationships, business processes, and product innovations, social media are likely to have a wider range of organizations functions and implications that are different from the traditional e-business technologies (e.g., CRFR, ERP, POS, ... etc).

5.1. Theoretical and managerial implications

Taking the resource-based view of a firm's information capability in this research, we consider firms' social media initiatives as strategic resources for capacity improvement. In line with the recent discussion regarding the adoption of RBV in the OM context (Hitt et al., 2016b), we focus on the mid-level organizational outcomes of operational efficiency and innovativeness. Hitt et al. (2016a) maintained that RBV has the potential of greater integration with the knowledge-based view and the theoretical lens of dynamic capability. In addition to process integration through the traditional e-business technologies, firms can also create a competitive edge through fluid information flow, sustaining their knowledge-based advantage. Although OM researchers have long realized the competitive advantages residing in distinct routines and capabilities, they rarely consider enhancing such capabilities by building social information networks and facilitating information brokerage through social media technologies. The contemporary research on RBV suggests that although process routines and operational advantage are critical capabilities to firms, they can be quickly eroded. A higher level of capability through knowledge-based advantage and dynamic capacity is likely to be more enduring. Compared with previous OM research, we consider information technology adoption at the more strategic level for reaching untapped knowledge sources, rather than just transactional effectiveness.

We argue that firms' social media initiatives lead to operational efficiency and innovativeness through an information-rich social network that yields knowledge-based advantage. Specifically, social media networks that are low in repeated connections (i.e., low in cohesion) but high in connectivity to uncharted domains (i.e., rich in structural holes) are particularly beneficial for firms. Wu (2013) theorized and empirically demonstrated that information diversity and social communication are the "two intermediate mechanisms" (p. 30) of an information-rich social network through which social media improve employees' productivity. According to Aral and Van Alstyne (2011), information in local, closely connected network neighborhoods tends to be redundant, providing mainly repetitive information. Instead, structurally diversified contacts should provide channels through which new information flows (Burt, 1992). The access to novel information through

social media should increase the breadth of employees' absorptive capacity, simulating learning and new ideas (Cohen and Levinthal, 1990; Rodan and Galunic, 2004). In addition, with the rapid globalization of business, workforces become increasingly diversified (Bente et al., 2008; Crouse et al., 2011). Social media are increasingly more important not only for information sharing and idea generation, but for continuous task update, employee collaboration, and customer co-creation across geographical areas (Bente et al., 2008; Crouse et al., 2011).

Our research offers some important practical implications for managers. We provide practitioners with initial empirical evidence that social media initiatives help enhance efficiency and foster innovativeness of firms. For practitioners, in addition to public relations and marketing communication, investments in social media initiatives also help facilitate employee collaboration, interfirm coordination, and idea generations. More practically, managers can consider adopting internal online knowledge sharing networks, establishing business-to-business online networking communities of their specific industry, enhancing customer interaction through publishing blogs and product ratings, and initiating online idea sourcing by posting and rating ideas. Certainly, operations managers need to think strategically how unrestricted information flow can be valuable to their firms, in particular how social media can be adopted to reach untapped knowledge sources. For OM practitioners, the idea of efficiency is not simply to streamline operations and reduce complexity, but to develop an information-rich social network that yields knowledge-based advantage.

The need for organizations to be both efficient and innovative (i.e., the concept of ambidexterity) has been an increasing concern for operations managers. Traditionally, many OM techniques emphasize instilling best practices and optimizing business processes. Such OM practices might be in conflict with organizational innovation. For example, Benner and Tushman (2003) argued that process techniques, by design and intent, exploit existing capabilities with a scant concern for innovation capability building. Process management techniques such as ISO 9000 are geared towards reducing variations and achieving greater conformance, enhancing operational efficiency at the expense of exploratory innovation (Benner and Tushman, 2002). Some process management practices are blamed for having "destroyed more innovation than any other" (Amabile and Khaire, 2008, p. 104). Our

research, in contrast, indicates that through promoting information flow, a firm's social media initiatives contribute to both operational efficiency and innovation improvements. Consistent with recent OM research (e.g., Choo et al., 2007; Kim et al., 2012; Schroeder et al., 2008), we stress the need for both efficiency and innovation (i.e., exploitative and exploratory learning). We believe that OM principles and techniques will also benefit from a continuous stream of knowledge exchange facilitated by contemporary information technology such as social media. Exploitative and exploratory learning are two critical elements for the long-term prosperity of organizations. Current OM research stresses the importance of rigorous process management, organizational conformance, and variance reduction, while simultaneously "creating a context that enables problem exploration between disparate organizational members" (Schroeder et al., 2008, p. 536), leading to greater and more heterogeneous knowledge. This is in line with the recent perspective that the OM function is an organizational learning and exploration process, which in turn will benefit from information flow in a knowledge-based environment (e.g., Gutiérrez Gutiérrez et al., 2012; Jacobs et al., 2015).

5.2. Limitations and concluding remarks

Our research is limited in terms of its scope. Most notably, we demonstrate that firms' social media initiatives enhance operational efficiency and innovativeness in general. However, we do not consider the circumstances under which firms are likely to benefit more from social media. Certainly, we believe that some firms are likely to benefit from social media more than others. Wu (2013) argued that knowledge-based, information-intensive jobs (e.g., business consultants or head hunters) are likely to benefit more from social media adoption. On the other hand, highly focused organizations (e.g., OEM factories) may not benefit much from social media initiatives. Another related question concerns whether there exists an optimal level of socialization and information flow within an organization (or for an employee). Obviously, information processing and socializing can be time-consuming and the adoption of social media within firms can distract work-related duties. There exists a trade-off between exploring uncharted domains and a focus on current tasks based on existing knowledge.

We acknowledge that our measure of social media initiatives based on related firms'

announcements in Factiva is not perfect. An alternative measurement approach is to use data about firms' annual budgets or spending on social media. However, we have tried various ways, including consulting directly with International Data Corporation, a research firm specializing in information technology and consumer technology, but failed to obtain the social media spending data at the firm level. Nevertheless, social media announcements from Factiva actually provide quite detailed descriptions of a firm's social media initiatives, providing a good proxy of the actual adoption of a firm. Moreover, our verification of firms' implementation of social media initiatives and data from comScore provide further support to our measurement approach.

The strict proof of the cause and effect relationship between independent and dependent variables is always a challenge in management research. Our research, like any OM research, might suffer from the issue of endogeneity. As pointed out by Hitt et al. (2016b), the best way to avoid the endogeneity and common method bias is in the initial research design. In this research we used panel data with time lags between dependent and independent variables. Through the analysis of six-year longitudinal panel data, we actually examined the yearly performance effects (operational efficiency and innovativeness) of social media initiatives. We compared the yearly differences between firms with social media initiatives (at different levels) with organizations without any social media initiatives. Despite this, the issue of endogeneity remains because the choice of firms to adopt social media initiatives is not random. To tackle this problem, we used System GMM estimation in our analysis. System GMM estimation employs the IV techniques to construct instruments that are correlated with the endogenous variables but orthogonal to the error term. More importantly, the System GMM estimator overcomes the difficulty in obtaining external exogenous instruments through transforming existing time-series data, and addresses the weak instruments concern with a simultaneous estimation of both level and difference equations.

To conclude, we empirically demonstrated that social media initiatives have positive impacts on operational efficiency and innovativeness, two critical organizational objectives of firms. By collecting longitudinal data from multiple sources, we constructed two DPD models to account for the influence of firms' past operational efficiency and innovativeness, respectively, and employed the

System GMM estimator to address the endogeneity concern. We ground our research in the resource-based view of the firm and social network theory with regard to information flow. Social media have revolutionized the way in which an organization is related to customers, other stakeholders, and the public, tapping different possibilities in various organizational functions, from marketing to operations management and new product development.

We believe that more research on the impact of firms' social media initiatives is needed. We encourage OM researchers to examine other possible operational outcomes of firms' social media efforts at both internal operational and supply chain levels. At the internal operational level, anecdotal evidence suggests that adopting social media in organizations might lead to higher product quality, customer satisfaction, and operational visibility (Kane et al., 2014; Kiron et al., 2013; Martin and van Bavel, 2013). At the supply chain level, academics can focus on performance outcomes such as buyer-supplier relationship, inter-firm trust, and supply chain efficiency (e.g., inventory days). While we focus on the positive performance outcomes of social media, we should not lose sight of their possible underlying drawbacks. For example, some practitioners have warned that excessive information flow through social media may lead to employee burnout and unrestrained knowledge sharing to external social networks may hurt firms' competitive advantage (Gaudin, 2010; Molok et al., 2010). Most importantly, we believe that researchers should move beyond the simple question as to whether or not firms' social media initiatives lead to positive performance outcomes. Instead, researchers should study the impacts of contingency factors and their performance implications. As discussed, firms' benefits from social media initiatives might be contingent on their operational characteristics such as information intensity, knowledge requirements, and supply chain complexity. For example, firms with responsive versus efficient supply chain strategies might benefit differently from their social media initiatives.

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Table 1

A sample of social media initiatives.

Category	Example	Date	Text extracted from Factiva
Employee Collaboration and Internal Communication	Unisys Corp (UIS)	11 Dec 2010	At Unisys, we have launched My site earlier this year, which is our equivalent of Facebook. What has happened because of this is, all our employees across the world have a platform to talk about the work they are doing, ask questions to each other, and share best practices. My site has been giving employees constant access to everyone, including top management.
	ConocoPhillips (COP)	23 Mar 2009	The Houston-based ConocoPhillips has developed about 100 online knowledge sharing networks, which are used by about 9,500, or 28% of its worldwide employees to post questions and find answers from colleagues.
	Honeywell (HON)	18 Apr 2007	Connectbeam, Inc., a leading provider of enterprise social software, announced today that it has been chosen by global technology company Honeywell (NYSE: HON) to provide social bookmarking and tagging, expertise location, and enterprise social networking capabilities to Honeywell employees. Using Connectbeam software, Honeywell knowledge workers will be able to locate and manage information together while easily networking with each other's knowledge, interests and skills in a secure, behind the firewall implementation.
Interfirm Cooperation and Supply Chain Management	Arrow Electronics (ARW)	11 Feb 2011	Assisting resellers with collaborating on sales opportunities and building relationships with other resellers, system integrators and other solution providers, Arrow Enterprise Computing Solutions, a business segment of Arrow Electronics Inc., launched a social networking site called Virtual Bench initially for its North American IBM channel community. Over time, the network will be continually extended to include other Arrow ECS supplier lines.
	General Electric (GE)	24 May 2011	Just as LinkedIn was developed for professional networking, and Facebook for social networking, Aravo Assure (TM) was developed to harness the power of collaborative networks to drive more efficient, effective business-to-business relationships for companies of all sizes. Starting this month, GE will provide access to Aravo Assure(TM) to its 750,000 suppliers to simplify processes and data requirements associated with selling goods and services to GE.
	American Express (AXP)	28 Jul 2008	American Express Business Travel announced plans to launch a business-to-business online networking community for the corporate travel industry. A first-of-its-kind resource, BusinessTravelConnexion.com will bring together a consortium of industry decision makers, suppliers, and experts in the industry's most extensive online, community platform.
New Product Development and Idea Generation	Dell (DELL)	16 Feb 2007	At Dell IdeaStorm (www.dellideastorm.com), users are asked to post ideas for new products and feedback on current Dell offerings. Users can rate ideas, using a voting function similar to popular social news site Digg. Dell said it would use some of that feedback in developing new products.
	Deutsche Bank (DB)	14 Oct 2010	Deutsche Bank's global transaction business unit announced it is introducing an online community forum where clients can engage with bank staff in the development of new products. With the theme "Drive DB!", the Web 2.0-based community site lets clients participate in steering product design and development through online voting, debates and information sharing with other clients and with product, sales and service experts at Deutsche Bank.
	Hyundai Motor	9 Feb 2009	Hyundai Motor America today announced it has partnered with Passenger, the technology leader in on-demand Customer

	(HYMTF)		Collaboration, to create the “Hyundai Think Tank,” a private online community for Hyundai owners. Hyundai Think Tank members will help shape the future of the brand and new products through online discussions, facilitated meetings with executives and other activities.
Public Relations and Corporate Social Responsibility	Sears (SHLD)	24 Aug 2011	In its latest initiative to support America’s military members, Sears has teamed with Rebuilding Together to conduct “Operation Rebuild for Heroes at Home,” a social media contest that gives communities across the U.S. the opportunity to help servicemen and women in need.
	Merck (MRK)	10 Feb 2011	Merck Serono, a division of Merck, today announced the launch of UniteMS.net, a groundbreaking international social network designed specifically for people living with and affected by multiple sclerosis (MS) around the world. UniteMS is intended to offer a digital venue for the MS community to empower themselves through best in class information, gain inspiration from worldwide stories of hope, and explore a trusted environment with the most and easiest avenues to communicate with peers.
	Western Union (WU)	27 Oct 2008	The Western Union Company (NYSE:WU) and the Western Union Foundation today announced the launch of a new online platform for social giving, ‘Our World Gives’: http://apps.facebook.com/ourworldgives . Aimed at reaching the 18 million members of the Facebook social networking site, the program seeks to increase awareness of critical social issues and charitable community spirit.
Customer Service and Customer Relationship Management	Delta Air Lines (DAL)	30 Jun 2010	Delta Air Lines is expanding its use of social media as a customer service tool, launching a pilot program this month with a five-person team to respond to customer concerns sent to the airline on Twitter.
	Royal Bank of Scotland (RBS)	16 Nov 2011	The Royal Bank of Scotland group is turning to social media to expand its ‘helpful banking’ positioning, with a social CRM initiative that will allow consumers to give feedback on banking with its NatWest and RBS chains.
	Vodafone (VOD)	26 Oct 2011	Vodafone is to roll out a new customer service system to help capture the increasing number of social media communications the telco is experiencing with its customer base. The new system, as part of the telco’s ‘One Connect’ strategy, will seek to capture tweets and Facebook messages along with more traditional email, voice and SMS-based customer enquiries.
Sales and Marketing	Delta Air Lines (DAL)	12 Aug 2010	Delta Air Lines Inc. said Thursday it’s launched a new “Ticket Window” on Facebook that will allow passengers to book directly on the social media site. It’s the first time an airline has allowed customers to reserve flights on Facebook.
	Live Nation (LYV)	23 Jan 2007	Live Nation announced that it has signed a deal with the internet’s social music network, Last.fm, agreeing to provide the music fan website with U.S. and Canadian concert information from LiveNation.com. The direct feed to Last.fm will give music fans instant access to concert information, as well as links to purchase tickets.
	Walt Disney (DIS)	03 Jun 2010	The Walt Disney Co. has created what it believes is a first-of-its-kind application allowing Facebook users to buy tickets to Toy Story 3 without leaving the social networking site and while, at the same time, prodding their friends to come along. The application, called Disney Tickets Together, could transform how Hollywood sells movie tickets by interweaving purchases with the forces of social networking.

Table 2

Summary information on performance measures and social media initiatives.

	Operational Efficiency	Innovativeness
Number of sample firms	281	281
Sample periods for dependent variables [no. of two-year consecutive data obtained]	7 years (2006-2012) [i.e., 6 two-year consecutive data]	7 years (2006-2012) [i.e., 6 two-year consecutive data]
Total number of consecutive firm-years with consecutive data	1,686 (281 firms x 6 years)	1,686 (281 firms x 6 years)
No. of <i>effective firm-years</i> with available consecutive data	1,159 out of 1,686 (68.7%)	1,125 out of 1,686 (66.7%)
Sample time periods for independent variable (i.e., social media initiatives)	6 years (2006-2011)	6 years (2006-2011)
Total number of social media initiatives from 2006-2011	841 announcements	841 announcements
Total number of social media initiatives in the <i>effective firm-years</i>	730 announcements in 1,159 firm-years	690 announcements in 1,125 firm-years
Average number of initiatives per firm per year in the <i>effective firm-years</i>	0.629 (ranged from 0 to 30)	0.613 (ranged from 0 to 30)
Number of firm-years with at least one initiative in the <i>effective firm-years</i>	320 out of 1,159 (27.61%)	310 out of 1,125 (27.55%)

Table 3

Descriptive statistics of sample firms.

Panel A: The distribution of sample firms across industries					
2-digit SIC codes	Industries	Firm frequency	Firm percentage		
36	Electronic & other electric equipment	27	9.6%		
73	Business services	27	9.6%		
28	Chemical & allied products	25	8.9%		
35	Industrial machinery & equipment	24	8.5%		
37	Transportation equipment	15	5.3%		
38	Instruments & related products	15	5.3%		
20	Food & kindred products	12	4.3%		
50	Wholesale trade - durable goods	11	3.9%		
53	General merchandise stores	11	3.9%		
26	Paper & allied products	9	3.2%		
51	Wholesale trade - nondurable goods	9	3.2%		
80	Health services	8	2.8%		
25	Furniture & fixtures	7	2.5%		
56	Apparel & accessory stores	7	2.5%		
58	Eating & drinking places	7	2.5%		
63	Insurance carriers	6	2.1%		
33	Primary metal industries	5	1.8%		
48	Communications	5	1.8%		
54	Food stores	4	1.4%		
79	Amusement & recreation services	4	1.4%		
Other SIC codes	Other industries	43	15.3%		
Panel B: The characteristics of sample firms					
Variable	Unit	Mean	Std. deviation	Minimum	Maximum
Sales	Millions of dollars	30362.34	53309.11	1318.80	444948.00
Total assets	Millions of dollars	34084.31	72599.20	487.50	797769.00
Operating income	Millions of dollars	4678.65	8651.23	5.00	78669.00
Number of employees	Thousands	81.92	166.46	1.02	2200.00
Cost of goods sold	Millions of dollars	20602.57	41232.78	80.30	359806.16
Capital expenditure	Millions of dollars	1463.70	3635.29	3.66	30975.00
Return on assets	Ratio	0.15	0.07	0.00	0.63
Age	Years	65.91	45.20	1.00	209.00
R&D expense	Millions of dollars	916.66	1805.31	0.00	10991.00
Advertising expense	Millions of dollars	684.50	1182.78	0.60	9315.00

Table 4

Correlation matrix.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Operational Efficiency	1									
2. Lagged Operational Efficiency	0.799**	1								
3. Innovativeness	0.178**	0.184**	1							
4. Lagged Innovativeness	0.174**	0.186**	0.798**	1						
5. Social Media Initiatives	0.120**	0.108**	0.121**	0.088**	1					
6. Firm Size	0.062*	0.066*	0.261**	0.237**	0.215**	1				
7. Firm Profitability	0.508**	0.399**	0.099**	0.104**	0.046	0.007	1			
8. Firm Age	0.045	0.062*	0.056	0.057	-0.026	0.145**	-0.023	1		
9. Firm R&D Intensity	0.302**	0.298**	0.053	0.067*	0.008	-0.095**	0.062*	-0.042	1	
10. Firm Advertising Expense	0.120**	0.149**	0.116**	0.110**	0.115**	0.555**	0.048	0.264**	0.109**	1
Mean	0.668	0.668	0.226	0.208	0.070	9.599	0.147	3.937	0.044	5.536
Standard Deviation	0.107	0.108	0.931	0.923	1.129	1.180	0.067	0.807	0.066	1.692

* $p < 0.05$, ** $p < 0.01$.

Table 5

The impact of social media initiatives on operational efficiency.

Variable	System GMM	OLS
Intercept	0.715** (2.611)	0.212** (6.425)
Lagged Operational Efficiency	0.153** (3.701)	0.607** (13.714)
Social Media Initiatives	0.003* (2.417)	0.002* (2.239)
Firm Size	-0.005 (-0.222)	0.005 (1.936)
Firm Profitability	1.049** (9.776)	0.464** (8.260)
Firm Age	-0.058 (-1.771)	0.001 (0.282)
Firm R&D Intensity	-0.214 (-1.238)	0.169* (2.501)
Firm Advertising Expense	-0.010 (-0.909)	-0.001 (-0.546)
Year Dummies	Included	Included
Industry Dummies	Included	Included
Number of firm-year observations	1159	1159
Wald Chi-square	217.38**	
Sargan statistic	$p = 0.42$	
AR(1)	$p = 0.03$	
AR(2)	$p = 0.56$	
R-squared		0.72
F-value		65.89**

Notes:

1. * $p < 0.05$, ** $p < 0.01$.
2. t -statistics are in parentheses.

Table 6

The impact of social media initiatives on innovativeness.

Variable	System GMM	OLS
Intercept	-2.612 (-1.243)	-0.917** (-3.523)
Lagged Innovativeness	0.131* (2.339)	0.759** (40.282)
Social Media Initiatives	0.036** (2.657)	0.030* (2.322)
Firm Size	0.331* (2.221)	0.074** (3.121)
Firm Profitability	0.276 (0.357)	0.600* (2.102)
Firm Age	0.045 (0.089)	-0.006 (-0.214)
Firm R&D Intensity	0.738 (1.285)	0.366 (1.076)
Firm Advertising Expense	-0.117 (-1.585)	-0.005 (-0.328)
Year Dummies	Included	Included
Industry Dummies	Included	Included
Number of firm-year observations	1125	1125
Wald Chi-square	32.38*	
Sargan statistic	$p = 0.34$	
AR(1)	$p = 0.00$	
AR(2)	$p = 0.24$	
<i>R</i> -squared		0.66
<i>F</i> -value		64.74**

Notes:

1. * $p < 0.05$, ** $p < 0.01$.
2. *t*-statistics are in parentheses.

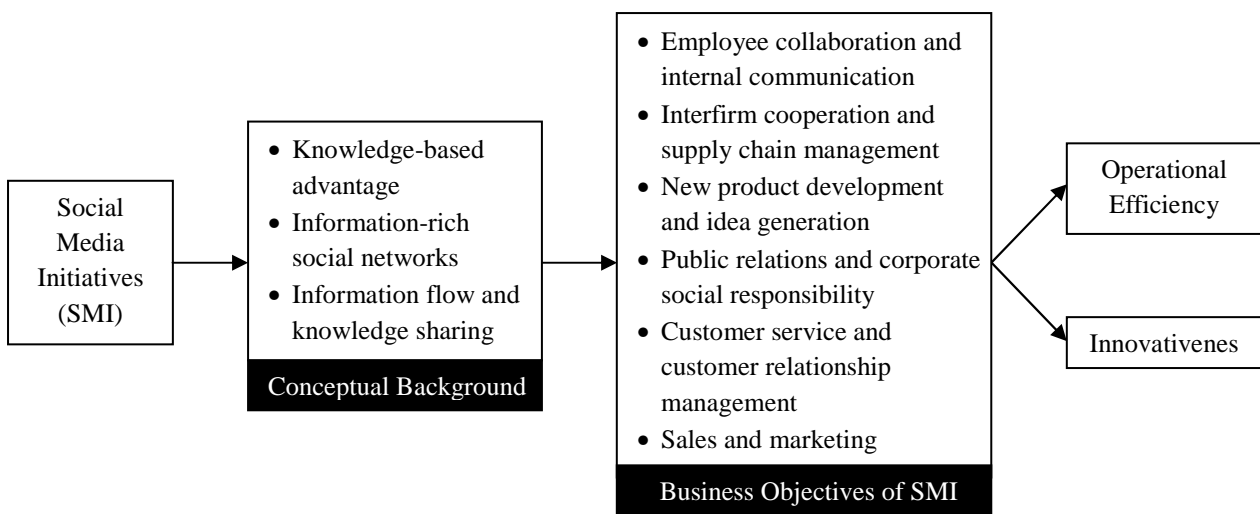
Table 7

Difference-in-difference results.

	Difference-in-difference	<i>N</i>	<i>t</i> -statistics	<i>p</i> -value
Operational Efficiency	0.005	315	2.097	0.037
Innovativeness	0.120	300	3.840	0.000

Figure 1

The conceptual framework of our research.



Appendix

A social media initiative announcement extracted from Factiva.

DOW JONES

Honeywell Chooses Connectbeam for Social Bookmarking and **Social Networking**; New **social software** allows enterprise users to connect and collaborate on demand

420 words

18 April 2007

12:00 GMT

PR Newswire (U.S.)

PRN

English

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REDWOOD CITY, Calif., April 18 /PRNewswire/ -- Connectbeam, Inc., a leading provider of enterprise **social software**, announced today that it has been chosen by global technology company **Honeywell** (NYSE: HON) to provide social bookmarking and tagging, expertise location, and enterprise **social networking** capabilities to **Honeywell** employees. Using Connectbeam software, **Honeywell** knowledge workers will be able to locate and manage information together while easily networking with each other's knowledge, interests and skills in a secure, behind the firewall implementation.

Honeywell's implementation is based on Connectbeam's Social Bookmarking & Networking Appliance, a pre-configured appliance server deployed behind the enterprise firewall, and Connectbeam's Application Connector for Google Enterprise Search.

Honeywell's * has posted about the Connectbeam implementation at http://econtent.typepad.com/econtent/2007/03/tagging_inside_.html.

* Connectbeam's CEO, commented, "Connectbeam solves two key problems facing every enterprise worker: how to find information that they can be certain is current, accurate and significant, and how to locate and connect with knowledgeable colleagues."

"Connectbeam's integration with Google Enterprise Search was important to **Honeywell**," added Connectbeam Vice President of Sales, * "By making Google search results more useful, Connectbeam helps **Honeywell** employees do better, more efficient work, while improving the company's ROI on its Google search investment."

Integration with enterprise search, from Google and a number of other vendors, allows Connectbeam to provide social search. Search results now highlight information from your colleagues' searches, especially the information that they have found most useful. Connectbeam also points the user to related searches that can extend knowledge. Most important, Connectbeam social search instantly and effortlessly identifies and connects enterprise workers with colleagues whose interests and knowledge enhances theirs. Connectbeam integration means that every enterprise search increases collective intelligence and makes it easily available to enterprise workers.

About Connectbeam: Connectbeam is a leading provider of Enterprise 2.0 **social software**, bringing **Web 2.0** information-sharing and ease of use to the enterprise, so that organizations and their employees can connect and collaborate on demand. Privately held, Connectbeam is located in California's Silicon Valley. More information about Connectbeam and its offerings can be found at <http://www.connectbeam.com>.

SOURCE Connectbeam, Inc.

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