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ORIGINAL ARTICLE

Factors affecting the adoption of cloud services in enterprises

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Abstract Cloud computing services offer enterprise clients many advantages such as reduced costs, easy maintenance and the easy re-provisioning of resources, thus contributing to increased profits. However, little is known about the adoption behavior of such services among enterprises. This study applies the technology–organization–environment framework to investigate determinants of cloud computing service adoption behavior. Data collected from 102 valid enterprises in Taiwan provide strong support for the model. Results indicate that technological (i.e., relative advantage, observability and security), organizational (i.e., financial costs and satisfaction with existing IS) and environmental (i.e., competition intensity) factors were positively related to intention to adopt cloud computing services, accounting for 52 % of variance. Implications and limitations are discussed.

Keywords Cloud computing services · TOE · Innovation diffusion theory · IS adoption

1 Introduction

Cloud computing refers to "a model of computing in which firms and individuals obtain computing power and software applications over the Internet" (Laudon and Laudon 2012). Through the use of technologies such as web services, virtualization

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and grid computing (Sultan 2011), cloud computing represents a large step towards the realization of utility computing, which treats computing resources (e.g., computing power, application software, virtual storage, etc.) as a conventional utility comparable to telephone services and electricity. By adopting cloud computing services, the cost of computing, and the demand for highly specialized labor needed to maintain computer systems will drastically reduced (Durkee 2010).

In terms of financial impact, many analysts and market research firms have made optimistic predictions for the future of cloud computing services. According to a report by Global Industry Analysts Inc. (2015), the global cloud computing services market will grow to reach US$127b by 2017 and more than 24 % of IT budgets will be allocated to cloud solutions in 2015 (IDG 2014). With such positive predictions, it comes as no surprise that as much as 85 % of new commercial enterprise apps will be built for cloud environments by 2016 (IBM 2013).

Despite the apparent benefits of cloud services, many enterprises are still hesitant to adopt them. The possible reasons behind this hesitancy are multifaceted. Some companies seem to have technical concerns. For example, many skeptics believe that cloud computing is less secure than traditional on-site data storage solutions (Frost and Sullivan 2012; Bailey 2015). They also worry that potential outages could increase the complexity of maintaining business performance and system reliabilities (Armbrust et al. 2010; Bailey 2015). Other concerns are organization-related, with various enterprises suspecting that their unique characteristics might reduce the usefulness of cloud computing services. For example, small- and medium-sized companies lack the resources of larger firms and thus seem more likely to adopt cloud computing due to the attraction of scaling flexibility and pay-as-you-go cost structures. Moreover, the "sharing" concept of cloud services also reduces a company's control over its IT/IS. This concept requires a different approach toward company's ownership of IT/IS. Therefore, to better serve their customers, cloud computing services providers require a clearer picture of factors affecting enterprise adoption intentions.

In current study, we have developed and empirically tested a conceptual model based on the technology–organization–environment (TOE) framework (Tornatsky and Fleischer 1990). The TOE framework, which differs from many adoption theories (e.g., technology acceptance model (TAM), theory of planned behavior (TPB), unified theory of acceptance and use of technology (UTAUT)), not only provides a technological perspective, but it also emphasizes the important influences of organizational characteristics and environmental factors. It is quite suitable in the context of cloud computing because adopting cloud computing services requires a completely different mindset (i.e., a willingness to rely heavily on cloud service providers for needed IT resources).

Some prior studies have empirically examined the determinants of cloud adoption based on the TOE framework (Alshamaila et al. 2013; Low et al. 2011; Lian et al. 2014). These works highlight the importance of various perspectives to establish an understanding of cloud computing adoption conditions. However, few (if any) consider critical factors such as security, financial costs, satisfaction with existing IS and the surrounding regulatory environment as determinants of cloud computing service adoption. These factors have not only been shown to be important in studying IT/IS related adoptions (Miller 2008; Armbrust et al. 2010; Jaeger et al. 2008; Matsuura 2011; Subashini and Kavitha 2011) but also serve as vital issues especially for most cloud services provided by third-party vendors since, by choosing cloud services, companies no longer own or manage the adopted IT/IS by themselves. In such cloud services, cloud service clients share infrastructure with security levels set by cloud service providers and have no visibility nor control over where their data and assets are located. While financial advantages may be an important driver in adopting cloud services, the much wider range of functions (as compared to in-house enterprise information systems) provided by cloud services may also cause the shift away from self-managed systems. Additionally, the widespread adoption of cloud services requires updated regulatory frameworks (Zhu et al. 2004, 2006).

Thus, to attempt to close the research gap, this study examines what factors contribute to the companies' adoption of cloud services, specifically, the research questions of interest to this study are what are the key factors within the context of public cloud service adoption and the moderating effects of firm size and industry type in cloud service adoption? To examine factors involved in cloud service adoption, we applied the TOE and propose determinants of cloud computing adoption by decomposition innovation, organizational and environmental characteristics into specific beliefs dimensions. This multifaceted view provides a better understanding of adoption behavior. The results of this study were based on data collected from real firms and raise implications for research and practice. In terms of its contribution to IS research, the current work extends TOE by providing important factors on technology, organization and environment dimensions that affect cloud service adoption. The findings also provide significant insights for practitioners in developing effective strategies to promote cloud computing services.

The remainder of this study is organized as follows: Sect. 2 provides a theoretical overview; Sect. 3 proposes the research model and rationales of hypotheses tested; Sect. 4 describes the research method; and Sect. 5 provides the results of empirical tests. Section 6 presents discussions of the analysis. Finally, Sects. 7 and 8 discusses implications for researchers/practitioners/and limitations and future research directions, respectively.

2 Theoretical background

2.1 Cloud computing services

Cloud computing refers to applications delivered as a service over the internet and computing resources (hardware and software) in the data centers that provide on-demand access to these resources and services (Armbrust et al. 2010). Cloud services can generally be offered in three main areas: applications (Software as a Service—SaaS), platform (Platform as a Service—PaaS) and hardware (Infrastructure as a Service—IaaS) (Vaquero et al. 2009; Goscinski and Brock 2010; Mell and Grance 2011): (1) SaaS allows users to access web-based software via their browser without installing and maintaining any software themselves. SaaS providers offer productivity applications (e.g., office software) and programs (e.g., CRM, ERP) on a subscription basis. Google Docs and Salesforce are some well-known SaaS solutions. (2) In PaaS, application developers develop and run their software solutions on a cloud platform, typically including operating systems, a programming language execution environment, databases, and web servers. Google's App engine, Microsoft's Azure and Amazon Web Services are early market leaders. (3) IaaS allows users to access infrastructure resources including virtual computers, servers, storage devices and data center space to support enterprise operations. Modern firms may have very large data computing and storage requirements which can be met by cloud service providers. Examples include Amazon's Elastic Compute Cloud (EC2), Mosso's Hosting Cloud and GoGrid's Cloud Servers. The current study defines cloud computing as a computing platform offered by a third party which dynamically provides, configures, and reconfigures servers to address a wide range of e-business needs (Goscinski and Brock 2010).

Core cloud computing technologies include virtualization, multitenancy and Web services (Marston et al. 2011) at all three cloud layers: SaaS, PaaS and IaaS. Virtualization technologies partition hardware and thus provide flexible and scalable computing platforms to accommodate a variety of user needs (Wang et al. 2010). It has been applied to all aspects of applications—memory, storage, processors, software, networks, as well as IT services (Vouk 2008). Multitenancy refers to a software architecture in which a single instance of an application software serves multiple clients. A cloud can uses this technology to share system resources securely among multiple applications and cloud tenants (e.g., businesses, organizations, etc.). A Web service is a software system designed to support interoperable machine-to-machine interaction over a network (W3C 2004). It enables users to access systems or server applications using a software client (e.g., a web browser) over a network. Since these technologies can be considered technological innovations, technological innovation theory (i.e., innovation diffusion theory) can be used as a reference discipline for empirical studies of cloud computing adoption.

Cloud computing differs from traditional IT/IS in terms of target customers (i.e., firm size and industry type), prior adoption research has largely overlooked such differences. For more practical implications, there is a need to analyze the determinants of cloud computing adoption in terms of different firm sizes and industries.

2.2 TOE and related studies

Adopting IS/IT requires businesses to aggregate computer hardware and application software to support operations, management and decision making. Over the past decade, the technology–organization–environment (TOE) framework has received considerable academic attention in exploring organizational adoption of IS/IT, as shown in Table 1. TOE posits that an organization's adoption of IS/IT is influenced by three factors: technology, organization and environment. Technology refers to the technologies available to an organization and how the characteristics of those

Table 1 Previous TOE studies

Authors (years)	Context	Technology	Organization	Environment
Chau and Tam (1997)	Open system	Perceived benefits Perceived barriers* Perceived importance of compliance to standards, interoperability and interconnectivity	Complexity of IT infrastructure Satisfaction with existing systems* Formalization on system development and management	Market uncertainty
Thong (1999)	Information systems	Relative advantage Complexity Compatibility	Size* Employees' IS knowledge* Information intensity CEO's innovativeness CEO's IS knowledge	Competition
Kuan and Chau (2001)	EDI	Perceived direct benefits* Perceived indirect benefits	Perceived financial cost* Perceived technical competence*	Perceived industry pressure* Perceived government pressure*
Zhu and Kraemer (2005)	E-Business	Technology competence*	Size* International scope Financial commitment*	Competitive pressure* Regulatory support*
Zhu et al. (2006)	E-Business	Technology readiness* Technology integration*	Firm size* Global scope Managerial obstacles*	Competition intensity* Regulatory environment
Low et al. (2011)	Cloud computing	Relative advantage* Complexity Compatibility	Top management support* Firm size* Technology readiness	Competitive pressure* Trading partner pressure*
Alshamaila et al. (2013)	Cloud computing	Relative advantage* Uncertainty* Geo-restriction* Compatibility* Complexity* Trialability	Size* Top management support*Innovativeness* Prior IT experience*	Competitive pressure Industry* Market scope* Supplier efforts and external computing support*
Lin (2014)	Supply chain management system	Perceived benefits* Perceived costs*	Firm size Top management support* Absorptive capacity*	Trading partner influence Competitive pressure*
Lian et al. (2014)	Cloud computing	Data security* Complexity Compatibility* Costs	Relative advantage Top manager's support* Adequate resource* Benefits	Government policy Perceived industry pressure*

* Significant factors

technologies influence the adoption process. Organization refers to organization characteristics such as firm size and global scope. Environment refers to the arena in which the organization conducts its business, including its industry, competitors and regulations (Tornatsky and Fleischer 1990). TOE is a general model which does not specify factors of each aspect influencing the adoption of IT/IS in different contexts. Thus, researchers need to incorporate related factors which fit the contexts of the studies. The current study considers the characteristics of cloud computing services and proposes a model using the factors raised by previous TOE-related studies to explain business adoption of cloud computing services.

2.3 Cloud service adoption regarding TOE perspectives

2.3.1 Technology perspective beliefs

For firms weighing the adoption of IT/IS, the main consideration are the innovation characteristics of IT/IS. Cloud services are regarded as an innovation because cloud-based IS offer firms the ability to rent software or infrastructure while using pay-as-you-go access to software and resources to facilitate business operations (Marston et al. 2011). Innovation diffusion theory (IDT) attempts to explain which factors will influence the adoption of a particular innovation (Rogers 1983). In the past few decades, studies have successfully applied IDT to explain the intention to adopt IT/IS (Tam 1996; Beatty et al. 2001; Slyke et al. 2002). Moreover, previous TOE-related research also considers IDT attributes as technology factors to explain IT/IS usage (e.g., Hung et al. 2010a, b; Alshamaila et al. 2013). Therefore, the current study used these perceived attributes of innovation such as relative advantage, ease of use, compatibility, trialability and observability to explore the firms' adoption of cloud computing services.

Although IDT is a well-developed innovation diffusion theory, more attention is due to alternative antecedents to the adoption of cloud computing services. We believe that the original IDT should be considered with more belief-related variables. Actually, to provide a more comprehensive explanation of IT/IS usage and examine consumer behavior in specific contexts, previous studies have added many extended perception variables to IDT (Bradford and Florin 2003; Agarwal and Prasad 1997; Hsu et al. 2007; Chen et al. 2002). In the context of cloud computing services, security is commonly seen as the key obstacle to adoption (IDC 2008; Bailey 2015). Therefore, in the present study, perceived security is integrated into the perceived attributes of IDT and its effects are empirically verified.

2.3.2 Organizational perspective beliefs

Previous studies on IS adoption by firms has indicated that organizational context plays an important role in managerial decisions (Raymond and Bergeron 1996; Byrd and Davidson 2003; Lee et al. 2009). Organizational context refers to the characteristics of the organization, and many previous studies on TOE have included firm size and global scope as common organizational characteristics (Grover 1993; Thong 1999; Pflughoeft et al. 2003; Zhu et al. 2004, 2006). Firm size is defined by the number of employees in the firm whereas global scope is defined as the geographical extent of a firm's operations in the global market. This study uses firm size as the organizational aspect since the conditions of IS usage are different between large and small firms (Ein-Dor and Segev 1978; Zhu et al. 2003). While larger firms have more resources and infrastructure to facilitate IS adoption, smaller firms may not recognize IS as a core competence and have more barriers to adoption such as financial constraints or lack of professional expertise. In addition, cloud computing services are internet-based applications, and thus render global scope less material as a distinguishing factor given the global reach of the internet.

To promote a more comprehensive understanding of the organizational aspects of cloud service adoption, this study proposes financial costs and satisfaction with existing systems as additional organization factors (Kuan and Chau 2001; Chau and Tam 1997; Min and Galle 2003). For firms, cloud services are a new approach to IS usage since firm simply rent the services or use them on a pay-as-you-go basis, unlike traditional systems which usually must be purchased outright (Armbrust et al. 2010; Sultan 2011). This promises substantial decreases in IS costs including set-up, operations, management, maintenance and training. Moreover, the present study suggests that the satisfaction level with existing systems plays a significant role in terms of motivation to change, and firms with lower levels of satisfaction with their existing IS may be more likely to consider adopting cloud services.

2.3.3 Environmental perspective beliefs

In recent decades, a number of studies have used both competition intensity and regulatory environment as common environmental factors in TOE (Zhu et al. 2004, 2006; Hsu et al. 2006). Competition intensity refers to the degree to which a company is influenced by competitors, while the regulatory environment was defined as the degree to which innovations are affected by the government or corporate rules. To quickly adapt to a fast-changing competitive environment, firms require IS which can be quickly set-up and facilitate business operations. Cloud services meet these criteria, thus competition intensity may be an important factor influencing the adoption of cloud services. In addition, issues related to the regulatory environment go beyond technical and organizational concerns (Buyya et al. 2008; Brodkin 2008). Matsuura (2011) indicated that uncertainty regarding regulatory compliance issues associated with cloud service activities acts to restrict the diffusion of such services. For example, there is uncertainty currently exists as to the specific regulatory requirements applicable to the cloud service as well as the appropriate methods and processes by which to ensure regulatory compliance for cloud operations. Hence, these two factors are examined in this study.

3 Conceptual model and hypotheses

Figure 1 illustrates our model, which is based on TOE and the related literature. It asserts that a firm's adoption of cloud computing services is determined by technology (i.e., relative advantage, ease of use, compatibility, trialability,

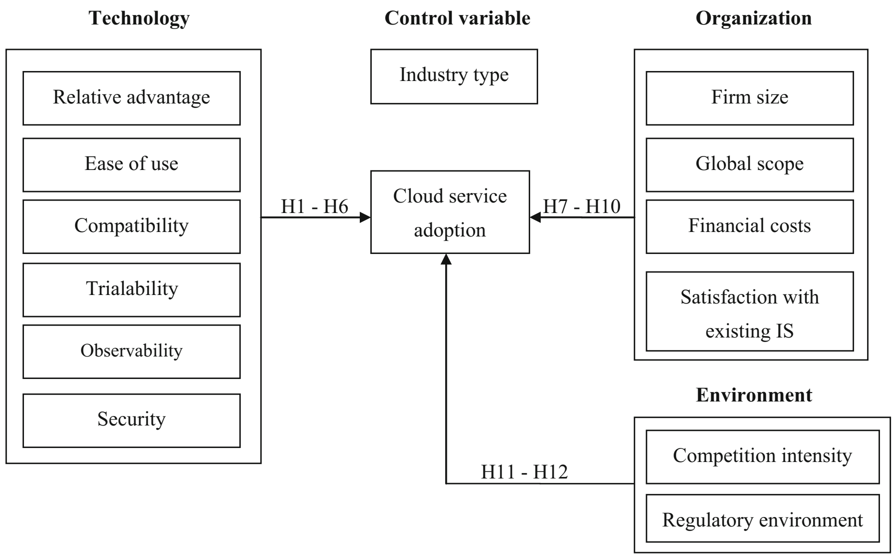

Fig. 1 Research model

observability and security), organization (i.e., firm size, global scope, financial costs and satisfaction with existing IS) and environment (i.e., competition intensity and regulatory environment). Construct definitions, the network of relationships illustrated in the model, and the rationale for the proposed links are explained in the following section.

3.1 Technology factors

Relative advantage is defined as the degree to which a cloud service is perceived as an improvement on the system it is intended to replace. Perceived ease of use is defined as the degree to which an individual believes that using a cloud service would be free of effort. Compatibility is defined as the degree to which a cloud service is perceived as being consistent with the existing values, needs, and past experiences of the potential adopters. Trialability is defined as the degree to which a cloud service may be experimented with before adoption. Observability is defined as the degree to which the results of a cloud service are observable to others. Previous research has demonstrated the validity of the IDT across a wide range of information technologies (Grover and Goslar 1993; Karahanna et al. 1999; Rajagopal 2002; Chen et al. 2009). Specifically, the characteristics identified by Rogers and his successors explain acceptance behavior in internet applications. Accordingly, we propose the following hypotheses:

H1 Relative advantage is positively associated with a firm's intention to adopt cloud computing services.

H2 Ease of use is positively associated with a firm's intention to adopt cloud computing services.

H3 Compatibility is positively associated with a firm's intention to adopt cloud computing services.

H4 Trialability is positively associated with a firm's intention to adopt cloud computing services.

H5 Observability is positively associated with a firm's intention to adopt cloud computing services.

Perceived security was defined as the extent to which a user believes that using cloud services will be risk-free. A survey conducted by IDC (2008) showed that a majority (74.6 %) of firms perceived security as being their major concern about cloud services. Armbrust et al. (2010) also indicated that security such as data lock-in as well as data confidentiality and auditability are critical obstacles for the growth of cloud services. Security has become the most important factor influencing an enterprise adoption of internet-related services since risk perception has been increased in the context of threats associated with online applications. For example, Min and Galle (2003) empirically verified that the purchaser's perceived concern over the lack of security has a greater negative effect on the adoption of internet services than that of EDI for e-purchasing. Accordingly, we propose the following hypothesis:

H6 Security is positively associated with a firm's intention to adopt cloud computing services.

3.2 Organization factors

Previous research has shown that firm size is seen as a factor influencing IS adoption (Grover 1993; Lertwongsatien and Wongpinunwatana 2003). However, the results were somewhat mixed (Lee and Xia 2006). For example, Zhu et al. (2003) found that larger firms were more likely to make dedicated investments in e-business. Similarly, Hung et al. (2010a, b) found that the large hospitals are more likely than small ones to adopt CRM tools. Grover and Martin (1993), on the other hand, verified that organization size had no significant effect on selection of telecommunications technologies.

The advantages of scaling flexibility and pay-as-you-go cost structure may make cloud services attractive to SMEs, while large firms may be reluctant to adopt such services because it entails an effective loss of self-control over their IT/IS infrastructure. Accordingly, we propose the following hypothesis:

H7 *Firm size is negatively associated with a firm's intention to adopt cloud* computing services.

This study defines global scope as the geographical extent of a firm's operations in the global market. Williamson (1983) suggested that the effect of global scope can be explained from a transaction-cost perspective. For example, firms operating in different geographic regions need to locate their target market and build channels in every region, resulting in higher search costs (e.g., searching for consumers, trading partners, distributors, etc.), especially when firms expand into heterogeneous markets (Gurbaxani and Whang 1991). Cloud services may help reduce transaction costs and search costs for customers and suppliers as the company expands its geographic scope. Zhu et al. (2003, 2006) empirically verified that global scope is positively related to e-business adoption. Similarity, cloud services are kind of e-business operation. Firms with large scope may be more highly motivated to adopt cloud services to reduce transaction costs for customers and sellers. Accordingly, we propose the following hypothesis:

H8 Global scope is positively associated with a firm's intention to adopt cloud computing services.

Cloud services are a new way to facilitate business operations without incurring the cost of buying and managing the underlying hardware and software. Firms which adopt cloud services avoid costs associated with system set-up, operations, management, maintenance as well as personnel training. Past studies have confirmed that firms are less likely to adopt new IS if doing so entails significant new financial costs (Chau and Hui 2001; Kuan and Chau 2001; Pflughoeft et al. 2003; Min and Galle 2003). Inversely, lower financial costs may positively influence a firm to adopt cloud services. Accordingly, we propose the following hypothesis:

H9 Lower financial costs are positively associated with a firm's intention to adopt cloud computing services.

Generally, low satisfaction with existing systems provides the impetus to search for new ways to improve performance (Rogers 1983). As a result, satisfaction with existing systems plays an important role in influencing the adoption of new IS. Chau and Tam (1997) empirically verified that higher levels of satisfaction with existing systems reduce the likelihood of adopting open systems. Accordingly, we propose the following hypothesis:

H10 Higher levels of satisfaction with existing IS are negatively associated with a firm's intention to adopt cloud computing services.

3.3 Environment factors

The external environment is an important consideration in IS adoption (Pan and Jang 2008; Oliveira and Martins 2010). Two constructs of environmental context (i.e., competition intensity and the regulatory environment) are believed to influence cloud service adoption. We defined competition intensity as the degree to which a company is influenced by competitors in the market. Firms under greater competition may be more inclined to seek competitive advantage through adopting new IT/IS (Porter and Millar 1985; Zhu 2002). Many studies have empirically confirmed that competitive intensity will impact IT/IS adoption decisions (King et al. 1989; Xu et al. 2004; Zhu et al. 2006). Moreover, firms may adopt cloud services in the hopes of rapidly generating opportunities to create new competitive advantages in highly competitive business environments (Petrakou et al. 2011). Accordingly, we propose the following hypotheses:

H11 Competition intensity is positively associated with a firm's intention to adopt cloud computing services.

We defined the regulatory environment as the degree to which the cloud service is affected by government or company rules. Government policy and related legislation play a critical role in affecting the development and diffusion of innovation (Nelson and Soete 1988). When companies store their data and run the execution tasks in an external cloud environment, the safety of their data depends on the robustness of the surrounding regulatory environment, and a lack thereof may constrain firms from considering such services (Jensen et al. 2009). This places an emphasis on regulatory issues such as liability, compliance, data portability and indemnity. For example, lack of a proper regulatory environment in India has left firms there reluctant to adopt cloud computing (Menon 2013). Therefore, governments could help cloud services providers to implement e-services by regulating cloud services to increase trustworthiness and by establishing supportive legislation to ensure the security of cloud-based transactions. Prior studies have also confirmed that regulatory issues will significantly impact IT/IS adoption (Kraemer et al. 2002; Gibbs and Kraemer 2004; Zhu et al. 2004). Accordingly, we propose the following hypothesis:

H12 A supportive regulatory environment is positively associated with a firm's cloud intention to adopt computing services.

3.4 Control variable

Industry type is proposed as an important control variable affecting the level of cloud service adoption. Chatterjee et al. (2002) indicated that financial services or other service-oriented firms are more able than manufacturers of physical products to conduct extensive activities in cyberspace, including marketing, sales, order processing, delivery and customer support services, and this difference may result in different patterns of cloud service adoption among various industry types. Accordingly, industry type is added as control variable for could service adoption.

4 Methodology

4.1 Sample

The research sample included 1000 enterprises in Taiwan. Questionnaires were sent to the president of each company along with a cover letter explaining the study objectives and a stamped return envelope assuring respondent confidentiality.

Before conducting the main survey, we administered both a pre-test and pilot test to validate the instrument. The pre-test involved regular consultation with two MIS professors and IS executives. These respondents were asked to comment on the constructs, including the wording of the scales, the length of the instrument, and the format of the statements. Finally, to reduce possible ambiguity in the items, a pilot test was administered to 12 EMBA (executive master of business administration) students who hold executive IS positions in their respective firms.

Although questionnaires were sent directly to the president of each firm, responses were generally prepared by the firm's CIO or by personnel directly responsible for the implementation and management of cloud services. The data were collected over a period of 1 month, with 98 complete and valid questionnaires returned. Due to the low response rate (9.8 %), follow-up phone interviews were conducted over 2 weeks which raised the valid response rate to 10.2 %. This response rate was still lower than expected, and was likely due to survey fatigue, the absence of incentives as well as the lengthy and extensive nature of the questionnaire. However, the response rate is still consistent with those of similar surveys in the well-regarded IS journals including JAIS, ISR, MISQ, EJIS, MS and JMIS which have published studies with low response rates (Sivo et al. 2006). To ensure the sample is free of any non-response bias, we adopted the procedure suggested by Armstrong and Terry (1977) and compared the demographic variables of the first thirty and the last thirty subjects using a two-tailed *t* test. The results showed no significant differences ($p < 0.05$) between these two groups. The industry breakdown among respondents was 55.9 % manufacturing, 25.5 % general services and 18.6 % financial services. Table 2 summarizes the respondent profiles.

4.2 Measurement development

The questionnaires were developed from material which had been previously discussed and tested, and the list of items is presented in the "Appendix". The items were slightly modified to suit the cloud computing IS context. The scaled items for relative advantage, ease of use, compatibility, trialability, observability and intention to adopt cloud computing services had been developed and validated by Moore and Benbasat (1991). Security was measured with items adapted from Chellappa and Pavlou (2002). Firm size was measured by the number of employees in the organization, log-transformed to reduce data variation (Meyer and Goes 1988). Global scope mainly measures the geographic coverage of the firm's operations (Zhu et al. 2004). The scale items for perceived financial cost and satisfaction with existing IS were developed from studies by Kuan and Chau (2001) and Chau and Tam (1997). To develop a scale for measuring competition intensity and the regulatory environment, we utilized measures developed by Zhu et al. (2003, 2006), modified to suit the cloud computing IS context. Most questions were posed with a five-point Likert scale, ranging from "disagree strongly" (1) to "agree strongly" (5); however, some questions involved binary choices.

5 Results

5.1 Descriptive statistics and model assessment strategy

Descriptive statistics were also calculated as shown in Table 5. Results show that, on average, our sample responded positively to cloud services (the averages of all constructs exceeded 3 out of 5) except for perceived security and regulatory environment. In addition, we also tested the differences of technology–organization–environment perceptions regarding cloud services and intention to adopt cloud services between experienced companies (i.e., adopters, n = 31) and potential companies (i.e., potential adopters, n = 71). The result of ANOVA analysis revealed that the difference between the two groups is not statistically significant.

Both the measurement and structural models were tested using partial least squares (PLS), a structural modeling technique well suited for complex predictive models (Chin 1998a, b) which can be applied to relatively small sample sizes (Fornell and Bookstein 1982) and has been widely used in recent years (Jarvenpaa et al. 2004; Pavlou and Fygenson 2006; Walczuch et al. 2007). According to Chin (1998a, b) and Gefen et al. (2000), the minimum sample size for a PLS analysis should be greater than 10 times the number of items for the most complex construct. Since the most complex construct in this study uses four items for measurement, the sample size of 102 is adequate to perform PLS analysis. PLS Graph 3.0 was used to assess both models.

5.2 The measurement model

Discriminant and convergent validities were examined using the following tests. First, we performed a factor analysis to validate the scales. The cross-factor loadings (Table 3) indicate good discriminant validity because the loading of each measurement item on its assigned latent variable is larger than its loading on any other construct. Notably, to control for the effects of common method variance, the Harman single-factor test has been frequently employed in IS research (Jarvenpaa and Majchrzak 2008). We performed this test by loading all of the items in this study into an exploratory factor analysis, with ten factors resulting. The results generated a large number of factors with one factor, accounting for 27 % of covariance among the measures at maximum. The other nine (with eigenvalues greater than one) contributed to 49 % of the remaining variance, each accounting for 4–11 %. This suggests that, while there is likely to be some common method variance, the effect is small.

Second, the results of the test of the measurement model are listed in Table 4. The data show that the item reliability ranged from 0.66 to 0.98, exceeding the acceptable value of 0.50 (Hair et al. 1992). Notably, SA2 has been dropped because its item reliability was below the threshold value of 0.5. The internal consistency of the measurement model was assessed by computing the composite reliability. Consistent with the recommendations of Fornell (1982), all composite reliabilities were above the benchmark of 0.60. The average variance extracted for all constructs

Table 2 Demographic profile

Measure	Items	Frequency	Percent
Industry type	Finance	19	18.6
	Service	26	25.5
	Manufacturing	57	55.9
Position	CIO	47	46
	CEO	7	7
	Manager	31	30
	Other	17	17
Annual revenue (NT$ 100 million)	1–5	31	30.4
	5–10	58	56.8
	Over 10	12	11.7
	Don't know	1	0.01
Number of employees in the firm	1–200	63	61.7
	200–400	17	16.7
	400–800	10	9.8
	Over 800	12	11.8
Cloud adoption experience	Adopters	31	30.3
	Potential adopters	71	69.7
Solutions used/plan to use	WWW	40	39.2
	Backup IS	33	32.3
	Portal site	31	30.3
	ERP	29	28.4
	E-mail	23	22.6
	KM	19	18.6
	CSS	18	17.6
	HRM	15	14.7
	FAI	14	13.7
	CCM	12	11.7
	PDM	10	9.8
	SCM	10	9.8
	EC	9	8.8

exceeded the threshold value of 0.5 recommended by Fornell and Larcker (1981). As the three values of reliability were above the recommended thresholds, the scales for evaluating these constructs were deemed to exhibit adequate convergence reliability.

Finally, the results in Table 5 show that the square root of the AVE from the construct is much larger than the correlation shared between the construct and the other constructs in the model, thus implying that constructs were empirically distinct. In summary, the measurement model test, including convergent and discriminant validity measures, was satisfactory.

Table 3 Factor analysis results with cross loadings

	PE	FC	PS	CO	RE	OB	TR	CI	SA	RA
RA1	0.112	0.658	0.166	−0.038	0.016	0.071	−0.015	−0.085	−0.026	*0.516*
RA2	−0.023	0.251	0.184	0.001	−0.030	0.066	0.062	0.138	0.124	*0.754*
RA3	0.062	0.274	0.031	0.308	0.046	−0.003	0.109	0.196	−0.079	*0.590*
PE1	*0.887*	0.123	0.064	0.191	−0.052	0.021	0.064	0.025	−0.060	0.105
PE2	*0.865*	0.132	0.042	0.195	0.045	−0.056	0.052	0.082	0.111	0.059
PE3	*0.773*	0.311	0.062	0.249	0.007	0.034	0.069	0.071	0.154	−0.058
PE4	*0.832*	0.243	0.152	0.240	0.059	0.140	0.107	0.050	0.018	−0.062
CO1	0.336	0.218	0.183	*0.745*	0.067	0.163	0.166	−0.047	−0.067	−0.038
CO2	0.321	0.142	0.086	*0.849*	0.071	0.111	0.037	0.091	0.089	0.172
CO3	0.292	0.123	0.107	*0.855*	0.017	0.005	0.024	0.088	0.004	0.077
TR2	0.112	0.102	0.137	0.054	0.042	0.181	*0.918*	0.083	0.027	0.095
TR3	0.143	0.095	0.108	0.097	0.083	0.182	*0.904*	0.140	0.081	0.061
OB1	0.474	−0.068	0.090	0.050	0.161	*0.487*	0.238	0.041	0.014	0.379
OB2	0.400	0.030	0.081	0.237	0.255	*0.536*	0.177	0.146	−0.021	0.346
OB3	0.005	0.050	0.211	0.040	−0.005	*0.849*	0.140	0.001	0.110	0.014
OB4	−0.001	0.101	0.149	0.099	0.137	*0.862*	0.161	0.043	0.118	−0.010
PS1	0.103	0.001	*0.843*	0.110	0.135	0.141	0.009	−0.085	0.004	0.128
PS2	0.037	0.088	*0.857*	0.011	0.231	0.016	0.048	0.092	−0.004	0.055
PS3	0.104	0.062	*0.616*	0.116	0.160	0.233	0.388	0.045	0.043	0.058
PS4	0.120	0.170	*0.623*	0.175	0.157	0.232	0.094	0.236	−0.069	0.067
FC2	0.200	*0.758*	0.010	0.269	0.034	0.067	0.101	0.113	−0.013	0.264
FC3	0.170	*0.823*	0.089	0.114	0.033	0.062	0.121	0.070	−0.059	0.075
FC4	0.291	*0.827*	0.055	0.148	0.059	0.012	0.025	0.050	0.169	0.069
SA1	0.026	0.058	−0.025	0.017	0.107	0.077	0.088	−0.036	*0.913*	0.001
SA2	0.113	−0.014	0.004	0.000	0.057	0.117	0.004	0.051	*0.910*	0.045

Table 3 continued

	PE	FC	PS	CO	RE	OB	TR	CI	SA	RA
CI1	0.117	−0.053	0.054	0.133	0.086	−0.063	0.159	*0.811*	−0.065	0.169
CI2	0.092	0.060	0.048	0.067	−0.012	0.023	0.118	*0.889*	0.055	0.142
CI3	−0.044	0.293	0.090	−0.125	0.076	0.319	−0.109	*0.544*	0.050	−0.123
RE1	0.055	0.014	0.108	0.074	*0.853*	0.140	0.227	0.081	−0.054	0.043
RE3	−0.035	−0.023	0.254	0.027	*0.858*	0.117	−0.002	−0.069	0.079	−0.090
RE4	0.061	0.146	0.236	0.023	*0.830*	−0.017	−0.068	0.127	0.203	0.096

RA relative advantage *PE* perceived ease of use, *CO* compatibility, *TR* trialability, *OB* observability, *PS* perceived security, *GS* global scope, *FC* financial cost, *SA* satisfaction with the existing IS, *CI* competition intensity, *RE* regulatory environment

Italics emphasize the principle effects of factor loadings

Table 4 Reliability

Item	Item reliability	Composite reliability	Average variance extracted
RA1	0.82	0.83	0.62
RA2	0.81		
RA3	0.71		
PE1	0.90	0.95	0.83
PE2	0.92		
PE3	0.89		
PE4	0.93		
CO1	0.70	0.81	0.59
CO2	0.80		
CO3	0.77		
TR2	0.98	0.98	0.97
TR3	0.98		
OB1	0.80	0.88	0.65
OB2	0.84		
OB3	0.77		
OB4	0.81		
PS1	0.79	0.88	0.65
PS2	0.82		
PS3	0.79		
PS4	0.82		
GS1	0.96	0.84	0.72
GS3	0.76		
FC2	0.90	0.93	0.81
FC3	0.90		
FC4	0.89		
SA1	n/a	n/a	n/a
CI1	0.66	0.79	0.56
CI2	0.74		
CI3	0.83		
RE1	0.87	0.91	0.78
RE3	0.85		
RE4	0.91		
IN1	0.90	0.91	0.83
IN3	0.93		

n/a loadings, composite reliability, and average variance extracted are not applicable to the single-item constructs

5.3 Tests of the structural model

We examined the structural equation model by testing the hypothesized relationships among the research variables (Fig. 2). The results show that relative advantage, observability, financial cost, satisfaction with existing IS and

Table 5 Descriptive statistics (means and SD) and discriminant validity

	Means	SD	RA	PE	CO	TR	OB	PS	FS	GS	FC	SA	CI	RE	BI
RA	3.65	0.57	0.78												
PE	3.50	0.63	0.274	0.91											
CO	3.27	0.61	0.315	0.592	0.77										
TR	3.57	0.82	0.247	0.269	0.269	0.98									
OB	3.28	0.68	0.284	0.324	0.352	0.456	0.80								
PS	2.96	0.70	0.314	0.257	0.340	0.365	0.465	0.80							
FS	5.08	1.25	−0.002	−0.128	−0.171	−0.030	0.037	−0.129	1						
GS	0.53	0.59	0.030	−0.080	−0.102	0.086	−0.082	0.012	−0.095	0.84					
FC	3.41	0.73	0.576	0.466	0.442	0.246	0.265	0.260	−0.033	0.078	0.90				
SA	3.36	0.81	0.045	0.097	0.058	0.149	0.190	0.042	0.084	−0.063	0.105	1			
CI	3.32	0.66	0.260	0.169	0.159	0.242	0.245	0.228	0.018	−0.071	0.245	0.023	0.74		
RE	2.82	0.71	0.125	0.114	0.166	0.193	0.308	0.448	−0.084	0.074	0.126	0.175	0.156	0.88	
BI	3.31	0.68	0.465	0.265	0.338	0.294	0.481	0.429	−0.011	−0.029	0.461	−0.073	0.463	0.192	0.91

Value on the diagonal represents the square root of average variance extracted (AVE)

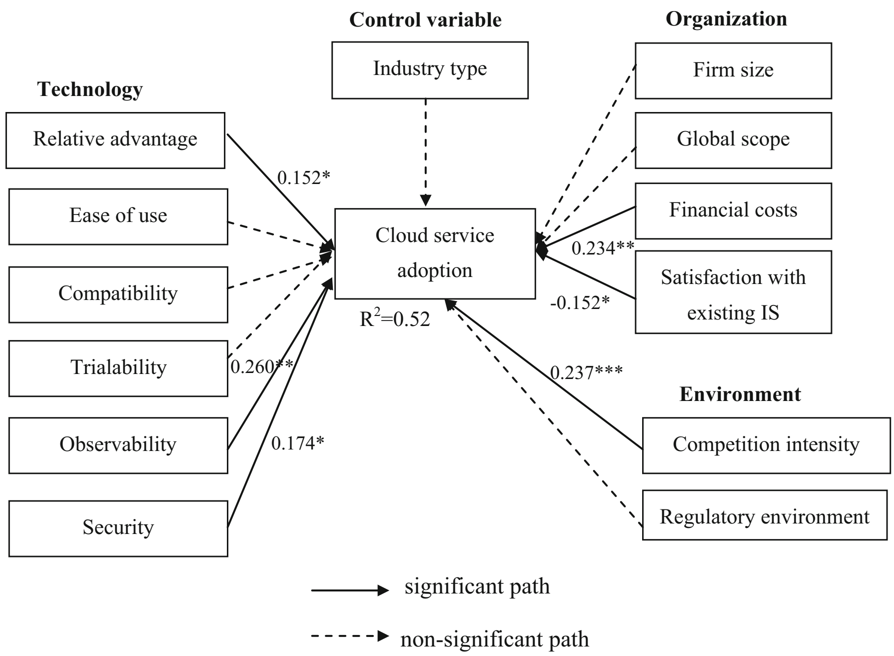

Fig. 2 Results of structural modeling analysis. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

competition intensity had significant effects on the intention to adopt cloud computing services ($\beta = 0.152$, $p < 0.05$; $\beta = 0.260$, $p < 0.01$; $\beta = 0.174$, $p < 0.05$; $\beta = 0.234$, $p < 0.01$; $\beta = -0.152$, $p < 0.05$; $\beta = 0.237$, $p < 0.001$), thus supporting hypotheses 1, 5, 6, 9, 10 and 11. Together, these six paths accounted for 52 % of the variance in intent to adopt. Contrary to expectations, perceived ease of use, compatibility, trialability, firm size, global scope and regulatory environment had no direct influence on intention to adopt. Therefore, hypotheses 2, 3, 4, 7, 8 and 12 were not supported.

5.4 Tests of the moderating effect of firm size and industry type on adoption

Though the results of this study had shown that firm size did not significantly affect cloud adoption intention, prior studies indicated that large firms and SMEs perceive IT implementation differently (Lee and Xia 2006). Moreover, the flexibility and pay-as-you-go characteristics of cloud computing may trigger different kinds of adoption behaviors with respect to the firm size (Sultan 2011). Hence, the sample was further categorized into large firms (n = 39) and SMEs (n = 63) to compare the coefficients of the corresponding paths between perceptions of TOE factors and intention to adopt cloud services. This study ran the structural model on these two subgroups, with results summarized in Table 6. For large firms, perceived security ($\beta = 0.468$, $p < 0.05$) and competition intensity ($\beta = 0.396$, $p < 0.05$) significantly impacted intention to adopt cloud services, accounting for 65 % of the variance. For

Table 6 Comparison of firm size and industry type

Constructs	Intention to adopt			
	Firm size		Industry type	
	Large firms (n = 39)	SMEs (n = 63)	Finance/service (n = 45)	Manufacturing (n = 57)
Relative advantage	0.125	0.189*	−0.045	0.170
Perceived EOU	0.060	−0.121	−0.219	0.006
Compatibility	−0.041	0.024	0.042	0.058
Trialability	−0.248	0.172	0.114	0.074
Observability	0.236	0.208	0.449*	0.049
Perceived security	0.468*	0.090	0.347	0.230*
Firm sizes	n/a	n/a	0.238*	−0.068
Global scope	−0.009	−0.009	−0.082	−0.042
Financial cost	0.238	0.211*	0.330*	0.169
Satisfaction with the existing IS	−0.084	−0.109	−0.206	−0.122
Competition intensity	0.396*	0.256*	0.190	0.261*
Regulatory environment	−0.084	−0.101	−0.302	0.033
Industry type	0.195	−0.264**	n/a	n/a
R^2	0.65	0.60	0.62	0.54

SME is defined as enterprises which employ fewer than 200 persons (Taiwan Research Institute 2015)

$^{*}p < 0.05$; $^{**}p < 0.01$

SMEs, relative advantage, financial cost, competition intensity and industry type significantly influenced attitudes (β = 0. 189, $p < 0.05$; β = 0. 211, $p < 0.05$; β = 0. 256, $p < 0.05$; β = 0. 28, $p < 0.05$; β = −0.264, respectively). Together, these four paths explain 60 % of the observed variance in cloud adoption intention. In addition, our study also adopted the approach proposed by Keil et al. (2000) to test the significance of the coefficient differences. The comparison results show significant differences in all path coefficients between large firms and SMEs.

In the current study, we also tested the moderating effect of industry type on adoption intention. The finance and service industries are combined into a single category since these two industries are more data-intensive. As a result, industry type was classified into two categories: finance/service (n = 45) and manufacturing (n = 57). The structural model was applied to these subgroups. Results for the finance/service type show that observability, firm size and financial cost had significant effects on the intention to adopt cloud computing services (β = 0.449, $p < 0.05$; β = 0.238, $p < 0.01$; β = 0.330, $p < 0.05$). Together, these three paths accounted for 62 % of the variance for intention to adopt. For manufacturing, only perceived security and competition intensity had a significant effect on adoption (β = 0. 230, $p < 0.05$; β = 0. 261, $p < 0.01$), accounting for 54 % of the variance. In addition, the results show significant differences in all path coefficients between finance/service as well as manufacturing by testing the significance of the coefficient differences.

Since industry type had a significant effect on intention to adopt in the SME subgroup, this study further tested the difference of intention between finance/

Table 7 *T* test analysis on descriptive statistics for industry type and firm size

	Industry type			Firm size		
	Fin/Serv	Manufacturing	*p* value	Large	SMEs	*p* value
Intention to adopt	3.02 (0.562)	3.54 (0.565)	0.001**	3.30 (0.688)	3.01 (0.563)	0.133

Fin/Serv represents financial/service

$^{**}p < 0.01$

service and manufacturing. For the average ratings in judged intention to adopt the cloud service, the descriptive statistics show that the intention in finance/service (m = 3.02) is significant smaller than in manufacturing (m = 3.54) (see Table 7). In addition, we also tested the difference of intention between large firms and SMEs since firm size had a significant effect on adoption in the finance/service type. In this subgroup, the subject ratings found no significant difference between large firms and SMEs (see Table 7).

6 Discussion

This study reveals that the proposed model can predict firm adoption of cloud computing services ($R^2 = 52$ %). The empirical analysis offers several insightful findings.

First, relative advantage, observability and security significantly influence adoption in a technological context. Specifically, observability was found to have the most significant influence on adoption, with a coefficient significantly higher than others ($\beta = 0.265$). This finding stresses the point that cloud services can be rapidly implemented and provide quick tangible results. Therefore, the easier it is for users to see the results of cloud services, the more likely they are to adopt. Moore and Benbasat (1991) indicated that observability includes visibility and result demonstrability. Visibility refers to the innovation as being visible in the adoption context and result demonstrability refers to the results of using an innovation being perceived as tangible. Such visibility and result demonstrability stimulates peer discussion of cloud services, as the adopter's colleagues and friends will often request information related to such services. The more firms adopt cloud services, the more widely such information will be spread and thus the more firms it will attract.

The other two significant factors in perceived attributes of innovations are relative advantage and security. Apparently, the greater the perceived relative advantage of an innovation such as cloud services, the more rapid its rate of adoption will be. Past studies have also verified this phenomenon (Thong 1999; Tan and Teo 2000; Wu and Wu 2005). Therefore, cloud services are considered to be an improvement over the approaches they are used to replace. Notably, this result is inconsistent with past cloud adoption research which found relative advantage to have a significantly negative influence on cloud computing adoption (Low et al. 2011). One possible explanation for this inconsistency is that companies today are more familiar with cloud computing and tend to recognize the benefits such services provide (Hsu et al. 2014). Additionally, the results revealed that security plays a key role in influencing firm intention to adopt cloud services. This finding agrees with past IT adoption research that found perceived security to be a consequential factor influencing cloud computing adoption behavior (Gupta et al. 2013). Failure to resolve firms' security concerns, such as privileged user access, data lock and recovery, increases the degree of perceived risk to the point where firms reject the innovation. Nevertheless, for the average ratings in judged security, the descriptive statistics show that the score of perceived security of cloud service is 2.96 on a five-point scale, indicating that firms still perceive cloud service security as being insufficiently robust.

Perceived ease of use had no significant effect on cloud services adoption. This is possibly because most existing IS are web-based applications which users access over a network such as the internet or an intranet. Part of the popularity of such web applications is the convenience of using a web browser as a client, and the experience of using such applications is similar to that of cloud services in which users access resources through networked client devices (e.g., PCs, tablets and smartphones) and a browser. From the user's perspective, cloud services are similar to other web-based applications, thus perceived ease of use becomes a lesser apparent influencer in cloud service adoption.

In Tornatzky and Klein's (1982) meta-analysis of innovation adoption, compatibility with one individual's existing value system was consistently related to innovation adoption. However, our findings show that perceived compatibility of cloud services has no positive influence on intent to adopt. This result might be explained by the fact that firms exhibit greater innovativeness and willingness to try a new cloud service which may not be compatible with their existing values, needs, and past experiences. In addition, the results of our analysis indicate that trialability was not a significant predictor of adoption intent; this result was inconsistent with the results obtained by Moore and Behbasat. One possible explanation for this result is that most of cloud services provided today are designed to replace existing software and/or hardware systems (e.g., enterprise systems and data storage). Moreover, cloud services can also be considered as a kind of web-based application. Since users may have a clear understanding of the functional benefits provided by the cloud services providers and perceive them as being easy to use (due to their prior experience with web-based applications), trialability does not have a significant effect on intention to adopt.

Second, only two organizational factors (financial cost and satisfaction with existing IS) were found to influence intent to adopt, while the other organizational aspects such as firm size and global scope had no significant effects. Cloud services are actually perceived as dramatically decreasing IS costs including costs for set-up, management, and maintenance and training, thus driving the adoption of cloud services. Moreover, satisfaction with existing IS had a negative effect on adoption intention. This finding agrees with the results of past innovation research that organizations innovate in response to some perceived performance gap (Rogers 1983). The benefit of cloud services lies in the significant time and cost savings they offer firms. Therefore, such a motivation is always related to a lower level of satisfaction with existing IS.

Unexpectedly, firm size and global scope had no significant effect on intent to adopt, findings which contradict previous empirical studies (Pflughoeft et al. 2003; Zhu and Kraemer 2005; Soares-Aguiar and Palma-Dos-Reis 2008). Larger firms are more likely to adopt IS since they possess more resources. Therefore, large firms tend to spend more effort and money to implement in-house IS while small firms usually either outsource their IS needs or use off-the-shelf solutions. However, our finding suggests that firm size had no significant effect on cloud service adoption. This is consistent with the findings of Benlian et al. (2009), which indicates that firm size does not matter in the adoption of SaaS. A possible explanation is that cloud service providers offer a web-based IS solution including software, hardware, OS, programming language execution environment, databases and web servers, freeing clients from having to manage their own IS infrastructure and platform. Firms at any scale, therefore, just pay for the services they use.

Another plausible finding is that a large geographic scope does not necessarily give firms an advantage in adopting cloud services to achieve their business objectives. Empirical research has previously verified that e-business applications can help firms with a global operational needs (Zhu et al. 2003). However, the results of the present study do not support this point. One possible reason for the lack of statistical significance may lie in the difficulty of integrating cloud services with in-house IS and the relatively limited capacity for customization. IDC (2008) reported that these challenges were major issues for enterprise adoption of cloud services. While global firms require in-house global information systems to facilitate business operations, commercial cloud services seem unable to provide sufficient integration with in-house system or customization to fit global scope requirements. In fact, Zhu et al. (2006) also suggested that firms with a larger geographic scope should integrate various IS applications in-house to capture the benefits of internet innovations for facilitating transactions.

Third, competition intensity was found to have a significant effect on cloud service adoption, suggesting that firms facing strong competition tend to adopt cloud service more aggressively, a finding which supports the results of previous studies. However, at 2.82 (mean), indicating that lack of clarity in the current regulatory environment is leaving firms unsure of how to comply with relevant laws. In addition, the regulatory environment is not significantly associated with the adoption of cloud services. In fact, according to the IDC (2008), the main challenges and issues facing cloud service adoption include regulatory requirements which prohibit the use of cloud services. Therefore, even though the current study indicates that the regulatory environment is not an influential factor in cloud service adoption, this factor bears further investigation.

Finally, industry type (a control variable) had no significant effect on cloud service adoption. This is consistent with the findings of Teo et al. (2009) in indicating no significant relationship between industry type and e-procurement adoption. One possible explanation for this result is that firms perceive cloud service as being a kind of web-based IS. Industries including finance, general services and manufacturing have become accustomed to using these web-based IS to increase value chain activity efficiency. Thus, most firms should have web-enabled business environments to support operations.

7 Implications

7.1 Implications for researchers

This research has indicated several implications for academic research on cloud computing adoption. First, this study contributes to a theoretical understanding (e.g., TOE) of the factors that promote cloud service usage. While studies on beliefs regarding technology acceptance about IT/IS use have received more attention in theories of adoption (e.g., TAM, TPB and UTAUT), our model implies that organization and environment can be influential factors in cloud service adoption. Theoretically, TOE stresses the importance of technology, organization and environment as key determinants. This study decomposed these three dimensions and this decomposed TOE model explained much of the variance in cloud service adoption.

Second, while previous studies based on TOE had examined somefactors influencing firm's cloud computing adoption (Alshamaila et al. 2013; Lian et al. 2014; Low et al. 2011), current study revealed the other key factors such as security and financial costs which have direct influence on cloud computing adoption. The findings had verified these factors are important drivers in adoption cloud service. In addition, the results of this study provide empirical evidence that satisfaction with existing IS as a barrier to cloud adoption. Thus, researchers must pay attention to the impact on in-house IS while firm adopting new IS such as cloud service.

Finally, to test the moderating effect of firm size and industry type on adoption, we conduct the analysis and empirical findings are applicable in different firm size and industry type contexts. A large body of firm size and industry type affecting IS adoption studies needs to be accumulated (Lee and Xia 2006). This study contributes to this line of research in the cloud service and encourage future studies can be conducted in other contexts.

7.2 Implications for cloud service practitioners

For cloud service practitioners, empirical analysis results provide the following insights. First, the findings strongly highlight the importance of observability. Therefore, cloud service providers should work to enhance client perception of visibility and result demonstrability. For example, in many workplaces, the use of cloud service such as SaaS (i.e., Google Gmail and Docs) and IaaS (i.e., Dropbox) has helped emphasize their conferral of status on potential users. Frequent workplace usage makes this innovation both highly visual and observable. In addition, cloud service providers are continuously improving the relative advantage and security of cloud services. Adopting cloud services brings significant benefits including operational efficiency and cost savings, along with access to expanded applications and services. Moreover, enhancing the perception of security is a key to motivating adoption. Therefore, to eliminate security risks, we suggest that cloud service providers should present to their clients with a more concrete service contract that clearly states provider liability, service level guarantees, data protection and security measures, and penalties for data breaches/non-performance, etc. (Benlian and Hess 2011; Hon et al. 2012; Sandeep et al. 2014).

Second, compared to the implementation and deployment of traditional IS, cloud-based IS provides increased flexibility and scalability in terms of systems upgrading and maintenance. Therefore, cloud service providers should emphasize the effectiveness of cost reductions in their marketing strategies. In addition, though the results of this study indicated that a higher degree of satisfaction with existing IS is negatively correlated with intent to adopt cloud services, this does not imply that the target company necessarily has a low opinion of the effectiveness of cloud services. Thus, cloud service providers need to devote more effort to integrating cloud services and existing IS. In addition, as expected, without incurring significant upfront IT/IS investments, cloud services help companies quickly establish new products and services in the competitive market. Cloud providers need to emphasize the positive impact adoption of cloud services can have on client competitive advantage. Namely, providers can highlight that adopting cloud services allows companies to focus their attention and resources on developing core competencies rather than on developing and maintaining IS.

Third, to provide more practical insights, this study further tested the moderating effect of firm size on adoption. Our findings also show that the large firms and SMEs have different determinants for adopting cloud services, as shown in Table 5. Perception of competition intensity had a significant impact on both groups. This finding suggests that firms adopt cloud service because it can help firms increase competitiveness. In addition, cloud service providers will be interested in the significant effects of other factors. For large firms, cloud service providers should stress security measures to prevent data breaches, data loss and data leakage which are of particular concern to large firms (Infoworld 2013). For SMEs, providers should emphasize how adoption can increase a firm's relative advantage and reduce operating, management, maintenance and training costs. Moreover, among SMEs, manufacturing firms were found to be significantly more inclined to adopt cloud services than those in the finance/service and manufacturing sectors (Table 6).

Finally, to compare the effects of perceived attributes between firms in the finance/service and manufacturing sectors, the sample was divided into two parts based on industry type. As shown in Table 5, the findings indicated that the intention of finance/service firms to adopt cloud services is determined by observability, firm size and financial cost, while that of manufacturing firms is determined by concerns for security and competition intensity. Seeking to determine the most appropriate strategies for specific industry type, cloud service providers should take into consideration the significant relationship between these factors and adoption intention. In addition, as shown in Table 7, the moderating effect of firm size on adoption in finance/service firms shows no significant difference between large firms and SMEs in the finance/service sector.

8 Limitation and further research directions

The results of this study need to be interpreted with caution for several reasons. Firstly, the respondents are presidents, CIOs or cloud services-related managers or staff in Taiwan's manufacturing, financial and service sectors, and thus the results may be influenced by the unique characteristics of Taiwan's corporate culture. Second, statistical analysis can only provide numerical relationships. Interpretation of these numbers depends on the author's subjective appraisal. Nevertheless, results consistent with established theories and previous studies can increase confidence in the findings. Third, although this study focused exclusively on the TOE contexts, other firm characteristics (e.g., organizational structure and corporate culture) and cloud services (e.g., scalability, guaranteed quality of service, reduced upfront investment, minimization of business risks) may also influence the adoption of cloud services. Future research should examine whether these characteristics influence intent to adopt. Additionally, future studies may investigate influential factors in various cloud service deployment models (e.g., private, public and hybrid) as well as service models (e.g., SaaS, PaaS and IaaS). Finally, the level of analysis is also a limiting factor. This study examined only factors suggested by TOE, IDT and the current literature. Other TOE factors such as perceived barriers to adoption, technological readiness, top management support, organizational readiness and organizational technology policy may conceivably have an influence on adoption. Hence, future studies may investigate the influence of these additional variables to better understand the adoption of cloud services.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix

List of items by construct

Relative advantage (RA) Moore and Benbasat (1991).

1. Using cloud services reduces costs (e.g., customer service, procurement, human resources, IT training, investment and administration management).*
2. Using cloud services saves time (e.g., customer support, employee and supplier management).*
3. Using cloud services increase my productivity.*

Perceived ease of use (PE) Moore and Benbasat (1991).

1. Learning to operate cloud services is easy for me.*
2. I believe that it is easy to get a cloud service to do what I want it to do.*

3. My interaction with cloud services is clear and understandable.*
4. Overall, I believe that cloud services are easy to use.*

Compatibility (CO) Moore and Benbasat (1991).

1. Using cloud services is compatible with all aspects of my work.*
2. I think that using cloud services fits well with the way I like to work.*
3. Using cloud services fits into my work style.*

Trialability (TR) Moore and Benbasat (1991).

1. I've had a great deal of opportunity to try various cloud services.
2. Before deciding whether to use any cloud services, I was able to properly try them out.*
3. I was permitted to use a cloud service on a trial basis long enough to see what it could do.*

Observability (OB) Moore and Benbasat (1991).

1. I would have no difficulty telling others about the results of using cloud services.*
2. I believe I could communicate to others the consequences of using cloud services.*
3. I have seen what others in my organization do with cloud services.*
4. Cloud services are very visible in my organization.*

Perceived security (PS) Chellappa and Pavlou (2002).

1. I believe that my work will not be manipulated by unauthorized persons when using cloud services.*
2. I believe that cloud services will not expose my work to unauthorized persons.*
3. I believe that cloud service providers and their personnel are careful to comply with relevant laws and regulations.*
4. I believe that cloud services provide reliable data recovery to keep my business running well.*

Firm size Meyer and Goes (1988).

Approximately how many employees does your organization have in total, including all branches, divisions, and subsidiaries?

__________ (people) Don't know

Global scope Zhu et al. (2004).

1. Was your company established outside of Taiwan? (Y/N)?
2. Does your company have international subsidiaries? (Y/N)?

Financial cost (FC) Kuan and Chau (2001).

1. Using cloud services reduces set-up costs.
2. Using cloud services reduces running costs.*
3. Using cloud services reduces systems management and maintenance costs. *
4. Using cloud services reduces training costs.*

Satisfaction with existing IS (SA) Kuan and Chau (2001).

1. Our existing IS serves the needs of the company.*
2. I am satisfied with the price/performance of our existing IS.

Competition Intensity (CI) Zhu et al. (2003, 2006).

1. Degree of local competition. (1—low, 5—high)*
2. Degree of national competition. (1—low, 5—high)*
3. Degree of international competition. (1—low, 5—high)*

Regulatory Environment (RE) Zhu et al. (2003, 2006).

1. Government provides incentives to adopt cloud services.*
2. Government procurement policies mandated the use of cloud services.
3. Business law supports cloud services.*
4. There is adequate legal protection for customer or supplier transactions using cloud services.*

Behavioral intention to adopt cloud services Lu and Yeh (1998); Taylor and Todd (1995).

1. The company intends to use cloud services.*
2. Our company is willing to adopt cloud services.
3. It is worth using cloud services in our company.*

*Denotes items retained for data analysis.
Y/N dummy variable.

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