# An Empirical Analysis of Software-as-a-Service (SaaS) Development Mode and Firm Performance

Yuanyuan Chen
(Corresponding Author)
E-mail: ychen200@cba.ua.edu
Culverhouse College of Business
University of Alabama

**Abstract**

We study the firm characteristics and industry factors that influence on-premises software providers' SaaS development modes (i.e., develop SaaS in-house or through M&A). We find that firms with solid marketing and R&D capabilities are more likely to create SaaS internally. In turn, internal development increases the firm's market share. However, firms that developed SaaS through M&A are more likely to face reduced gross profits. In addition, it will take relatively long for acquirers to benefit from the M&A of SaaS businesses. Our research has managerial implications for firms shifting from an on-premises business model to the SaaS business.

## 1. Introduction

Recent years have witnessed the rapid development of cloud computing on both the demand and supply sides. About two-thirds of spending on application software will shift to the cloud by 2025[1]. Many on-premises software companies have jumped on the bandwagon and delivered their software products that run on the cloud computing infrastructure (Mell and Grance 2011; Peng and Gala 2014). For example, Adobe launched its Creative Cloud in 2014, and this was its first massive update since killing the Creative Suite. Salesforce.com offered its customers a subscribed-based CRM system, attracting many small and medium businesses that could not afford to use on-premise CRM. The shift to the cloud has been accelerated over the past years because organizations responded to the business and operations disruption caused by COVID-19. Software and technology service providers need to adapt to the accelerated pace of the cloud shift.

A new business model called Software as a Service (SaaS) delivers Software on the cloud platform. Unlike the traditional on-premises software business model in which software providers offer Software over desktop or in-house servers, SaaS is a bundle of services delivered on the open cloud infrastructure. (Heublein 2012). Shifting to the SaaS business model significantly disrupts on-premises software companies' operations and revenue generation (Christenson and Overdorf, 2000). Thus, on-premises companies must choose a way to transit to the SaaS business. Traditional on-premises software companies may choose to develop SaaS by exploiting their knowledge pools and resources. Alternatively, they can explore external knowledge sources to fulfill this goal. For example, they can enter the SaaS market by merging and acquiring an existing SaaS company or forming an alliance with other SaaS companies. Some companies take both approaches to develop SaaS. In this study, westudyhow firms choose SaaS development modes and the performance outcome of their choice of SaaS development modes.

We use the resource-based view to identify what firm and industry characteristics affecton-premises software companies' SaaS development mode and how the choice of SaaS development mode impacts on the firms' performance. Existing cloud computing and SaaS literature has not study the SaaS development mode and its impacts on firm performance. Our study fills this research gap through a comprehensive empirical study of on-premises software providers' SaaS technology development mode.

## 2. Theory and Hypothesis Development

[1] Stamford, Conn. Feb. 9, 2022. "Gartner says more than half of enterprise IT spending in key market segments will shift to the cloud by 2025." https://www.gartner.com/en/newsroom/press-releases/2022-02-09-gartner-says-more-than-half-of-enterprise-it-spending.

### 2.1 Literature Review

Prior literature has studied the technology development mode extensively (Leiblein et al. 2002; Mudambi and Tallman2010; Lahiri and Narayanan 2013). Researchers have examinedthe factors that influence firms' technology development mode from the resource-based view (Mudambi and Tallman 2010). Resource-based viewposes that a firm's resources determine its technology development mode. A firm's resources include all its assets, capabilities, and organizational processes, as well as other things that could be regarded as a strength of the firm which can be further used and implemented in its strategies(Barney 1991).Resource-based view argues that only the resources that are difficult to imitate by firms' competitors can enhance firms' competitive advantage in the market. Rare resources and valuable resources are imperfectly imitable.

Our research is related to the following three streams of literature: technology and innovation development, merge and acquisition, alliance literature, and the relationship between technology development and firm performance.

Technology and innovation development are essential for technology companies to compete and survive in hypercompetitive industries. New market entrants have strong incentives to develop radical innovation to compete with incumbent companies with large install bases and market shares. In contrast, incumbent companies need to innovate incrementally to maintain their competitive advantages and market shares and, in the meantime, respond to radical innovations (Cohen 2010; Henderson 1993; Henderson and Clark 1990).

Prior studies have examined the determinants of firms' technology development strategies. Many studies have highlighted that human capitals, e.g., managers and executives, play an important role in technology innovation development. For example, Burgelman (1983) emphasized the managers' leading roles in innovation development projects, while Wiseman and Gomez-Mejia (1998) argued that executives' risk-taking behavior determines firms' R&D investments. Other scholars studied how financial resources and cash flows influence a firm's R&D intensity (e..g, Chen and Miller, 2007). Scholars have also explained the heterogeneity of firms' technology developments from environmental and technology uncertainty perspectives (e.g., Robertson and Gatigon (1989).

Prior studies have also investigated how institutional ownerships affect firms' choice of technology development modes. For example, Hoskisson et al. (2002) discuss how firms' ownership structure influences their choice between internal and external sourcing of innovation technologies. Villalonga and Mcgahan (2005) found that firms' resources, structure, and experience, as well as their relationship with other firms, affected firms' choice of technology development. Parmigiani (2006) examined how firms developed technologies in-house and concurrently bought technology innovation from external sources. She found that firms are more likely to acquire technology innovations with a moderate asset specificity and uncertainty level from other firms. Vanhaverbeke (2002) examined the formation of technology alliances and found that the ties and network distance between firms determined the forms of technology alliances. So far as we know, no study has examined the SaaS development strategies of traditional on-premises software providers.

The second literature stream is about merger and acquisition (M&A) as well as alliance decisions of a firm. M&A is the common approach through which technology companies acquire new resources and capabilities to enter a new market (Hayward 2002). Ahuja and Katila (2001) studied the innovation performance of acquiring firms. They distinguished technological and non-technological acquisitions and argued that the absolute size of the knowledge base positively impacts the firm's innovation performance. In contrast, the relative size of the acquired knowledge base negatively affects performance. King et al. (2008) found that resource complementary between target and acquiring firms affect post-acquisition performance. However, Barden (2012) studied the innovation adoption of the acquired firm after being acquired and found that the acquired firms continued to innovate after the acquisitions.

Alliances and joint ventures are alternative approaches to accessing external technology and knowledge. Allying with other firms enables the focal firm to access complementary assets and capabilities required for new product development (Lahiri and Narayanan, 2013). Van de Vrande (2013) found that the variance in technological proximity and sourcing mode diversity could affect innovative performance.

Similarly, Lahiri and Narayanan (2013) found that alliance portfolio configuration affects a firm's innovation and financial performance. Innovation could improve firms' performance in many different perspectives (Cohen 2010). Li et al. (2009) studied why some software firms fail in the innovation. They examinedthe relationship between organizational capabilities and firm's survivor, Specificially, they studied three organizational capabitities:marketing capabilities, R&D capabilities, and operation capabilities.Dotzel et al. (2013) investigated the relationship between service innovation and firm value. They found thatservice innovation (Internet- enabled innovation and people-enabled service innovation)affects firms' idiosyncratic risk, systematic risk, as well as firm value.Prior studies have also examined the impacts of team-level and individual-level innovation on firm performance. Tzabbar (2009) found that scientists' or innovators' work changes firms'technological positions. Huckman and Staats(2009) highlighted the importance of team familiarity and manger's role in innovation activities.Teece (1986) argues that firms canbenefit from technological innovation bythe appropriation of their knowledge stock, which helps firmsgainningcompetitive advantages in the market.

Our study adds to this stream of research by examining the on-premises software providers' choices between internal and external development of SaaS software and the impacts of SaaS technology development mode on firm performance.

**2.2 Hypothesis Development**

Prior researches regard internal development as an exploiting search while external development is an exploratory search (Mowery et al. 1996; Hoskisson et al.2002; Fleming and Sorenson 2004). Exploration could be captured as a search, discovery, and innovation process, while exploitation is exemplified by refinement, implementation, and execution. Firms need to allocate their resources and capabilities to exploitation and exploration (Heublein 2012), as acquiring knowledge helps in reconfiguring the existing knowledge bases (Raisch et al. 2009), strengthening the firm's innovative capability (Palomeras and Meler 2010). The acquisition is an effective way for firms to gain new technology, knowledge, resources quickly, and customer base (Cohen and Levinthal 1990), thereby entering the new market efficiently (Hayward 2002). Alliances are an alternative way of access to new knowledge from external sources (Lahiri and Narayanan, 2013)., Whether a firm develops SaaS technology internally or acquires SaaS technologies from external sources (e.g., M&A and alliance) depends on the firm's resources. The choices of SaaS development mode affect the firm's SaaS market entry performance and its on-premises businesses.

SaaS causes disruptions to traditional on-premises software businesses in the way that SaaS uses a "pay-per-use" pricing model. Therefore, SaaS can attract those software users who cannot afford to pay the expensive upfront license of traditional on-premises software (Armbrust et al. 2009). However, SaaS may impact the firm's on-premises business because users may switch from conventional licenses to SaaS. Furthermore, as the "pay-per-use" model takes a long time to make profits than the upfront licenses, the revenue and cash flow may decrease before the SaaS business has a large customer base. Thus, deciding which way to enter the SaaS market so that firms quickly make profits is meaningful to on-premises software providers when they shift to the cloud-based business. They need to balance their cost in investment in SaaS and gain certain profits or advantages in the market. We consider two ways of SaaS development modes: external development, which relies on resources outside the firm's boundary, and internal development, which is based on the firm's R&D activities.We examine the determinants to the SaaS development modes.

*2.2.1 Factors that influence firms' SaaS development modes*

Resource-based view poses that a firm's competitive strength comes from its unique combination of resources. Firms can identify and combine different resources to gain higher profits, and the imperfect mobility makes its combination hard to copy and follow (Ranft and Lord 2002). Therefore, a firm's resources determine its technology development strategies (Dotzel et al., 2013; Peteraf, 1993).

Organizational slack is this kind of resource that affect the choice of technological development (Mayer and Salomon 2006). Organizational slack includes the firm's cumulative stock and surplus that can be used in further operation. A larger amount of organizational slack supports a firm in pursuing a growth strategy

(Steensma and Corley 2011). Firms with organizational slack can develop technology through in-house technology teams or acquire technology from other companies.

By acquiring radical innovation, acquirers can enter the new market and gain the first-mover advantage (Wernerfelt 1984). Also, combining acquired unique resources with the firm's existing resources will expand the acquirer's value-creation capability (Amit and Zott, 2001). Therefore, we hypothesize that firms with large organizational slacks are more likely to develop their SaaS through technology acquisitions of other companies.

H1: *Firms with greater organizational slacks are more likely to merge and acquire SaaS technology companies to develop their SaaS business.*

Knowledge is an overwhelmingly productive resource in the firm (Grant 1997).Firms provide a platform to integrate knowledge stock (Grant 1996). Dosi and Nelson (2010) argue that firms with strong absorptive capacity can assimilate new knowledge acquired externally efficiently and effectively. Absorptive capacity is a firm capability to explore and exploit external knowledge and absortthe new knowledge from outside sources(Cohen and Levinthal 1990). Previous studies showed that it is hard for firms to assimilate new knowledge if it doesn't have knowledge that is related to the new technologyand does not have strong absorptive capacity (Talyor 2010; Salvato 2009; Lewin et al. 2011).Therefore, we hypothesize that

H2: *Firms with absorptive capacity are more likely to merge and acquire SaaS technology companies to develop their SaaS business.*

As SaaS is a service-oriented business model, firms' on-demand service experience is important for their SaaS development strategy. Software companies providing on-demand services have knowledge and resources to adjust their operations and software delivery to service-oriented model. Their on-demand experience can help them shift to SaaS easily and quickly. Furthermore, it might be easier for these firm to assimilate the cloud-related knowledge if they have experience in the on-demand software. Thus, we hypothesize that on-demand experience will make on-premises firms more likely to seek for external knowledge source because they can assimilate the knowledge quickly and then launch cloud-related products.

H3: *Firms with on-demand experience are more likely to merge and acquire SaaS technology companies to develop their SaaS business.*

Industry factors may affect firms' choice of technology development modes (Leiblein et al. 2002; Dotzel et al. 2013).In the highly competitive industry,firms may imitate their competitors' competitive actions. Therefore, competitors'SaaS development actions influence individual firm's R&D investment on SaaS and the development mode (Cohen 2010). An inverted-U shape relationship between industry competition and firms' innovation has been predicted in previous studies (Cohen 2010), suggesting that, in the high concentrated industry, firms are less likely to invest in innovation because they would rather invest to sustain their advantages within the industry and maintain a resource-dominant position. Thus, we expect that:

H4:*When the industry competition is high, firms are less likely to merge and acquire SaaS technology companies to develop their SaaS business.*

2.2.2 The impacts of SaaS Development modeson firm performance

New technology development is important for firms, especially for those in the high-technology industry. Prior studies hasdemostrated that innovation and new technology increases firms' productivity and financial performance (Lahiri and Narayanan 2013). The technology development mode may influence a firms' performance in two ways (Zott and Amit 2008). First, from the knowledge assimilation perspective, M&A allows firms to quickly access external technologies and extend their internal capabilities and resources. But acquirers may fail to recognize what they need and assimilate the acquired technology if they don't have experience and absorptive capacity (Henderson and Clark 1990). Furthermore, even if acquirers can incorporate acquired

technology, it usually takes a long time for the acquirer to assimilate external knowledge. Hence, the acquisition may not bring firms as much return as expected (Hayward 2002; Benson and Ziedonis 2009).

From the resource-based perspective, acquirers have the install base of the acquired technology, which can generate revenues for acquirers. In addition, on-premises software companies can enter the SaaS market instantly if they acquire a SaaS company directly. The quick entrance can help acquirers grasp market share quickly. Therefore, the impacts of M&A of SaaS business on the acquirer's performance can be positive or negative.

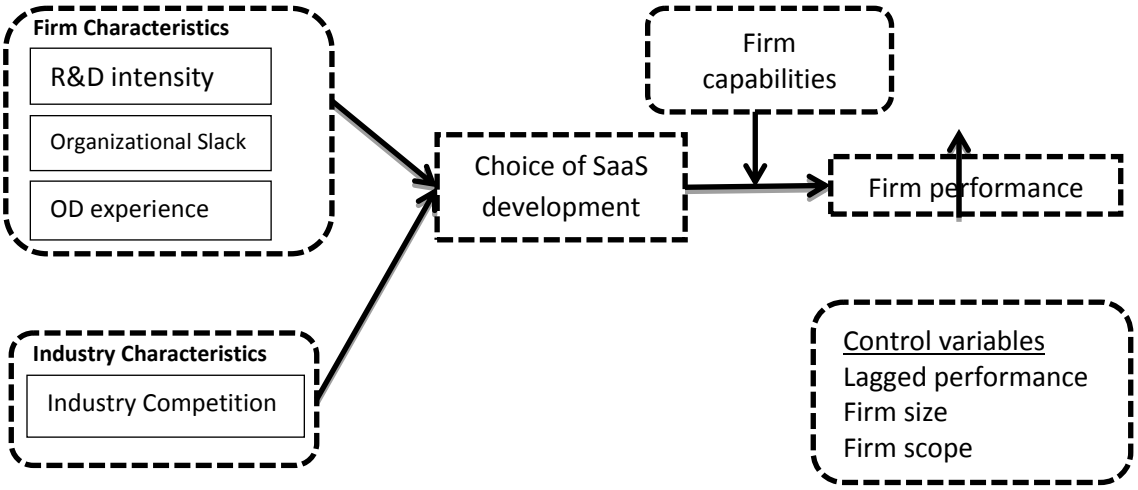
*1.1.1. Moderating effects of marketing capability*

A firm's capabilities combine its skills and knowledge to help it utilize different resources to achieve superior performance (Krasnikov and Jayachandran 2008). Marketing capability represents a firm's ability to understand consumers' preferences and the ability to respond to customers' needs (Li et al. 2010). It has been found that marketing capability is necessary for firms to keep their competitive advantage in the market (Weerawardena 2003). Market capabilities can influence firms' innovative output and thus is critical for firms in the high-technology market (Dutta et al.1999). Prior studies have demonstrated that marketing ability moderates the relationship between innovation and firm performance (Xiong and Baharadwaj, 2013). Firms with a strong marketing capability are more likely to profit from technology innovation (Dutta et al.1999). Thus, we expect that:

H5: *Marketing capability increases the positive performance impacts of the SaaS development mode.*

We include firm size and scope as control variables (Vanhaverbeke et al., 2002; Berrone et al., 2013; Suraz et al., 2013). Figure 1 shows the conceptual model.

**Figure 1 Conceptual Model**




## 3. Empirical Analysis

### 3.1 Data Collection

We collected data from multiple resources. First, we assembled a list of firms operating in computer programming, data processing, and other computer-related services (SIC 737) from COMPUSTAT. We then download the firm's 10-K forms from lexisnexis.com and EDGAR for 2003-2013. And we also download company news from Factiva in those years. To process these text data, we use a batch of keywords which include "announce," "launch," "introduce," and "beta," combined with cloud-related keywords "SaaS," "software as a service," "cloud computing," "on-demand" and variations with dashes. We firstly identified companies that have introduced cloud-related services or on-demand applications. Then we coded the dates of SaaS product launch, mode of SaaS product development, and SaaS product and service descriptions. We code SaaS development

modes as make, buy, make and buy. We also coded data about the firm's competitive actions (i.e., alliance, merger and acquisition, other capacities/scale actions) from the news. Finally, we collected the firm's accounting and financial data from CRSP and COMPUSTAT.

And we collected the firm's patent data from US Patent and Trademark Office (USPTO). Because of the mess in the assignee's name of the patents, we first try to standardize the company's name before we search for their patent. The patent's assignee name is not the same as that shown in Compustat. This could raise problems because we gather names from Compustat and try to find their patent stock. To solve the problem, we used data and Stata code from the NBER patent data project to standardize the company's name first and then used the cleaned name for search in USPTO.

We have collected data from companies from SIC737 during 2003-2013. Under SIC737, 1400 companies, among which 342 have announced the launch of cloud-based software applications during the past ten years. Among the companies, 280 choose to develop their SaaS-related product in-house, accounting for more than half of the total companies. One hundred ten companies chose to acquire SaaS companies or join an alliance to deliver SaaS. And 48 companies in our sample choose to invest in both internal development as well as external sourcing. Most of these companies provide business application software. Some of them provide system software or Internet services.

### 3.2 Model Specification

In the first stage, we are interested in the firms' choice of make or buy or both make and buy. We code the choices as order numbers. Thus, we use the logit model to predict a firm's choices. The dependent variable is coded as following: =1, No SaaS; =2, Make; =3, buy; =4, make and buy. We consider coding dependent variables proper because as the number becomes larger, investment in SaaS development is also larger.

The model is specified in this way:

$$p_{ij} = \Pr(y_j = i) = \Pr(\kappa_{i-1} < \alpha_i + \beta' X_j \le \kappa_i) = \phi(\kappa_i - \beta' X_j) - \phi(\kappa_{i-1} - \beta' X_j)$$

where $X_j$ is the vector of the independent variable. In the conceptual model, we predict that firm characteristics and industry characteristics will influence the firm's development choices. Besides, we also add control variables in our model: firm size and business scope, which are represented by the number of segments of the firm.

In stage 2, we model the firm's performance using the following model:

$$Q_{it} = \alpha_i + \beta_1 Make_{it-1} + \beta_2 Buy_{it-1} + \beta_3 Both_{it-1} + \lambda Mode * FirmCapabilities_{it-1} + \delta controls_{it} + u_{it}$$

Mode refers to a firm's development mode: make, buy and both make and buy. Because we think that lagged variables have more predictive power on a firm's development mode choice, we incorporate lagged variables in our model (Ahuja and Katila 2001). Following Xiong and Bharadwaj (2013), we use the system GMM to estimate the model. After Arellano-Bond's (1991) dynamic panel estimator was put forward, it has been increasingly used these years. It has many advantages and is suitable in our context. GMM estimator is designed for 1) "small T, large N" panels, 2) linear function model, 3) independent variables that are not strictly exogenous 4) fixed individual effects. In our context, the system GMM estimator is suitable to use, and it will resolve some endogenous problems that are concerned. We consider that decisions made by the firm might be affected the firm's performance which means there might be a simultaneous problem here.
And there also might be an omitted variable issued occurred in the model. System GMM is suitable for reducing these two problems. Thus, we choose it as our estimator.

### 3.3 Variable Measurements

We have two research questions. The first one aims at finding factors that will affect a firm's choice of technology development mode. The second is to examine the association between SaaS development mode and firm performance. Firms simultaneously pursue different objectives depending on their strategy. Thus, we choose other financial performance measurements as dependent variables. For example, technology development will

affect a firm's operating margin and sales growth. And we also examine how technology development will affect market share.

In specific, we have the following dependent variables:

*Market share*: Market share is a good indicator of firm performance (Xiong and Bharadwaj 2013). It could be calculated as sales of firm i divided by total market sales.

*Sales growth*: Sales growth is calculated as the company's growth rate. It's also a good proxy for overall firm performance. Therefore, we calculate it as the annual growth rate of a firm.

*Gross margin*: Gross margin is used to determine the value of incremental sales. We use the difference between revenue and cost of goods divided by revenue to represent it (Suarez et al., 2013).

*Abnormal return*: Despite the above measurements, we also use the abnormal return to measure firm performance. Annual abnormal returns could be regarded as a cumulative abnormal return of 12 months in a year. Thus, we calculate it as $\sum_{k=1}^{12} \boldsymbol{R}_{it} - \boldsymbol{R}_{rf,t}$, $R_{rf,t}$ is expected return in the stock market. We obtained the data from CRSP.

Since we have two-stage models, we have two different sets of independent variables. For the first stage, we have measured:

*Organizational slack*: Following Berrone et al. (2013), organizational slack is measured by selling, general, and administrative (SGA) expenses divided by sales.

*Free cash flow:* Cash flow is the amount of cash generated and used by a company in a year. We take the logarithm of free operating cash flow in the model.

*On-demand experience*: Before launching SaaS, some companies might already have on-demand services. Because it might be easier for these companies to enter the cloud market, thus we code on-demand experience as a dummy variable through the news.

In the second stage of analysis, we use the following variables:

*Marketing capability*: Several important factors could affect a firm's performance. As suggested by Li et al.(2010) and Xiong and Bharadwaj (2013), a firm's capabilities are an essential element that is expected to influence firm performance. This ability will help firms maintain a good relationship with their customers and improve their selling and promotion of their products. Following Li et al. (2010) and Xiong and Bharadwaj (2013), we calculate marketing capability using stochastic frontier estimation of the equation: revenue=f (patents; sales, general, and administrative stock; receivables).

*Operating capability*: Unlike marketing capability, the operating capability is a firm's ability to distribute and use its resources effectively. From the previous study, we also calculate operating capability using stochastic frontier by the equation: operating income=f (cost of goods sold, capital expenditures, employees).

*Absorptive capacity*: Despite those capabilities affecting firm performance, we also consider a firm's absorptive capacity. Absorptive capacity is important for firms because it indicates the ability to learn external knowledge and apply new knowledge (Lichtenthaler and Lichtenthaler, 2009). We use R&D intensity as a proxy of absorptive capacity (Mowery et al. 1996). R&D intensity is measured by research and development expense divided by total assets.

*Advertising intensity*: As we discussed before, a firm's marketing resource will affect its performance; we also account for it by considering advertising intensity (Villalonga and McGahan, 2005). Similarly, advertising intensity is measured by advertising expense divided by total assets.

*Interaction terms*: we include firms' development modes and capabilities interaction terms in the model since we are interested in whether firms' abilities will moderate the relationship between development modes and firm performance.

Industry factors are also influential on firm performance. Therefore, our industry concentration, growth, and competition measures are consistent with previous research (Fang et al., 2008; Suarez et al., 2013; Xiong and

Bharadwaj, 2013). Therefore, we use HHI to represent industry characteristics affecting a firm's performance.Herfindahl index is used to measure the concentration of industry. It's calculated as $H=\sum_{i=1}^{N} S^2$.

*Control Variables*

We also control the firm's size, age, and year dummy, indicating whether the firm's SaaS development was before or after 2009. And we also control the annual gross national product (GNP) to control macroeconomic influence. Firm size is used as the control variable. We use the logarithm of total employee number as a proxy of firm size.

Table 1 explains the variable measurements and Table 2 shows the summary statistics of variables. We report the correlation matrix of variables used in Stage 1 and Stage 2 analyses in Table 3 and Table 4, respectively.

**Table 1 Measurements of Variables**

| **Variable** | **Measurement** | **Data Source** | **Reference** |
|---|---|---|---|
| Sales growth | Annual growth rate of firm i | COMPUSTAT | Suarez et al. (2013) |
| Market share | Sales of firm i /total market sales | COMPUSTAT | Xiong and Bharadwaj (2013) |
| ROA | $\frac{net\ income}{TA}$ | COMPUSTAT | Moatti et al. (2013) |
| Gross margin | $\frac{revenue - cost\ of\ goods\ sold}{revenue}$ | COMPUSTAT | Suarez et al. (2013) |
| CAR12 | $\sum_{k=1}^{12} Rit - Rrf,t$ | CRSP | Xiong and Bharadwaj (2013) |
| Independent variable | | | |
| Makeonly | Binary variable<br>=1, if firm develops SaaS in-house; otherwise =0 | Factiva,<br>SEC filings | Arora et al., (2014) |
| Buyonly | Binary variable<br>=1, if firm acquires SaaS; otherwise =0 | Factiva,<br>SEC filings | Arora et al., (2014) |
| Both (make&buy) | Binary variable<br>=1, if firm develop SaaS in-house and acquire SaaS; otherwise =0 | Factiva,<br>SEC filings | Arora et al., (2014) |
| Organizational slack | SGA/sales | COMPUSTAT | Berrone et al. (2013) |
| Free cash flow | Log(free operating cash flow) | COMPUSTAT | Xiong and Bharadwaj (2013) |

| | | | |
|---|---|---|---|
| Marketing Capability | Stochastic Frontier Estimation | COMPUSTAT USPTO | Xiong and Bharadwaj (2013) |
| R&D intensity | $\frac{R\&D\ expense}{Sales}$ | COMPUSTAT | Villalonga and McGahan (2005) |
| Ad intensity | $\frac{Advetising\ expense}{Sales}$ | COMPUSTAT | Villalonga and McGahan (2005) |
| Mode*Marketing Capability | The interaction of marketing capability and each of three SaaS development modes | | Self-generated |
| Mode*Operating Capability | The interaction of operating capability and each of three SaaS development modes | | Self-generated |
| Mode*R&D intensity | The interaction of R&D intensity and each of three SaaS development modes | | Self-generated |
| Mode*Ad intensity | The interaction of AD intensity and each of three SaaS development modes | | Self-generated |
| Ondemand experience | Dummy variable: =1, has on-demand experience | Factiva News | Self-generated |
| HHI | $H=\sum_{i=1}^{N} S^2$ | COMPUSTAT | Vrande (2013) |
| Noseg | Number of segments | COPMUSTAT | Wiles et al. (2012) |
| Firm size | Ln(emp) | COMPUSTAT | Ahuja and Katila (2001) |

**Table 2 Statistics Description**

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Develop_mode | 8363 | 1.27 | 0.66 | 1.00 | 4.00 |
| ODexp | 8350 | 0.17 | 0.38 | 0.00 | 1.00 |
| HHI | 8350 | 0.18 | 0.09 | 0.00 | 0.99 |
| slack | 6917 | 3.47 | 52.53 | 0.00 | 3348.00 |
| lgfreeCF | 5183 | 2.61 | 2.25 | -4.51 | 10.16 |
| ADintensity | 3598 | 0.26 | 8.07 | 0.00 | 457.00 |
| RDintensity | 5673 | 0.89 | 19.99 | 0.00 | 1325.50 |
| grossmargin | 7463 | -4.45 | 165.80 | -180.00 | 1.00 |
| CAR12 | 2816 | 0.05 | 0.53 | -2.32 | 5.13 |
| salesgrow | 6119 | 1.24 | 43.42 | -1.00 | 3218.67 |
| mktshare | 7753 | 0.01 | 0.05 | 0.00 | 1.00 |
| makeonly | 8363 | 0.13 | 0.34 | 0.00 | 1.00 |
| buyonly | 8363 | 0.07 | 0.25 | 0.00 | 1.00 |
| both | 8363 | 0.03 | 0.16 | 0.00 | 1.00 |
| MKcap | 6823 | 0.17 | 0.08 | 0.00 | 0.78 |
| cumRDintensity | 5223 | 0.49 | 3.81 | 0.00 | 201.40 |
| cumADintensity | 2878 | 0.33 | 8.91 | 0.00 | 457.33 |
| lnemp | 6761 | 0.69 | 0.95 | 0.00 | 6.08 |
| noseg | 6593 | 2.48 | 0.77 | 1.00 | 6.00 |

**Table 3 Stage1 Variable Correlations**

| | choice | ODexp | HHI | slack | lgfreeCF |
|---|---|---|---|---|---|
| Develop_mode | 1.000 | | | | |
| ODexp | 0.278 | 1.000 | | | |
| HHI | -0.116 | -0.020 | 1.000 | | |
| slack | -0.018 | -0.019 | 0.016 | 1.000 | |
| lgfreeCF | 0.088 | 0.013 | -0.007 | -0.093 | 1.000 |
| ADintensity | -0.068 | -0.060 | 0.088 | 0.216 | 0.002 |
| RDintensity | -0.014 | -0.024 | 0.016 | 0.898 | -0.100 |
| lnemp | 0.067 | 0.035 | 0.000 | -0.050 | 0.825 |

**Table 4 Stage2 Variable Correlations**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| cumRD | 1.00 | | | | | | | | | | |
| cumAD | 0.18 | 1.00 | | | | | | | | | |
| grossMargin | -0.13 | -0.62 | 1.00 | | | | | | | | |
| CAR12 | -0.06 | -0.09 | 0.11 | 1.00 | | | | | | | |
| salesgrowth | 0.00 | 0.03 | 0.07 | 0.19 | 1.00 | | | | | | |
| mktshare | -0.09 | -0.01 | 0.02 | -0.01 | -0.03 | 1.00 | | | | | |
| makeonly | -0.03 | 0.00 | 0.05 | 0.06 | 0.04 | -0.07 | 1.00 | | | | |
| buyonly | -0.04 | -0.04 | 0.05 | 0.05 | -0.01 | -0.04 | 0.21 | 1.00 | | | |
| both | -0.05 | -0.01 | 0.03 | 0.05 | 0.00 | -0.03 | 0.48 | 0.68 | 1.00 | | |
| MKcap | -0.03 | 0.03 | -0.03 | 0.01 | -0.01 | -0.08 | -0.05 | -0.01 | 0.04 | 1.00 | |
| lnemp | -0.29 | -0.02 | 0.04 | 0.01 | -0.02 | 0.62 | 0.03 | 0.04 | 0.03 | -0.08 | 1.00 |
| noseg | -0.05 | -0.08 | 0.05 | 0.04 | 0.00 | 0.07 | -0.06 | -0.02 | 0.02 | 0.00 | 0.02 |

As shown in Table 3 and Table 4, all correlations are lower than 0.70. The mean variance inflation factor (VIF) is 3.56,indicating that our data has no multicollinarity problems.

## 4. Analysis Results

### *4.1. Stage 1 Analysis Results*

The result of Stage 1 regression is reported in Table 5. As we predicted in our model, a firm's characteristics significantly impact its choice of development mode. Specifically, firms are more likely to invest in SaaS if they have more cash flow. This makes sense because firms with more cash flow are more likely to invest in new technology. However, we don't find resource slack as a significant factor that affects the firm's decision in the model. We can consider cloud computing a radical innovation because it changes the business model. Previous literature found that larger firms are less likely to do radical change because they benefit less from this kind of innovation (Cohen 2010). But they will also change this because they fear losing potential chances of remaining a monopoly or gaining more market share. Thus, resource slack might not matter a lot here because not all firms regard SaaS as a radical change. This evaluation is not dependent on their size or slack. Overall, it plays a less important role in decision-making.

We also find that a firm's cumulative R&D intensity negatively impacts a firm's investment in SaaS. R&D intensity could be regarded as an indicator of the firm's innovation capability (Hughes 1988). Thus, as we have expected, firms with higher innovation capability are more likely to develop SaaS products than those with lower innovation capability. And compared with both make and buy, they are more likely to choose to acquire companies. In previous literature, R&D intensity is regarded as a proxy of absorptive capacity (Mowery et al. 1996). Compared with an inventive capacity which refers to the internal knowledge creation ability, absorptive capacity measures the firm's ability to acquire external knowledge (Lichthenaler and Lichtenthaler 2009). For firms that are better at assimilating knowledge outside their firm, acquiring firms or forming alliances with other firms might be enough for them to use external knowledge. Then they might have fewer incentives to make products themselves.

Furthermore, we find that on-demand experience significantly affects a firm's choices to develop SaaS products. Firms with such experience are more likely to develop SaaS than those who don't. Also, they tend to invest more in SaaS development. This might be because it is easier for firms to succeed by developing cloud-related products based on their on-demand experience. Advertising intensity could be regarded as part of market resources (Villalonga and McGahan 2005). In our model, higher advertising intensity leads to less investment in SaaS. We consider that this might be because firms who focus more on market propaganda are less likely to take risks in investing in new technology. Advertising-intensive firms could have higher brand capital which is hard to be shared. Thus, developing their products under the same brand could bring more benefits for these firms.

**Table 5 Stage1 Regression Result**

| **VARIABLES** | **D.V.= choice** |
|---|---|
| L.slack | 0.016 |
| | (0.021) |
| L.lgfreeCF | 0.155*** |
| | (0.054) |
| L.cumRDintensity | -0.011*** |
| | (0.318) |
| L.ADintensity | -0.070*** |
| | (0.018) |
| L.ODexp | 0.164*** |
| | (0.014) |
| L.HHI | -2.071 |
| | (2.826) |
| L.lnemp | -0.329*** |
| | (0.114) |
| L.noseg | 0.084 |
| | (0.146) |
| # ofObservations | 1,538 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

*Stage 2: Impacts on Financial Performance*

Following Ahuja and Katila (2001), we incorporated the lagged effects in our models. We also try to see if the company's capability will moderate the relationship between firms' technology development mode and firm performance. We first run regression on the essential factors, then add moderator effects to the model. Finally, we add the model of the interaction term of marketing capability and technology mode.Table 6 reports the results.

---Insert Table 6 Here---

Table 6 shows that the development mode decision has a different impact on different perspectives of a firm's performance. For market share, it seems that internal sourcing will help increase their market share by 0.4%, taking into marketing capability's moderator effects. There could be two reasons to explain this. First, from the demand side, SaaS products have their markets instead of the original software market. As Cohen (2010) pointed out: innovation could bring new demand. Like small and medium enterprises, at first, they might not be able to

afford a CRM system, but the situation changed when salesforce.com emerged and brought them the idea of "pay-per-use." Second, the company could be able to gain more market share by attracting people who are willing to switch. Some customers might switch from traditional software to SaaS products because it is more beneficial for them. Thus the company could also enhance its market share in the original market.

For sales growth, we can see from Table 6 that developing SaaS will decrease the growth rate. This could be the result of resource cannibalization (Roberts and Mcevily 2005). New products are likely to attract more attention, and they need the effort to be well understood and promoted. As a firm's resource is limited, then if the firm spends their resource on new products, existing products might suffer. Thus, the overall sales growth rate could be decreased by introducing SaaS products. However, both make and could help the company in sales growth. Acquiring a cloud-based firm or alliance with existing firms could help the focal firm enter the market quickly compared to internal development. When a focal firm acquires a target firm, not only does it acquire its technology and knowledge of it, but it could also acquire the customer base of the target firm. Allying with another might also help the focal firm to get benefits from its partner's customer base. Doing only one mode: make or buy, might have an uncertain outcome, but doing both make and buy signaling that the company has a more significant investment in SaaS and aims to get specific power in this market. This could make customers more confident in this company's new products. Besides, considering from the other perspective, usually, larger firms are capable of taking a risk doing this. They might be more attractive to customers because of their existing monopoly position.

Besides, we found that internal sourcing hurt gross margin. We know that gross margin depends on both revenue and cost. Sales increase might be accompanied by cost increase. New product development requires the company to invest in R&D and product marketing. Thus, the overall cost will be higher. Therefore, the gross margin decline might indicate the firm's declining competitiveness in its products. Internal development might cause this problem because it takes longer before the firm can launch the product. Especially when the firms' competitors already have SaaS-related products, internal development might harm the firm's competitiveness. However, we can see that if the firm has higher marketing capability, it will moderate the relationship between self-development and the company's gross margin. Sales could significantly enhance a company with higher marketing capability compared to cost. Thus, firms that are effective in marketing could benefit from internal development.

*4.3. Additional Analysis*

Despite all the firm performance measurements we discussed, we were also interested in how the make or buy decision would impact stock return. Because the acquisition could take quite a long time to finally complete, and internal software development might also take some time to promote, we consider using an annually cumulative abnormal return properly in our context. Our results show that the make or buy decision didn't affect the firm's abnormal return. Then we consider the effects of the decision in the year when the decision is made. Stock return is more sensitive to the company's decision. Thus, the make-or-buy decision could affect this year's abnormal return rather than next year's. Table 7 shows the result of further analysis. Here, we can observe that if the firm makes both and buys this year, it would negatively impact abnormal returns. Suppose the firm announces the launch of a new product and the acquisition of a SaaS-related firm. In that case, the investment in SaaS development will be high, and the risk will also increase as the investment increase. Thus, the investors might feel the high risk of the firm's decision, which eventually leads to less confidence in the firm.

---Insert Table 7 Here---

*4.4. Robustness Check*

In the previous section, we used system-GMM instead of OLS to release the simultaneous issue. System GMM is used in literature because it could remove some endogenous issues, i.e., simultaneous problems. And we now do further analysis to make our study robust. Second, we only consider the financial benefits of entering a new market. However, financial performance is just a single perspective. Based on the knowledge-based theory, internal knowledge development and external knowledge acquisition might differ. Thus, we also use patent stock as our dependent variable:

$$PatentStock_{(t)}=(1-\delta)PatentStock_{(t-1)}+patentNo_{(t)}$$

Here we set $\delta=0.15$ to calculate patent stock. We are considering that patents might need longer to be granted.

Thus, we incorporate two-year lag variables in our model to test the effects of the development mode. The results are shown in Table 8.

---Insert Table 8 Here---

In model 1, we only include a variable that is variable lagged one year. This is because the development has no significant effects, while the lagged two-year variable shows that only both make and buy could harm the firm's innovation performance.

Previous research has shown that the absolute size of the acquired company relative to the two companies influences post-acquisition performance (Kapoor and Lim 2007)**.** Thus, we include the size of the acquired company in our analysis based on the employee number. The result remains consistent with our primary analysis.

**5. Discussion**

We identify the factors that could affect a firm's technology development mode: we find that firm's R&D investment influences a firm's choice of technology development mode, and firms with higher R&D investment intend to develop the cloud services internally. Though they have existed for over a decade, their uncertainty still exists in cloud computing development. Firms prefer internal development when they have such ability because the inner product might fit better with their business process (Christenson and Overdorf 2000). Besides, firms with enormous marketing power also prefer internal development because marketing power indicates their ability to satisfy customers' needs. Here we look over the relationship between a firm's capabilities and its choice of technology development mode. We further testify the relationship between different technology strategies and firm performance: financial and innovation perspectives. However, unlike expected, the development mode doesn't affect different financial performance perspectives in the same direction. Generally, internal development could not benefit the firms a lot but could help increase the firm's market share.

On the other hand, consistent with previous research, we found that acquisition could not benefit the firm but might negatively affect the firm's performance (Hayward 2002). However, while concurrent sourcing might reduce technological uncertainty because firms have to invest more in the technology development process than single mode, the return might require time. Thus, we have several practical implications for a firm's mode choice: first, a single mode should be a better choice for the firm. Whether firms make or buy, long or short-termly, they might not help the firm extend their business rapidly. However, firms should still pay more attention to software as a service second. However, the acquisition might not benefit the firm directly when firms with higher marketing capabilities are encouraged to acquire cloud-related firms and enter the cloud market as soon as possible. Still, concurrent sourcing is not a good choice for most firms. Conflict from different sources of knowledge might further disturb the firm's product development process, which could result in a lack of growth in financial performance.

Our study has several contributions to IT value literature and strategy literature. Currently, cloud computing or software as a service is a hot topic, but not many researchers have been looking into the development mode of cloud services. Entering the cloud market is not without cost, but we are showing that the right way to enter is important. Furthermore, we want to study this new technology phenomenon because of its technical characteristics and the new "pay-per-use" idea in the software industry brought by cloud services. It could be regarded as a disruptive technology, and companies concerned about their innovation activities face the technology shock (Christenson and Overdorf 2000). Our study shed light on the development mode of technology and the firm's performance. We also showed that marketing capabilities are important in technology development: they could interact with each other and lead to different results for the firm.

However, our study is not without limitations. First, we only focus on software companies and study the development of SaaS. There are two other types of cloud computing: Infrastructure as a Service and Platform as a Service. We didn't consider these two. Second, we didn't consider the technological characteristics of those acquired firms or alliances, such as the technology overlap between the two companies and their technical capabilities (Sears and Hoetker 2014). Those target firms could be start-ups that focus on developing cloud services, and they might have various customer bases before they are acquired. These could be another critical issue that we could not capture in the future performance of these acquired companies. Still, we consider that we

can provide an overview of the development modes of cloud computing services and contribute to the companies who intend to join this market.

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**Table 6 GMM Analysis Result**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| VARIABLES | Gmargin | Gmargin | Salesgrow | Salesgrow | mktshare | mktshare | CAR12 | CAR12 |
| L.grossmargin | 0.420*** | 0.409*** | | | | | | |
| | (0.065) | (0.066) | | | | | | |
| L.salesgrow | | | 0.007 | 0.013 | | | | |
| | | | (0.016) | (0.016) | | | | |
| L.mktshare | | | | | 0.154*** | 0.179*** | | |
| | | | | | (0.047) | (0.046) | | |
| L.CAR12 | | | | | | | -0.183*** | -0.178*** |
| | | | | | | | (0.045) | (0.045) |
| L.makeonly | -0.145* | -0.602** | -0.378** | -1.092* | 0.004** | 0.003 | -0.325 | 0.360 |
| | (0.078) | (0.280) | (0.165) | (0.572) | (0.002) | (0.006) | (0.274) | (1.195) |
| L.buyonly | -0.192 | -1.930** | -0.118 | 1.135 | 0.003 | -0.005 | 0.261 | 1.872 |
| | (0.140) | (0.781) | (0.288) | (1.569) | (0.003) | (0.017) | (0.405) | (3.431) |
| L.both | 0.097 | 0.870 | 0.394** | 0.719 | -0.005** | -0.012 | -0.780** | -5.854 |
| | (0.080) | (0.536) | (0.169) | (1.081) | (0.002) | (0.012) | (0.356) | (3.705) |
| L.MKcap | -0.036 | 0.017 | -0.113*** | -0.942*** | 1.864*** | 1.559*** | -0.669 | -0.562 |
| | (0.028) | (0.019) | (0.343) | (0.349) | (0.399) | (0.400) | (0.561) | (0.622) |
| L.cumRDintensity | 0.031 | 0.024 | 0.103** | 0.091* | -0.001 | -0.001 | -0.074 | -0.182 |
| | (0.024) | (0.025) | (0.052) | (0.052) | (0.001) | (0.001) | (0.400) | (0.401) |
| L.cumADintensity | 0.261 | 0.213 | 0.251 | 0.140 | -0.001 | -0.002 | 0.202 | 0.493 |
| | (0.226) | (0.233) | (0.473) | (0.475) | (0.005) | (0.005) | (0.967) | (0.962) |
| L.make_Mkcap | | 0.0334* | | 0.049 | | 0.006 | | -0.038 |
| | | (0.018) | | (0.032) | | (0.040) | | (0.087) |
| L.buy_MKcap | | 0.105** | | -0.067 | | 0.054 | | -0.111 |
| | | (0.0444) | | (0.087) | | (0.095) | | (0.199) |
| L.both_MKcap | | -0.047 | | -0.028 | | 0.048 | | 0.321 |
| | | (0.030) | | (0.060) | | (0.065) | | (0.212) |
| HHI | -0.505 | -0.340 | -1.687** | -1.476** | -0.005 | -0.007 | -1.244 | -1.309 |
| | (0.339) | (0.352) | (0.695) | (0.704) | (0.008) | (0.007) | (1.243) | (1.263) |
| lnemp | 0.091 | 0.182 | -0.818*** | -0.693*** | 0.017*** | 0.014*** | 0.070 | -0.121 |
| | (0.115) | (0.116) | (0.219) | (0.212) | (0.003) | (0.002) | (0.362) | (0.385) |
| noseg | 0.012 | 0.001 | 0.034 | 0.031 | -0.002*** | -0.002*** | 0.070 | 0.057 |
| | (0.014) | (0.015) | (0.029) | (0.031) | (0.001) | (0.001) | (0.048) | (0.053) |

Number of observation is 1,356 and the number of firms is 316 in Column (1) –(6) and 789 and 180 firms in column (7) – (8). *** p<0.01, ** p<0.05, * p<0.1

**Table 7 Additional Analysis of Abnormal Return**

| | (1) | (2) |
|---|---|---|
| VARIABLES | CAR12 | CAR12 |
| L.CAR12 | -0.178*** | -0.190*** |
| | (0.046) | (0.046) |
| makeonly | 0.327 | 0.516* |
| | (0.289) | (0.307) |
| buyonly | 0.306 | 0.372 |
| | (0.346) | (0.351) |
| both | -0.875** | -0.706 |
| | (0.409) | (0.429) |
| L.MKcap | -0.237 | -0.554 |
| | (0.452) | (0.505) |
| L.cumRDintensity | -0.172 | -0.129 |
| | (0.393) | (0.379) |
| L.cumADintensity | -0.208 | 0.102 |
| | (0.951) | (0.967) |
| L.make_Mkcap | | -0.023 |
| | | (0.019) |
| L.buy_MKcap | | -0.012 |
| | | (0.023) |
| L.both_MKcap | | 0.120 |
| | | (0.021) |
| lnat | 0.164 | 0.073 |
| | (0.167) | (0.167) |
| HHI | -1.531 | -1.580 |
| | (1.243) | (1.231) |
| noseg | 0.080* | 0.087* |
| | (0.048) | (0.047) |
| Observations | 789 | 789 |
| Number of firms | 180 | 180 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table8: Innovation Performance**

| | (1) | (2) |
|---|---|---|
| VARIABLES | patentstock | patentstock |
| L.patentstock | 0.951*** | 1.537*** |
| | (0.0525) | (0.0600) |
| L2.patentstock | | -0.186*** |
| | | (0.0424) |
| L.makeonly | 0.121 | |
| | (0.122) | |
| L.buyonly | 0.143 | |
| | (0.180) | |
| L.both | -0.178 | |
| | (0.201) | |
| L.cumRDintensity | -0.011 | |
| | (0.853) | |
| L.make_RD | 0.448 | |
| | (0.697) | |
| L.buy_RD | -0.397 | |
| | (0.723) | |
| L.both_RD | 0.320 | |
| | (1.372) | |
| L2.makeonly | | 0.049 |
| | | (0.046) |
| L2.buyonly | | -0.017 |
| | | (0.058) |
| L2.both | | -0.254** |
| | | (0.099) |
| L2.make_RD | | -0.675** |
| | | (0.272) |
| L2.buy_RD | | 0.069 |
| | | (0.298) |
| L2.both_RD | | 1.731** |
| | | (0.732) |
| cumRDintensity | | 0.194 |
| | | (1.087) |
| HHI | -0.241 | -0.112 |
| | (0.343) | (0.289) |
| lnemp | 8.721 | 3.395 |
| | (13.10) | (10.59) |
| noseg | 0.371 | 0.108 |
| | (1.126) | (0.891) |
| Observations | 2,876 | 2,473 |
| Number of firms | 603 | 560 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1