

ASSESSING ECONOMIC PAYOFF OF CLOUD COMPUTING: MARKET EXPECTATION AND FIRM PERFORMANCE

Completed Research Paper

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Abstract

This study aims to assess economic payoff of organizational cloud computing adoption and identify complementary conditions under which firms are likely to achieve significant returns on their cloud computing investment based on market expectation. Employing the event study methodology, we analyze 219 firm-level announcements regarding cloud computing adoption. Also, in the study, we seek to investigate the post adoption effect of cloud computing on firms' financial performance in the longer horizon. From the results, we identified differences in the effect of cloud computing adoption on market returns according to adoption intention, firm size, industry sector, and cloud computing types. In the post adoption perspective, the empirical results presented that cloud computing led to significant impact on firm performance (e.g., ROA, ROS, and selling, general, and administrative expenses). These results can be used as useful references for understanding whether and in what ways cloud computing contributes to firms' business value.

Keywords: Cloud computing, event study, firm performance, market value of the firm, service innovation.

Introduction

In today's highly competitive and global business environment, firms face a difficult set of challenges in their efforts to improve their strategic and technological agility, and try to reduce the complexities of their business operations to sustain their business competence. Cloud computing leverages modern information technologies into a new business computing environment in response to the growing need for greater business integration, flexibility, and agility. As such, cloud computing is an innovative way to provide various on-demand IT services to multiple clients by using Internet technologies in a pay-per-use manner (Armbrust et al. 2009; Plummer 2008). Cloud computing is not limited to a technology infrastructure; rather, it reflects a new way in which IT can be used more strategically in business value creation. For example, IT cost reduction from the use of cloud computing eventually implies increase in a firm's slack resources that can be put into business-centric activities. Cloud computing offers various types of off-the-shelf IT capabilities (e.g., software, hardware, and platform) that can be instantly deployed in an organization. The feature implies that a firm can swiftly access to required IT resources for supporting its business processes and strategies, thereby contributing to improving business competence. For this reason, initiating cloud computing encourages business practitioners and IT researchers to better understand how its potential benefits can be maximized and address the problems inherent in successfully developing and implementing a new IT innovation in the organization.

Although the real application of cloud computing in the business environment has recently emerged (Staten 2008), few studies have examined this new IT and business phenomenon. The situation has left many untapped areas of research and will continue to do so as cloud computing evolves over time. The current study focuses on validating the economic values of cloud computing. For firms which are interested in deploying cloud computing, it is necessary to investigate economic consequences attributed from cloud computing investment. Suspicious opinions have emerged on the economic validity of cloud computing in the industry and academics (Brynjolfsson et al. 2010). From the research perspective, it is critical to clarify the economic salience of deploying this IT service innovation in a real business environment and specify the optimized conditions under which a firm can realize business values from cloud computing adoption.

Key research questions that motivate the first study are: (1) Does cloud computing investment receive a positive reaction from the market in terms of expected return? (2) How is the market reaction to cloud computing deployment different depending on contextual factors (e.g., firm size, industry, strategic intention, and cloud computing types)? (3) Does cloud computing result in improved firm performance after the years of its deployment? In order to understand economic payoff of cloud computing with diversified research perspectives, we, in this study, specify the 'payoff' into two ways: measuring the gain of market value of adopting firms and indentifying whether to improve their business performance. The basic idea of the first approach is based on investigating how investors evaluate the market value of the firm upon its cloud computing deployment (McWilliams and Siegel 1997). Employing the event study methodology, we analyzed 219 firm-level announcements regarding cloud computing adoption. As the complementary way of investigating post adoption effect, we compared average ROA performance of sample firms (since the year of adoption) to that of overall market. We also investigated whether cloud computing adoption eventually resulted in improved firm performance such as return on asset (ROA), return on sales (ROS), selling, general, and administrative expense (EXSGA), and growth rate of sales (GR).

The results indicated that cloud computing adoption was associated with positive increases in the firm's market value. In addition, we found that differences existed in market returns to cloud computing adoption according to the strategic adoption intention, firm size, and industry sector. From the perspective of business performance, our samples (i.e., firms adopting cloud computing) showed better ROA performance compared to market average ROA performance. Additionally, the empirical results indicated that cloud computing led to significant positive impact on firm performance such as return on asset (ROA), return on sales (ROS), and selling, general, and administrative expenses (EXSGA). In particular, the results suggested positive and significant relationship between investors' expectation for cloud computing adoption (measured by market returns) and adopting firms' realized financial performance. These results provide useful implications for the firm's decision-making about whether to adopt cloud computing to maximize its business value.

The rest of the paper is organized as follows: In Section 2, we discuss the concept of cloud computing including its differentiated characteristics. Section 3 provides the theoretical background of the current study. We develop our hypotheses in Section 4. Section 5 is devoted to the description of the event study methodology and our data for analysis. In Section 6, we present the results with hypotheses testing related to the influence of the adoption of cloud

computing on firms' market value. In Section 7, we provide an additional insight into the value of cloud computing by analyzing the relationship cloud computing adoption and firm performance. In Section 8, we discuss research implications from the empirical results. Section 9 concludes.

Conceptualization of Cloud Computing

Cloud computing has become one of the most prominent topics in the IT industry (Plummer 2008; Staten 2008). However, the identity of cloud computing remains unclear as the real application of cloud computing has just come into place for enterprise IT services. Thus, we attempt to identify the essential properties of cloud computing covering the definition of cloud computing, its characteristics, and business values.

Definition and Characteristics of Cloud Computing

Several opinions have been introduced for the definition of cloud computing. They embrace some overlapping notions depicting a universal image of "what cloud computing is." First of all, cloud computing can be seen as the use of Internet technologies for the provision of IT resources, implying highly adaptable, scalable, and ubiquitous IT services. Another overlapping key notion is that the new IT service practice can be applicable to a wide spectrum of IT service areas covering infrastructure, platform and application. Finally, the concept of cloud computing emphasizes the differentiated usage context conceptualized as "pay-by-use billing" and "on-demand service." Therefore, we define cloud computing with a simplified context as "an innovative way of providing various on-demand IT services for multiple clients using Internet technologies in pay-per-use manners."

The differentiated features of cloud computing can be broadly defined in four ways: (1) service-oriented design, (2) service delivery over the Internet, (3) flexible use of shared service, and (4) pay-per-use-billing. Within each key attribute, more detailed features of cloud computing are defined. See Table 1 for further details. These features as a whole characterize cloud computing as a new innovative IT service model capable of transforming existing IT operations.

Table 1. Characteristics of Cloud Computing		
Perspective	Key Attribute	Details
Resource Design	Service-Orientation	<p><u>IT service commoditization</u>: Standard offerings are defined by service providers as "off-the-shelf" items for external customers.</p> <p><u>On-demand self-service</u>: Service contents and necessary functions are provided at customers' request. Customers are free to initiate and terminate services without involving the service providers.</p> <p><u>Technology abstraction</u>: Service providers usually (or mostly) hide complex technology implementations behind service interfaces.</p>
Resource Delivery	Delivery over the Internet	<p><u>Internet technology engagement</u>: Internet technologies deal with multiple customer service requests at a time and provide enriched service contents.</p> <p><u>Availability</u>: Internet-mediated services are highly accessible in any computers connected on-line.</p>
Resource Usage	Flexible Use of Shared Service	<p><u>Computing utility</u>: Service providers own computing resources and supply them as utility products for multi-tenancy.</p> <p><u>Elasticity</u>: More flexible IT capabilities are adjusted to demand fluctuations of IT resources.</p> <p><u>Scalability</u>: Infinite capacity is allowed to scale up resource amount at a desired level.</p>
Resource Payment	Pay-per-Use Billing	<p><u>Subscription model</u>: Billing is based on the amount of service use measured according to CPU hours, data transferred, or data stored. Service providers have usage model to measure the service amount and offer different types of payment plans.</p>

Cloud Computing from Innovation Perspective

Previous IS literature provides a theoretical background for interpreting the identity of cloud computing from innovation perspective. According to the IS innovation typology (Swanson 1994), cloud computing can be viewed

as a Type III innovation in the sense that cloud computing can be applied to integrate various service-oriented IT resources with a firm's core business technology; such application leads to a wide scope of changes in a firm's business operation, IT management, and strategic use of IT. In the technology aspect, cloud computing aggregates modern IT features into a new business computing environment in response to the growing need for greater IT-business integration, flexibility, and agility.

Considering such characteristics, we consider cloud computing as a synthetic innovation (Hage 1980), which involves the combination of existing technologies in ways that create significantly new products or services. Cloud computing refers to a paradigm shift that offers flexible IT resources and services over the Internet. From technical point of view, cloud computing originates from a set of pre-existing technical concepts such as service-oriented architecture (SOA), distributed and grid computing, and virtualization. Although these technology components do not seem to be new, the innovativeness of cloud computing is based on its ability to aggregate existing services and generate the new way of providing computing services to customers. These theoretical perspectives support innovation features pertaining to cloud computing and emphasize its strategic role of business value creation in organizations.

Comparison of Cloud Computing to Traditional IT Service Models

As discussed in the previous section, from an IT provisioning perspective, cloud computing has the potential to innovate the practice of computing resources deployment, transform traditional IT service value chain, and bring chance for new IT business models. Linked with such potentials, cloud computing presents several differentiated features compared to the traditional model of IT provision.

First, cloud computing shifts the ownership of IT resources from the client side to the service provider side and supplies such resources as service items (Cearly and Smith 2009; Plummer 2008). The change in ownership implies that under the cloud computing environment, prior IT capital expenditure is transformed into operational cost, which should reduce the financial burden associated with the initial IT implementation and its subsequent maintenance (Cearly and Smith 2009).

Second, natures of cloud computing, such as elasticity and scalability, provide users with a more flexible resource management basis on which the amount of IT resources supplied to clients can be adjusted according to fluctuations in customer demand (Armbrust et al. 2009). The feature prevents resource shortages in case of under-provision and resource waste in case of over-provision. Such benefits consequently are self-reinforced by generating slack resources that can be allocated to more business-oriented tasks in organizations.

Third, the service interface of cloud computing and IT commoditization features provide clients with enhanced technology abstraction hiding detailed technology expertise behind cloud computing service items, reducing the burden of on-site system implementation (Staten 2008). Cloud computing offers various types of off-the-shelf IT services that can be instantly deployable to business processes of enterprise customers. The differentiated features enable clients to use on-demand IT and business functions reflecting the latest technology trends. Thus, by exploiting cloud computing, clients are able to follow up-to-date technology features without the burden of on-site system implementation and periodical maintenance and upgrades (Staten 2008).

Finally, cloud computing presents a different shape of IT service value chain. Through an increased service orientation and a continuing technology standardization, the classical IT service value chain has been transformed; the model of single-provider or one-stop provision of IT outsourcing is replaced by a cloud computing service network in which different service providers offer a wide range of cloud computing services at different IT infrastructure levels (e.g., software, hardware and platform). The emerging cloud computing service network allows users to deploy virtual and asset-free IT resources and also allows service providers to reorganize their existing services and offer new combinations of IT capabilities.

Theoretical Background

IT Investments and Firm Performance

Firms' Investments in information technologies have increased rapidly over the past three decades. These investments have affected firms' products, services and internal processes (Dos Santos et al. 1993). Today, most

organizations recognize that information technologies play an extremely important role in sustaining their business operations.

Some previous IS studies have made plausible claims that investments in IT can have important strategic consequences. This literature suggests that IT investment decisions have the potential either to improve a firm's competitive position or to allow the firm to become more vulnerable to competitive forces (Cash and Konsynski 1985; Ives and Learmonth 1984; Porter and Millar 1985). However, it is also ironic that as organizational investment in IT has increased, evaluating the effectiveness of IT in investments becomes elusive (Im et al. 2001), making it harder for IS researchers to identify the clear link between IT investment and firm performance. Does IT really pay off? Not surprisingly, numerous studies have attempted to answer this question. Some studies show that IT has made a significant contribution to productivity (Bharadwaj et al. 1999; Brynjolfsson and Hitt 1996; Brynjolfsson and Hitt 1998; Brynjolfsson and Yang 1997; Lee and Barua 1999; Menon et al. 2000). On the other hand, the results of other empirical studies relating IT investments and firm performance have been equivocal (Hitt and Brynjolfsson 1996; Weill 1992). Given these contradictory results, it has been argued that the intangible benefits of IT, such as improved quality, variety, timeliness, and customization, have not been appropriately measured primarily due to the use of conventional productivity measurement techniques (Brynjolfsson 1993; Brynjolfsson and Hitt 1998). Furthermore, as many factors influence firm performance, it is difficult to establish clear and proprietary causality between IT investments and firm-level performance (Im et al. 2001).

The review of IT productivity literature demonstrates that our understanding of business value of IT is still in infancy. While prior studies have focused on the economic impact of IT under the production function framework, our understanding is still limited due to un-measurable benefits that accrue from innovative IT practice such as cloud computing. Accordingly, we are motivated to apply alternative perspectives to analyze IT's contribution to firm performance.

Event Study on the Firm's Market Value

To provide a different way of measuring business performance, some IS researchers have adopted a stock market valuation approach based on the event study methodology, which is an efficient way to capture investors' overall assessment of a firm's value (McWilliams and Siegel 1997). The event study usually measures the stock market's reaction to unexpected events (e.g., announcements) to estimate how the event impacts the value of the firm. The underlying assumption is that capital markets are sufficient for evaluating new information about the key event (Fama et al. 1969), including IT investment, which can potentially impact the firm's expected future profits. This methodology has been recently used within IS literature. For example, the impact of unexpected announcements has been studied in regard to IT investment in general (Dos Santos et al. 1993), outsourcing (Peak et al. 2002), ERP system (Hayes et al. 2001), and so on. For cloud computing context, we can apply the event study methodology to analyze whether a number of announcements on cloud computing adoption can positively affect firms' abnormal returns on stock prices.

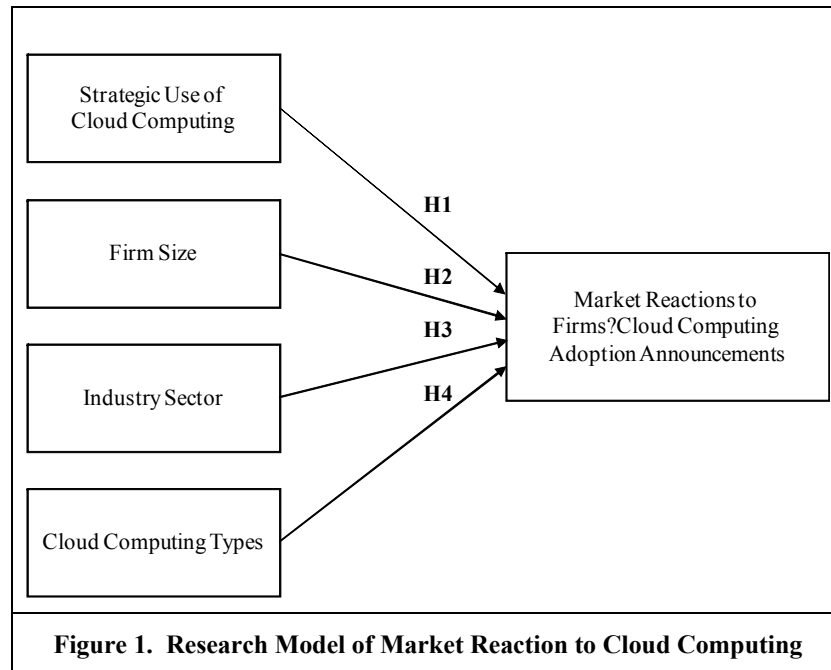
The results of prior event study works provides IS researchers with useful reference to understand the business value of IT that accounting measurements cannot control for. However, it does not necessarily imply that event study is the one that substitutes traditional IT productivity research. Rather, we understand that both approaches are complementary for each other to produce more diversified results for IT's contribution to creating business values. The review of IT productivity and event study literature finally provides theoretical background that motivates us to combine these two approaches to evaluate business values of cloud computing in broader perspectives such as market value and firm performance.

Research Model and Hypothesis

As previously discussed, the study seeks to identify complementary conditions under which firms are likely to achieve significant returns on their cloud computing investment based on market expectation. To this end, we propose several contextual factors that capture the firm's organizational and environmental aspects and technological features of cloud computing. More specifically, strategic use, firm size, industry sector, and cloud computing types are implemented in the research model as contextual factors to investigate their effects on the level of market expectation.

Strategic use refers to the purpose and the way in which a firm utilizes cloud computing from the perspective of strategic IT use. Firm size and industry sector represent organizational and environmental aspects of technology

adoption. Finally, cloud computing type reflects a primary technological feature of cloud computing that embraces various on-demand IT capabilities including software, hardware, and platform. Aggregating arguments regarding proposed contextual factors below, we present the research model as follows.



Strategic Use of Cloud Computing and Market Expectation

The basic idea of incorporating strategic use as an influencing factor is that market's evaluation of the expected value of the adopting firm can be different depending on business purposes of utilizing cloud computing. IT investments usually play a variety of strategic roles in sustaining and enhancing firms' business competence in the market. These roles are different according to firms' business goals and the context to which IT is applied. Prior literature suggests that strategic use of IT in organizations conceptually includes three categories (Schein 1992; Zuboff 1988): automating business processes for increased efficiency (automotive), facilitating virtual communications to senior management for better decision making (informative), and redefining business practices and industry relationships for creating new market (transformative). These types of strategic IT use are closely related to the firm's business strategies to create sustainable competitive advantages in two ways: operational efficiency, which attempts to improve internal work productivity, and strategic positioning, which aims to enhance business capabilities in the market (Chatterjee et al. 2001; Tallon et al. 2000).

However, previous IS studies argue that even for the new innovative technology like cloud computing, market expectations of such IT investments could be different depending on the purpose and way of utilizing the technology (Dehning et al. 2003; Dos Santos et al. 1993; Im et al. 2001). For instance, Dehning et al. (2003) posit that benefits from efficiency-oriented IT investments (e.g., automotive and informative) are to be short-lived because the practice is easy to be duplicated by competitors. For this reason, market will not positively react to these investments. Reversely, for IT investments focused on strategic positioning (e.g., transformative), market expectations would be higher because such investments can result in new business models and provide unique products and services that are difficult to be imitated by other competitors.

Drawing from such theoretical arguments, we expect that the market will react to firms' cloud computing deployment in different ways based on their strategic intention as shareholders and investors can usually evaluate the future value of the firm through the cloud computing adoption events. Thus, we propose the follow hypothesis:

Hypothesis 1: Cloud computing adoption announcements produce a significantly different level of abnormal shareholder returns according to strategic intention.

Firm Size and Market Expectation

The study also examines how market expectations of cloud computing deployment are affected by firm size. In IS literature, the relationship between firm size and IT has been widely investigated from different academic aspects such as technology adoption, IT investments, and market reactions to IT practices. In particular, mixed arguments and empirical results have been presented in terms of firm size effect on IT investments. Dewan et al. (1998) find that the level of IT investment is positively related to the degree of firm size including business scope and scale. Harris and Katz (1991) examine the relationship between IT intensity (i.e., the ratio of IT expenses to total expenses) and firm size. They find that small firms present relatively higher IT intensity than large firms do. Richardson and Zmud (2001) posit that small firms are more likely to sustain competitive advantages brought by IT investments compared to large firms because small firms are in less structural inertia and organizationally more agile in censoring, adopting, and internalizing new technologies for commercial purposes.

From information disclosure perspective, some studies consider firm size a proxy for the amount of pre-disclosure information and posit that it is more difficult for the market to be aware of the actions of small firms compared to large firms (Atiase 1985; Bamber 1986; Ziebart 1990). In short, the smaller firms are, the less likely they are to be disclosed as sources of information. Thus, all things being equal, the amount of unexpected information conveyed to the market by IT investment announcements should be inversely related to firm size (Im et al. 2001). Therefore, it would be expected that IT investment announcements of smaller firms marginally have more information content than those of larger firms. Then, the market reaction would be more favourable to IT investment announcements brought by smaller firms.

Other than the arguments suggested by previous literature, cloud computing itself has plausible potentials for small and medium-size enterprises (SMEs) who would like to put their resources more on building their businesses rather than making significant IT investments (Plummer 2008; Staten 2008). For SMEs struggling to acquire sufficient IT resources, the value proposition of providing various Internet-mediated IT capabilities with less or no up-front capital investment makes cloud computing a viable and affordable IT service model for SMEs. The situation may lead to more favorable market reaction to cloud computing initiatives by SMEs than those by large firms.

Aggregating such advantageous features of cloud computing and theories related to firm size effect on IT investments, we expect that market expectations of firms' cloud computing deployment can be different based on whether the client of cloud computing is a large firm or SME. Thus, we present the following hypothesis:

Hypothesis 2: Cloud computing adoption announcements produce a significantly different level of abnormal shareholder returns according to firm size.

Industry Sector and Market Expectation

Industry has frequently been considered as a salient influencing factor in several event study works (Dehning et al. 2005; Im et al. 2001; Oh and Richardson 2006; Telang and Wattal 2007). Although IT has been known as a major key factor in changing business practices, its role and impact may vary with industry types (Melville et al. 2004).

Previous studies have examined the relationship between industry sector and IT investments mostly based on information intensity attributed to industry characteristics (Cash et al. 1992, Jarvenpaa and Ives 1991). The most popular academic example is investigating the difference of industry effect on the level of IT investments between service firms (e.g., especially financial firms) and manufacturing firms. In general, service firms have more complex business models and are more broadly connected with customers and partners through direct and indirect business networks (Dewan et al. 1998). Under such business environment, service firms are prone to make broad and intensive IT investment to sustain their competitive advantages in the market.

From the perspective of market expectations, some studies argue that a service firm's IT investment decision can be considered as a major technological event, while a manufacturing firm's IT investment decision may not because IT investments from service industry side are usually expected to provide more impact on business performance than those from manufacturing industry (Cash et al. 1992, Jarvenpaa and Ives 1991, Johnston and Carrico 1988, Porter and Millar 1985). Also, in previous event study works, it has been suggested that the market shows more positive reactions to IT investment announcements brought by service firms than manufacturers although the studies have provided mixed empirical results (Dos Santos et al. 1993; Im et al. 2001; Oh and Richardson 2006).

Based on the theoretical arguments and empirical results, it would be expected that outcomes of IT investments may differ across industry sectors. More specifically, the service industry, which requires more information-intensive capabilities, tends to be affected to a greater degree than the manufacturing sector from cloud computing deployment (Porter and Millar 1985). This leads to:

Hypothesis 3: Cloud computing adoption announcements produce a significantly different level of abnormal shareholder returns according to industry sector.

Cloud computing Types and Market Expectation

Cloud computing can be regarded as a new IT provision model that delivers several forms of service-oriented IT capabilities. In other words, cloud computing is based on the concept of using the Internet to allow users to access technology-enabled services in the layers that consist of various types of information systems such as software, hardware, and platform. Categorized into different layers, cloud computing services are described in three types: software-as-a-service (SaaS), platform-as-a-service (PaaS), and hardware-as-a-service (HaaS). SaaS is the cloud application layer and provides Internet-enabled business applications that are instantly applied to end-users' business processes. PaaS is the cloud software environment layer that provides a programming language environment for cloud application developers. HaaS refers to virtual computational resources (e.g., server, storage, and communication network) that serve cloud applications and platforms.

Previous event studies on IT investments have examined various IS contexts covering from hardware infrastructure to applications. The results of those studies have yielded a different set of outcomes depending on investors' business expectations and characteristics of adopted IS (Dos Santos et al. 1993; Hayes et al. 2001; Im et al. 2001; Peak et al. 2002). In particular, Chatterjee et al. (2002) assess several IT investment announcements to examine whether IT infrastructure investments result in positive market expectations. They empirically find that IT infrastructure investments generate greater positive market returns than IT applications investments do. With this finding, they argue that the market more favorably reacts to IT infrastructure investments rather than IT applications investments as IT infrastructure has potentials to bring more innovative changes to a firm's business operations and strategies.

The impact of cloud computing can be different in the similar way that investors are likely to evaluate firms' cloud computing practices based on which cloud computing resources to be deployed for what business purposes. The market would prefer infrastructure-related cloud computing investment due to the expectations of relatively higher returns in the future. Thus, it would be anticipated that investors' and shareholders' reactions to a firm's cloud computing announcements can be different depending on the expectation of cloud computing on firm performance and the features of cloud computing types. This leads to:

Hypothesis 4: Cloud computing adoption announcements produce a significantly different level of abnormal shareholder returns by cloud computing types.

Research Method

Event Study Methodology

To investigate market reaction to firms' cloud computing investment, event study is applied as a primary research methodology. Recently, the event study has emerged as a pervasive mechanism by which researchers can explore the relationship between IT investments and business performance because the method provides the ability to measure investors' perceptions of the intangible costs and benefits associated with IT investments (Chatterjee et al. 2002; Dehning et al. 2005; Dos Santos et al. 1993; Im et al. 2001). For this reason, IS researchers have widely used the event study methodology as a relevant tool that can assess the business performance related to IT investments using market-based measures such as stock price or trading volume. The methodology draws upon the efficient market hypothesis (Fama et al. 1969) that capital markets are efficient mechanisms to process available information on firms. The logic underlying the hypothesis is the belief that investors in capital markets process publicly available information on firm activities to assess the impact of such activities; not only on current performance but also on the firm performance in future periods (Subramani and Walden 2001).

The key procedure of event study analysis is calculating abnormal returns responding to firms' cloud computing announcements. To measure the impact of a cloud computing adoption event, we need to estimate the normal return of the stock as it would have been had the event not occurred. The approach produces the following regression:

$$R_{s,t} = \alpha_s + \beta_s R_{m,t} + \epsilon_{s,t} \quad (1)$$

where $R_{s,t}$ is the return of stock s on day t , and $R_{m,t}$ is the market return on day t . α_s and β_s are firm-dependent coefficients to be estimated. The $\epsilon_{s,t}$ is a random error term for stock s on day t .

Using this equation, we can derive the abnormal return (AR), which indicates the difference between the expected returns based on general market movement and the actual returns shown as following:

$$AR_{s,t} = R_{s,t} - (\alpha_s + \beta_s R_{m,t}) \quad (2)$$

where α_s and β_s are the coefficients of the parameters obtained from ordinary least squares (OLS). In turn, the abnormal returns are simply the prediction errors of the model in equation (1).

The stock's abnormal return provides an estimate of the economic worth of the event (Brown and Warner 1980). Once abnormal returns of sample cloud investment announcements are calculated, a cumulative abnormal return (CAR) can also be calculated by aggregating all sample abnormal returns across the event window, which is defined as plus and minus a certain number of days from the event date (e.g., ± 5 days or ± 10 days). In order to avoid confounding effects due to the wide range of the event window (McWilliams and Siegel 1997), a narrow event window such as ± 1 day from the event is applied in the study. CAR for all sample abnormal returns usually represents the overall effect of cloud computing investment on the firm's market value. Finally, CAR is examined to verify its statistical significance using t-test with the null hypothesis that CAR is equal to zero.

Analysis Model

Other than the calculation and statistical test of CAR, we specify a regression model to empirically validate the hypotheses argued in the previous section. The model uses CAR as a dependent variable and incorporates four contextual factors corresponding to hypotheses 1 through 4 as independent variables. The model specification used in the study is described as follows:

$$CAR_i = \beta_0 + \beta_1 \text{Strategic_Use}_i + \beta_2 \text{Size}_i + \beta_3 \text{Industry}_i + \beta_4 \text{Type}_i + \epsilon_i \quad (3)$$

where CAR_i is cumulative abnormal return for firm i . Strategic_Use_i indicates firm i 's strategic use of cloud computing. In order to identify each sample firm's usage type, we review the context of cloud computing adoption announcements. We use a dummy variable, coded as "0" if there are any announcements that mention a goal of increasing business process efficiency (or cost reduction). We also code as "1" those announcements that mention transformative use of cloud computing such as producing new services or products, customer service improvement, and enhancing partner relationship. Size_i denotes firm size regarding whether firm i is a large enterprise ($\text{Size}_i = 0$) or a SME ($\text{Size}_i = 1$). To identify firm size, we apply the criterion of market capitalization used to categorize publicly traded firms into "Large Cap" (larger than 10 billion dollars) and "Mid and Small Cap" (less than 10 billion dollars). Industry_i refers to industry sector to which firm i belongs. In this study, SIC code is used to identify each sample firm's industry sector: service industry firm with $\text{SIC} \geq 6000$ ($\text{Industry}_i = 1$) and non-service industry firm with $\text{SIC} < 6000$ ($\text{Industry}_i = 0$). Type_i indicates cloud computing types that firm i adopt. In the study, dummy variables are generated for reflecting three types of cloud computing: SaaS, PaaS, and HaaS.

Data

In the study, the event is defined as a public announcement of a firm's cloud computing initiative in the media. The event study methodology aims to investigate the causal relationship between such an event and market reaction represented as the variance of a firm's market value. Thus, the methodology is based on searching a large range of news reports and rigorously analyzing their contents. We followed a procedure for a sample selection as suggested by McWilliams and Siegel (1997).

The sample data were collected from a full text search of news sources such as PR Newswire and Business Wire within the Lexis-Nexis academic search engine over the period from 2005 to 2010. Search keywords included names of focal technologies (e.g., cloud computing, SaaS, PaaS, and HaaS) and some action verbs such as adopt, implement, initiate, and deploy. More than 1,000 news articles were filtered based on the following sampling

criteria: (1) announcements in daily publications; (2) announcements by firms within major security exchanges; (3) announcements containing confounding effects such as dividends, earnings, and mergers and acquisition (Im et al. 2001; Oh and Richardson 2006). In particular, to control for the confounding effect, we eliminated the firms from the sample on the day that they had experienced confounding events (McWilliams and Siegel 1997); this sampling procedure yielded 223 cloud computing announcements. In addition, in the analysis step, we eliminated cloud computing announcements with extremely high or low abnormal returns (i.e., outliers) using Cook's distance analysis. Outlier analysis ultimately yielded 219 corporate cloud computing adoption announcements from 2005 to 2010.

The daily stock returns of the individual firms were retrieved from the Center for Research on Security Prices (CRSP) database. We also used a commercial Web portal like "Yahoo Finance" and a specialized Web search engine like "Lexis-Nexis Company Dossier" to retrieve daily stock returns not offered from CRSP (particularly, stock returns dated after January 2010). We used the list of firms in the S&P 500 index to collect announcements. As a result, the announcements were mostly for firms in the S&P 500. Therefore, we applied the S&P 500 index for the market return regression. Our analytical methods are consistent with prior studies using daily stock returns. For the analysis, we used an estimation period of 120 days and calculated the CARs over one primary event window: a 3-day interval, ranging from 1 day before to 1 day after the event. The length of the estimation period and the event windows used are consistent with prior studies of capital market responses (Subramani and Walden 2001).

Analysis Results

We conducted a cross-sectional analysis of the abnormal returns by estimating equation (3) to identify the complementary conditions on which different levels of market expectation for cloud computing investment depend. To estimate the model, we used ordinary least squares (OLS) procedures. In the model, CAR_i is the dependent variable for regression analysis. Table 2 summarizes the results of regression analysis.

Table 2. Results of Regression	
Dependent Variable	CAR (± 1)
INTENTION (Strategic positioning)	-0.0097* (0.0053)
SIZE (SME)	0.0104** (0.0051)
INDUSTRY (Service)	0.0128** (0.0056)
TYPE (SaaS)	0.0064 (0.0059)
TYPE (HaaS)	0.0042 (0.0067)
N	219
F – Statistics	3.01**
R – squared	0.0532
Note: Standard errors in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.01$	

As shown in Table 2, strategic intention was found to be significant at 10% level. The direction of coefficient is negative. The result indicates that compared to external focus, internal focus has relatively higher influence level on firm's cumulative abnormal returns, and the result shows that there is different level of abnormal shareholder returns by strategic intention to use cloud computing. Thus, Hypothesis 1 is supported. Firm size was also found to be significant at 5% level, indicating that SMEs report relatively higher influence on firm's cumulative abnormal returns. Hypothesis 2 is supported. Industry sector turned out to be significant at 5% level. The result presents that firms in service industry achieve higher abnormal returns than those in non-service industry, supporting Hypothesis

3. However, cloud computing type was found to be statistically insignificant. The results indicate that there is no difference in the level of influence on firm's cumulative abnormal returns across cloud computing types. More specifically, the results suggest that the impacts of SaaS and Haas are not different from that of PaaS. Thus, Hypothesis 4 is not supported.

As an auxiliary analysis, we also assessed the overall effect of firm's cloud computing deployment on market expectation. Table 3 presents the results of the average cumulative abnormal return (ACAR) for the 219 cloud computing deployment announcements. The table also indicates the test results for the significance of the effect. The main event window used for the study is ± 1 day in order to avoid confounding effects. As the result in the table indicates, the overall ACAR over the 3-day ($-1 \sim +1$) event window of all firms releasing adoption announcements was found to be significant at the 1% level (ACAR = 0.834%, $t = 3.590$, $p < 0.01$). This indicates that investors or shareholders favourably evaluate firms' cloud computing adoption initiatives within the short period of event windows.

Table 3. Average Cumulative Abnormal Return to Cloud Computing Adoption		
	ACAR (± 1)	<i>t</i>-value
Overall Effect (N=219) ¹	0.834%	3.590***
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.01$		

Extending the Current Study: Cloud Computing and Firm Performance

So far, in the study, we have examined the influence of cloud computing investment announcements on firm's market value using event study methodology. The approach usually focuses more on reflecting market expectation of future profits of firms upon new IT adoption event. However, market-based abnormal return may not be necessarily related to the realized firm's benefit. To complement the analysis of stock market data and investigate whether the use of cloud computing actually results in higher business performance, we conducted a different type of analysis based on performance-oriented indicators.

Based on the arguments previously raised for explaining the business value of cloud computing, we expect that proper adoption of cloud computing will lead to improved performance of firms in terms of revenue growth, cost reduction, and enhanced productivity (Brown et al. 1995; Smith et al. 1998). Previous IS studies regarding firms' financial performance related with IT adoption have utilized several profit and cost ratios as performance indicators (Aral et al. 2006; Bharadwaj 2000; Hitt et al. 2002). Considering the potential benefits and examined positive market reaction to cloud computing adoption, we need to investigate financial performance realized by adopting firms after their implementation.

In this study, the measurements of firm performance are return on asset (ROA) and return on sales (ROS). Also, we use selling, general, and administrative expense (EXSGA) for testing productivity and growth rate of sales (GR) for profitability (Lim et al. 2007). All performance variables are transformed into change variables that present performance difference after 3 years from cloud computing adoption. The model specification utilized in investigating firm performance after cloud computing adoption:

$$\text{Performance}_i = \beta_0 + \beta_1 \text{INTENTION}_i + \beta_2 \text{SIZE}_i + \beta_3 \text{INDUSTRY}_i + \beta_4 \text{TYPE}_i + \beta_5 \text{CAR}_i + \varepsilon_i \quad (4)$$

Performance_{*i*} denotes the dependent variable that represents firm *i*'s financial performance including ROA, ROS, EXSGA, and GR. In order to test whether a firm's financial performance affected by cloud computing can be different according to contexts, we incorporate the contextual factors utilized for investigating market expectations (e.g., strategic intention, firm size, industry sector, and cloud computing types). Furthermore, we employ firms' abnormal returns as an explanatory variable. In the model, CAR_{*i*} is defined as firm *i*'s cumulative abnormal return

¹ In this study, we also calculated ACAR for ± 5 and ± 10 days of event windows. ACAR for the ± 5 day event window was significant at the 1% level (ACAR = 1.284%, $t = 2.76$, $p < 0.01$). Similarly, ACAR for the ± 10 day event windows turned out to be positive and significant at the 5% level (ACAR = 1.293%, $t = 2.05$, $p < 0.05$).

with the event window from -1 day to +1 day for the announcement. The results of the firm performance analysis are described in Table 4.

Table 4. Cloud Computing Adoption and Firm Performance				
Dependent Variable	ΔROA_{Y3}	ΔROS_{Y3}	$\Delta EXSAG_{Y3}$	ΔGR_{Y3}
INTENTION (Strategic Positioning)	-0.1042 (0.2376)	-0.7564 (0.1927)	0.0815 (0.0525)	0.0577 (0.0585)
SIZE (SME)	-0.4971** (0.2273)	-0.3653** (0.1813)	-0.1312*** (0.04906)	-0.0835 (0.0550)
INDUSTRY (Service)	-0.0504 (0.2753)	-0.2086 (0.2118)	0.0752 (0.0592)	0.0557 (0.086)
TYPE (SaaS)	1.2522** (0.4897)	1.0015** (0.3981)	-0.0402 (0.1057)	0.0103 (0.1209)
TYPE (PaaS)	1.4635*** (0.5579)	1.1958*** (0.4484)	-0.0551 (0.1185)	0.0363 (0.1361)
CAR (± 1)	8.9890** (3.9083)	6.9265** (3.1443)	0.4055 (0.8383)	2.0517** (0.9548)
N	94	99	93	99
F – Statistics	2.81**	2.81**	2.21**	1.32
R^2	0.1624	0.1550	0.1337	0.0795
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.01$				

As shown in Table 4, SMEs were found to be negative and significant at 5% level for both ROA and ROS, which means that small and medium-sized firms have smaller change in ROA and ROS. It is contrast to our expectation that SMEs show larger change in ROA and ROS than large firms do because it is recognized that cloud computing is usually more favourable option to SMEs due to cloud computing's value proposition of various Internet-mediated IT capabilities with less or no up-front capital investment. However, SMEs turned out to be negative and significant at 1% level for EXSGA. The predicted sign for $\Delta EXSAG_{Y3}$ is negative because SMEs are expected to appreciate cost-effective benefits from their cloud computing deployment. Thus, the result indicates that SMEs can derive relatively higher cost-reduction effects while using cloud computing than large firms. Service firms turned out to be insignificant. The result did not satisfy the expectation that cloud computing provide significant greater impact on service firms' performance because service firms usually depend more on information processing for their business operations and thus receive more benefits from cloud computing adoption. Both SaaS and PaaS were found to be positive and significant at 1% and 5% levels respectively in ROA and ROS. The results indicate that cloud computing deployment targeted to business applications and platform could result in greater positive effect on firm performance. CAR (± 1) was found to be positive and significant at 5% level for ROA, ROS, and growth rate. The results suggest that there is positive relationship between investors' expectation for cloud computing adoption (measured by market returns) and adopting firms' financial performance in terms of business productivity and revenue growth. However, insignificant result between CAR (± 1) and EXSGA implies that cloud computing does not necessarily lead to cost reduction benefits as the market expects when deployed in business operations.

Discussion

The research findings in the study provide some implications for research and practice. First, the advantages of cloud computing still seem to be controversial (Brynjolfsson et al. 2010). But our results suggest that, the sample of cloud computing deployment announcements in the study is significantly associated with positive market expectations. The positive overall ACAR indirectly implies market's growing interest in firms' attempt to utilize up-to-date information technologies for higher operational efficiency and better market competence.

Second, a number of previous IS studies have empathized the role of IT as a tool for saving operational costs. One of the results in the study shows favorable reaction of investors to operation-oriented use of cloud (i.e., internal focus). The result implies that due to the recent mergence of cloud computing, investors' expectation relatively focus on cost-saving role of cloud computing. Yet, as cloud computing gets more diffused across business environment, the

new IT service model can provide sustainable benefits when utilized for market-oriented purpose such as value-added service to customers and better collaboration with suppliers and partners.

Third, the result of investors' favorable reaction to adoption of cloud computing for SMEs implies that cloud computing is a plausible choice to small and medium firms that do not possess sufficient slack resources to cover the large amount of initial investments for IS.

Fourth, some results of the current study indicate that there is a significant industry difference in abnormal returns to cloud computing adoption announcement especially between manufacturing and non manufacturing. The result implies that benefits of cloud computing can be different depending on the nature of each industry. From the study, it can be recognized that return to cloud computing adoption can be rapidly realized in more customer-interactive and competition-intensive industry, which are constituents of non manufacturing industry sector. Thus, managers who are thinking about the introduction of cloud computing to their organization need to consider the firm and industry-specific characteristics that can affect the success of cloud computing adoption and decide the appropriate timing to introduce.

Conclusion

Business value creation through the adoption of technology innovation is one of the most critical topics in IS literature because investing in a technology can only be justified by the returned values the technology generates. As a new trend of IT service innovation, cloud computing has recently indicated several potential advantages, such as cost reduction, IT management flexibility, and technology agility. Although cloud computing is considered a paradigm shift of IT service design and delivery in IS communities and has generated significant interest among business entities, little research has been conducted for this new IT and business phenomenon. The current study seeks to advance the argument on how the application of cloud computing can enhance a firm's market value and which conditions are favourable to the cloud computing's value-creating role.

Specifically, the study examined the influence of cloud computing adoption on the market value of the firm and explored contextual factors in positive abnormal returns. In analyzing a sample of 183 cloud computing adoption announcements, we found that cloud computing adoption announcements are associated with positive increases in the firm's market value, which implies that investors and shareholders favourably evaluate cloud computing initiatives as future benefits. This study is one of the first to assess economic payoffs of cloud computing adoption based on empirical validation. This study makes several contributions to the IS literature. First, the study extends the boundary of IS literature toward new IT and business phenomena and maintains academic attention to the latest issues in IT industry. Second, the study continues the debate about the business value of IT with a new IT service innovation—namely, cloud computing. Finally, this exploratory study provides a research foundation for the economic analysis of cloud computing, which can be applied to further study of cloud computing.

For the next step to further elaborate upon the current study, some additional works are required. First, to enhance the applicability of the research findings to real business environments, further efforts need to be devoted to collect more cloud computing-related announcements, analyze them, and derive more robust findings from more diversified sample announcements. Second, the study results argue the positive effect of cloud computing adoption on firm performance using a stock-market based approach. Thus, other aspects of firm performance need to be applied to validate the consistency of the results of this study.

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