Impact of Cloud Computing Adoption on Firm Stock Price – An Empirical Research

Completed Research Paper

Adam M. Mahmood
The University of Texas at El Paso
mmahmood@utep.edu

Faruk Arslan
The University of Texas at El Paso
farslan@utep.edu

Jagadish Dandu
Zayed University
Jagadish.Dandu@zu.ac.ae

Godwin Udo
The University of Texas at El Paso
gudo@utep.edu

Aurelia Nicholas-Donald
The University of Texas at El Paso
andonald@utep.edu

Abstract

In this paper, we investigate how cloud computing adoption impacts publicly traded 26 cloud-adopting companies’ stocks. In an effort to perform a valid assessment of a firm’s cloud adoption initiatives, we also evaluate the stocks of 26 companies, which did not adopt cloud computing and operate in the same industry with similar market capitalization. Our study differs from the previous studies in the area because it uses Fama-French three factor model to derive the stock abnormal returns for both adopters and non-adopters. Furthermore, given the announced risks of cloud computing in the literature, we analyzed the stock risk between adopters and non-adopters. Our preliminary analysis implies that businesses adopting cloud computing experience positive cumulative abnormal returns during the time the event was announced. Our research also indicates that both cloud adopting and non-cloud adopting companies suffer from higher stock risk during the announcement but this risk is not statistically significant.

Keywords

Cloud Computing, Event Studies, Abnormal Returns, Abnormal Risks

Introduction

Cloud computing is defined by National Institute of Standards and Technology (NIST) as “a model for enabling ubiquitous, convenient, on demand networked access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance 2009). The Cloud provides organizations with several opportunities such as low-cost computing via pay-per-use models requiring no initial investment, agility via rapid scalability, provisioning and deployment, ability to deal with big data, and better management of distributed resources (Marston et al. 2011; Subashini and Kavitha 2011). These opportunities can enable organizations, especially the small and medium-size enterprises, to be more competitive and innovative (Marston et al. 2011). Gartner Research notes that cloud computing will count for the majority of IT
spending by 2016 and predicts that half of the large enterprises will have hybrid cloud deployments by 2017 (“Gartner says cloud,” 2013).

Despite these glowing reviews, privacy and security issues have been the long standing concerns in cloud computing which make companies hesitant to adopt the cloud. Several factors such as lack of internal IT readiness, service quality standards, global regulations, and most importantly data protection and security issues hinder the growth of cloud computing (Chen et al. 2010; Bruening and Treachy 2009; Subashini and Kavitha 2011). In addition, the size of the organization, the perceived relative advantage of cloud computing, top management support, competitive and trading partner pressures can also influence the cloud computing adoption at the organizational level (Low et al. 2011). Furthermore, technical factors such as size of IT sources, resource utilization patterns, sensitivity of the data managed as well as the criticality of the activities performed by the organization can impact the adoption of cloud computing services (Misra and Mondal 2011). Given the practical need for organizations to evaluate the value of information technology (IT) investments as well as outsourcing decisions, there has been an emerging emphasis on assessing the impact of cloud computing on firm performance.

The objective of the present research is twofold: first, we would like to find out whether stock market favorably looks at publicly traded companies if they join a cloud group. We will measure this benefit using Fama and French’s (1993) abnormal returns. Second, since a number of researchers have expressed the concern about the risk of joining a cloud group (Ackermann et al. 2012; Marston et al. 2011; Subashini and Kavitha 2011), we will measure this risk using market beta based on Capital Asset Pricing Model (CAPM). In contrast, the aforementioned studies have used a simpler method; the market model, to determine the abnormal stock returns.

In the following section, we will review the literature on the impact of cloud computing adoption on the market value of publicly traded companies. We will then discuss our research hypotheses, research methodology, and results. We will conclude the paper by providing our findings and limitations of the present study and suggesting future research ideas.

**Literature Review**

The economic value for cloud computing adoption has fairly been accepted. Both providers and users are benefited in the sense that providers gain increased revenue by provisioning and organizing cloud resources at a lower cost and users benefit from lower entry cost for joining computer-intensive businesses. We will first discuss, in this section, a number of studies that cover the advantages obtained from the cloud adoption (Grossman, 2009; Marston et al. 2011; Zhang et al. 2010). This is followed by a discussion of a number of studies that discuss the disadvantages of joining a cloud group (Subashini and Kavitha 2011; Haeberlen 2010; Xiao and Xiao 2013). We will end this section by discussing two available studies that use the event study methodology to investigate the impact of joining a cloud group (Huntgeburth et al. 2013 and Parameswaran et al. 2011).

**Cloud computing advantages studies**

Grossman (2009) cited a number of benefits from using cloud computing: first, usage-based pricing model reduces capital expense because of the ability to scale up or down based on the demand. Second, cloud service providers enjoy the benefit of economies of scale because they can provide operations, business continuity, and security more efficiently since these services are bundled together. Finally, cloud computing architectures especially data storage services are very scalable.

Marston et al. (2010) cited a number of cloud computing advantages for smaller businesses: first, the cloud dramatically lowers the entry cost for smaller businesses to enter computer-intensive businesses. Second, the cloud can provide immediate access to hardware resources with almost no upfront capital investments on the part of small businesses. Third, cloud computing can lower IT barriers to innovation for many promising startups that require ubiquitous applications to more focused applications. Finally, the cloud makes it easier for businesses to scale their services.

Zhang et al. (2010) suggested that cloud computing is attractive to businesses because it does not require users to plan ahead for provisioning. It allows businesses to start small with lesser resources and increase resources when there is a rise in service demands. The authors use a survey to highlight architectural principles, design challenges, and future research directions for cloud computing.
Cloud computing disadvantages studies

Privacy and security concern has emerged as one of the most significant disadvantages of joining a cloud computing group (Chen et al. 2010). Following are some of the research studies that discuss the hindrances in joining the cloud.

Subashini and Kavitha (2011) posit that since cloud computing moves the application software and data resources to a large data center, it risks being exposed to a number of vulnerabilities such as virtualization, accessibility, web application, privacy, and security. The authors suggest that cloud service users need to be vigilant in understanding the risk of data breaches in this new environment. Since users no longer have physical possession of most of the outsourced data, it makes the data integrity protection in cloud computing a very challenging task for the users.

Haeberlen (2010) suggests that accountability could be a problem in cloud computing. The author recommends that the cloud could be more accountable to the users by getting a third party auditor involved. The auditor could function in an effective manner by using tamper evident logs, time-stamped records, virtualization-based replay, and inspection of records, among others. The author further recommends the use of a third party for privacy audits so that the third party can identify the fault without bias. The author also suggests that customers shall be given access to the audit logs.

Xiao and Xiao (2013) have provided a review of the security and privacy issues in cloud computing. The authors have identified five security and privacy attributes that include confidentiality, integrity, availability, accountability, and privacy. The authors have also put forth the relationships among these attributes. The authors conclude by identifying the vulnerabilities that may be taken advantage of by the intruders and defensive strategies that may be used by the cloud adopters.

Cloud computing event studies

Our review of the extant literature revealed only two event studies that have been conducted to investigate the stock market impact on a publicly-traded company after it joined a cloud group (Huntgeburth et al. 2013; Parameswaran et al. 2011). The common research question of these two studies is to find out whether cloud computing adoption announcements have a positive impact on the market value of the adopting firms. Both of these studies used only abnormal stock returns as the adoption-impacting performance measure.

Parameswaran et al. (2011) examined the stock market impact on the stocks of companies that announced adoption of cloud computing using the event study methodology. This impact was found to be not statistically significant.

Huntgeburth et al. (2013), on the other hand, observed positive and statistically significant cumulative abnormal returns (CAR) for the firms adopting cloud computing. Given the inconsistent results derived by these studies, the present research seeks to develop and empirically evaluate a more comprehensive framework to analyze the impact of cloud computing adoption announcement on a firm’s value.

Our study advances previous research for two reasons: first, previous studies found contradictory evidence on the impact of adopting cloud computing on the market value firms. It is, therefore, important that we conduct this study again. Second, none of the previous studies measured the impact of the adoption of cloud computing on a firm’s risk.

Hypotheses

H1: Cloud Adopter CAR > Cloud NonAdopter CAR

Hypothesis 1 states that the stock market reaction to publicly announced cloud computing adoption information will result in higher positive CAR for the adopters than for the non-adopters. Drawing on the Fama and French’s three factor efficient market theory, we provide a theoretical rationale for this hypothesis followed by the literature support.
Efficient Market Hypothesis suggests that all relevant information is impounded in a stock’s current price. It is, therefore, expected that cloud adoption announcement by a publicly traded company will have a positive impact on its stock price as shown in the following equation:

\[
R_{i,t} = \alpha_i - \beta_{i1} R_{m,t} - \beta_{i2} SMB_t + \beta_{i3} HML_t + e_{i,t}
\]  

(1)

where, \(R_{i,t}\) is the return for the firm \(i\) on day \(t\), \(R_{m,t}\) is the return on the market portfolio on day \(t\), \(SMB_t\) stands for the Small Minus Big (market capitalization) and \(HML_t\) stands for High Minus Low (book to market ratio) in the model, and \(e_{i,t}\) is the disturbance term.

After the regression parameters are estimated, the abnormal returns are calculated by subtracting expected returns from the observed returns (see Equation 2).

\[
A\bar{R}_t = \bar{R}_{i,t} - (\alpha_i - \beta_{i1} R_{m,t} - \beta_{i2} SMB_t + \beta_{i3} HML_t)
\]  

(2)

It is possible that the markets do not fully incorporate information instantaneously. The use of a multi-day event window is, therefore, required. During this event window abnormal returns are accumulated to form Cumulative Abnormal Returns (CAR). In the present research the event window consists of 3 trading days surrounding the event announcement date (see Equation 3).

\[
CARE = \sum_{t} A\bar{R}_t
\]  

(3)

There is also empirical support for H1 in the literature. Grossman (2009) cited a number of benefits from using cloud computing such as reduced capital expense, economies of scale, scalable data storage services. Marston et al. (2011) cited a number of cloud computing advantages for smaller businesses such as lower entry costs for entering computer-intensive businesses and immediate access to hardware resources with almost no upfront capital investments on the part of the small businesses. Zhang et al. (2010) suggested that cloud computing is attractive to businesses because it does not require users to plan ahead for provisioning.

**H2: Cloud Adopter Risk > Cloud Non Adopter Risk**

In hypothesis 2 we postulate, based on prior research studies, if a company joins a cloud computing group the beta (risk) for its stock will be higher because of the higher risk it will encounter in the cloud group. The privacy and security concern, as stated earlier, has emerged as one of the most significant disadvantages of joining the cloud.

There is also anecdotal literature support for H2. Subashini and Kavitha (2011), for example, stated that cloud computing risks data being exposed to a number of vulnerabilities. Haebeleren (2010) is concerned about the lack of accountability in cloud computing and recommended the use of a third party for privacy audits. Xiao and Xiao (2013) have identified a number of security and privacy attributes that could be problematic for cloud computing.

We used the one-factor model (market model), which is grounded in the Capital Asset Pricing Model (CAPM), to estimate the firm’s beta both pre (day -120 to day -10) event date and as post (day +1 to day +120) event date. Please see equation 4.

\[
R_{i,t} = \alpha_i + \beta_{i1} R_{m,t} + e_{i,t}
\]  

(4)

where, \(R_{i,t}\) is the return for firm \(i\) on day \(t\), \(R_{m,t}\) is the return on the market portfolio on day \(t\), and \(e_{i,t}\) is the disturbance term.
Research Methodology

In line with the previous studies, we leveraged the event study methodology and used abnormal returns as the endogenous economic variable to measure cloud computing adoption impact. Event studies, from a methodological point of view, are theoretically grounded (Fama 1970; Brown and Warner 1985). These studies are built on efficient market hypotheses (semi-strong form) that state that the market price at a point in time fully reflects all available public information before that point (Fama 1970). The event study, in the present research, will evaluate the impact of adopting cloud computing on the stock price of the publicly traded companies that adopted the cloud.

We expanded our research framework by incorporating two unique components: first, we used Fama-French three-factor model to describe the stock returns by taking into account the firm size, book-to-market value, and the industry of the firms adopting cloud computing services (Fama and French 1993). In contrast, the previous studies in the area have used the market model that does not incorporate the effect of firm size and book-to-market value.

Secondly, pursuing an experimental design approach allowed us to compare the abnormal returns for two groups of publicly-traded companies: a. businesses that adopted cloud computing (treatment group) and b. businesses that have not adopted cloud computing (control group). We believe comparing the abnormal return of the control group with the treatment group with similar characteristics will help us better understand the impact of cloud computing on the market value of these two groups.

We used LexisNexis Academic database to obtain the cloud service adoption announcements and filtered out any announcement with a possible confounding effect (please see Table 1 for details). In our sample, we used 26 publicly traded U.S. companies that had adopted cloud services and 26 companies that had not adopted cloud computing. We used an algorithm to ensure that the characteristics of non-cloud adopting publicly traded companies are similar to the characteristics of publicly traded cloud adopting companies. We further ensured that each paired business did not make any cloud service adoption announcement within the defined event window, operated in the same industry, and had a similar size. Following this procedure we collected relevant stock data for 26 cloud service adopting businesses and 26 non-cloud service adopting companies.

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Cumulative Abnormal Return (CAR)</th>
<th>Matching Non-Cloud Adopting Firm</th>
<th>Cumulative Abnormal Return (CAR)</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Service Adopting Firm</td>
<td>%</td>
<td>Matching Non-Cloud Adopting Firm</td>
<td>%</td>
<td>3M CO</td>
</tr>
<tr>
<td>A M N HEALTHCARE SERVICES INC</td>
<td>-0.099</td>
<td>HILL INTERNATIONAL INC</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>BEST BUY COMPANY INC</td>
<td>0.035</td>
<td>STAPLES INC</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td>BOEING CO</td>
<td>0.051</td>
<td>HONEYWELL INTERNATIONAL INC</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>C E C ENTERTAINMENT INC</td>
<td>0.007</td>
<td>7 DAYS GROUP HOLDINGS LTD</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>CENTURY LINK INC</td>
<td>-0.020</td>
<td>TELECOM ITALIA S P A NEW</td>
<td>-0.022</td>
<td></td>
</tr>
<tr>
<td>COCA COLA CO</td>
<td>0.015</td>
<td>PEPSICO INC</td>
<td>0.034</td>
<td></td>
</tr>
<tr>
<td>COLGATE PALMOLIVE CO</td>
<td>0.019</td>
<td>AVON PRODUCTS INC</td>
<td>-0.008</td>
<td></td>
</tr>
<tr>
<td>DISH NETWORK CORPORATION</td>
<td>0.016</td>
<td>VIRGIN MEDIA INC</td>
<td>-0.011</td>
<td></td>
</tr>
<tr>
<td>FAMILY DOLLAR STORES INC</td>
<td>-0.029</td>
<td>O REILLY AUTOMOTIVE INC NEW</td>
<td>-0.008</td>
<td></td>
</tr>
<tr>
<td>FLEXTRONICS INTERNATIONAL LTD</td>
<td>0.026</td>
<td>ADVANCED SEMICONDUCTOR ENGR INC</td>
<td>-0.002</td>
<td></td>
</tr>
<tr>
<td>GLAXOSMITHKLINE PLC</td>
<td>0.020</td>
<td>SANOFI AVENTIS</td>
<td>0.030</td>
<td></td>
</tr>
<tr>
<td>GROUPON INC</td>
<td>-0.031</td>
<td>HENRY JACK &amp; ASSOC INC</td>
<td>-0.016</td>
<td></td>
</tr>
<tr>
<td>HUNT J B TRANSPORT SERVICES INC</td>
<td>0.021</td>
<td>EXPEDITORS INTERNATIONAL WA INC</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>KIMBERLY CLARK CORP</td>
<td>0.019</td>
<td>3M CO</td>
<td>-0.001</td>
<td></td>
</tr>
<tr>
<td>LILLY E M &amp; CO</td>
<td>-0.003</td>
<td>GILEAD SCIENCES INC</td>
<td>-0.004</td>
<td></td>
</tr>
<tr>
<td>MORGAN STANLEY DEAN WITTER &amp; CO</td>
<td>0.065</td>
<td>NOMURA HOLDINGS INC</td>
<td>-0.032</td>
<td></td>
</tr>
<tr>
<td>NASDAQ O M X GROUP INC</td>
<td>0.065</td>
<td>N Y S E EURONEXT</td>
<td>0.040</td>
<td></td>
</tr>
<tr>
<td>NETFLIX INC</td>
<td>-0.003</td>
<td>INTERNATIONAL GAME TECHNOLOGY</td>
<td>-0.006</td>
<td></td>
</tr>
<tr>
<td>QUALCOMM INC</td>
<td>-0.014</td>
<td>INTEL CORP</td>
<td>-0.015</td>
<td></td>
</tr>
<tr>
<td>S L M CORP</td>
<td>0.009</td>
<td>C I T GROUP INC NEW</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>SAVVIS INC</td>
<td>0.045</td>
<td>PERFECT WORLD CO LTD</td>
<td>-0.011</td>
<td></td>
</tr>
<tr>
<td>SONY CORP</td>
<td>-0.001</td>
<td>HARMAN INTL INC NEW</td>
<td>-0.016</td>
<td></td>
</tr>
<tr>
<td>THOMSON REUTERS CORP</td>
<td>-0.003</td>
<td>PEARSON PLC</td>
<td>-0.018</td>
<td></td>
</tr>
<tr>
<td>TIME WARNER INC NEW</td>
<td>0.015</td>
<td>B C E INC</td>
<td>-0.003</td>
<td></td>
</tr>
<tr>
<td>WELLPOINT INC</td>
<td>0.011</td>
<td>AVIVA PLC</td>
<td>-0.007</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. List of Firms Adopting Cloud and Firms Not Adopting Cloud
Results

Abnormal Return Analysis

Our analysis of the daily abnormal returns over the 3-day event window (-1, +1) for the 26 firms that have adopted cloud computing shows positive cumulative abnormal return (mean CAR: 0.01), which is statistically significant at 0.1. On the other hand, the cumulative abnormal return for the 26 non-cloud adopting businesses during the same event window is negative and not statistically significant (please see Table 2).

<table>
<thead>
<tr>
<th>Firms Adopting Cloud</th>
<th>Firms Not Adopting Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>n: 26</td>
<td>26</td>
</tr>
<tr>
<td>Mean CAR [-1, +1]:</td>
<td>0.01 *</td>
</tr>
<tr>
<td>p-value</td>
<td>0.08</td>
</tr>
</tbody>
</table>

* Significant at 0.1

Table 2. Cumulative Abnormal Returns (CAR): Firms Adopting Cloud and Firms Not Adopting Cloud

In order to determine whether the CAR between the cloud-adopters and non-adopters are statistically different from each other, we performed a pooled t-test assuming equal variances between these two groups. Our t-test reveals that the CAR between these two groups are statistically different from each other (p-value: 0.056 ~0.05). Please see Table 3 for details.

| mean difference | df | t-value | Pr > |t| |
|-----------------|----|---------|------|---|
| -0.0133         | 50 | -1.96   | 0.056|

Table 3. Comparison of Cloud Adopters vs. Non- Adopters

We also performed a one-tailed t-test to further evaluate whether the mean CAR for the firms that adopted cloud computing is statistically greater than the mean CAR of the matching firms that did not adopt cloud computing. The results of one-tailed t-test show that mean CAR for the firms that adopted cloud computing is statistically greater than the mean CAR for the firms that did not adopt cloud computing at a significance level of 0.05 (t-statistic: 2.03, df: 48 and p-value:0.024). Based on this finding, H1 is supported at a significance level of 0.05.

Risk Analysis

In addition to the analysis of the mean CAR, we also performed a stock risk analysis on the cloud adopting and non-cloud adopting businesses (Table 4).

<table>
<thead>
<tr>
<th>Firms Adopting Cloud</th>
<th>Firms Not Adopting Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Event</td>
<td>Post-Event</td>
</tr>
<tr>
<td>Pre-Event</td>
<td>Post-Event</td>
</tr>
<tr>
<td>n: 26</td>
<td>26</td>
</tr>
<tr>
<td>Mean Beta:</td>
<td>0.939</td>
</tr>
</tbody>
</table>

Table 4. Comparison of Pre-Event and Post-Event Beta
The stock risk, measured in terms of firms' beta, has increased following the cloud adoption announcement ($\Delta: 0.029$). However this increase in the stock risk is not statistically significant ($t\text{-statistic}: -0.02$, $df: 50$, $p\text{-value}: 0.981$). We observe the same results for our control group that has not adopted the cloud during the same event window. There is a less increase in the stock risk ($\Delta: 0.003$) when compared to cloud adopting businesses' stock risk, however this increase is not statistically significant ($t\text{-statistic}: -0.20$, $df: 50$, $p\text{-value}: 0.84$). Based on this finding, H2 is not supported.

Discussion

Our preliminary empirical study, which uses Fama-French model to generate daily abnormal returns, shows that firms adopting cloud computing services experience a statistically significant positive abnormal return during the announcement period. This finding is in line with the Huntgeburth et al. (2013) study that uses market-adjusted model. It does not, however, agree with Parameswaran et al. (2011) study, which also uses market-adjusted model and observed positive abnormal return (not significant) for the firms that adopted cloud computing. Despite these inconsistent findings, one theme is clear; all these three studies reveal positive abnormal return for cloud adopters at a varying level of significance.

Dehning et al. (2003) pointed out that a valid assessment of a firm's IT-enabled initiatives can be performed within the context of competitors' actions. Our analysis of matching firms' abnormal returns shows negative but not significant abnormal returns. This finding is partially in line with the findings of Parameswaran et al. (2013) that also show positive but not significant abnormal returns for the competitors of the firms that adopted the cloud. This difference may be attributed to differences in method used to generate abnormal returns (Fama-French vs. Market-adjusted return model) and the procedure used to determine the matching firms. In our study, the matching firms are chosen essentially based on two criteria: 1) need to operate within the same industry and 2) firm size measured in terms of market capitalization shall be close to the firm adopting the cloud. By doing so, we intended to eliminate the firm size effect on the returns since firm size is a statistically significant moderator on abnormal returns in the case of cloud computing service and other technology adoptions (Huntgeburth et al. 2013; Jeong and Stylianou 2010).

A number of researchers have postulated that adoption of cloud computing may pose various risks especially security and privacy risks (Takabi et al. 2010; Subashini and Kavitha 2011). An important contribution of our research is that we have empirically investigated this risk. This is an important area that previous studies did not explore. A practical implication of the research is that it will provide practitioners with information on the risk factor involved in cloud computing adoption.

Limitations and Future Research

We used only a total of 52 publicly-traded companies in our study: 26 companies that adopted cloud computing and 26 similar companies that did not adopt cloud computing. The small sample size is a limitation of the study. We intend to increase our sample size and conduct this research again. This may provide us with better results with better significance levels.

We find no journal research studies that measure the abnormal trading volume due to a publicly announced cloud computing adoption. Trading around cloud computing adoption announcements should be of interest to potential investors because it is systematically associated with post announcement returns. We intend to investigate the effect of cloud computing adoption announcements by companies on the trading volume of these companies. We, therefore, intend to include trading volume analysis in our future research studies on cloud computing.
References


