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Efficiency or Innovation?
The Long-Run Payoff of Cloud Computing

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ABSTRACT

Considering the mixed arguments and uncertainty about the payoff of cloud computing, this paper empirically studies the long-term cloud computing impact on the financial performance, specifically from the perspective of efficiency and innovation. Taking 253 pairs of listed companies in China as the research sample, propensity score matching and difference in differences techniques combined with OLS regression are conducted to analyze a rolling 5-year panel data. The analysis results show that cloud computing adoption leads to years of financial performance decline followed by an upturn. The downward trend is more pronounced when it is adopted with innovation. This paper contributes to the existing literature by leveraging archival performance data to verify the long-term business value and revealing the value realization difference between efficiency- and innovation-oriented cloud computing adoptions. The findings remind the managers to see the two sides of cloud computing and make rational adoption decisions, especially cloud-based innovation, according to their actual situations.

KEYWORDS

Business Value, Cloud Computing, Efficiency, Financial Performance, Information Technology, Innovation, Listed Companies, Long-Term Payoff

INTRODUCTION

Cloud computing (CC), an Internet-based and on-demand IT service model, was first put forward by the Google CEO, Eric Schmidt, at the 2006 Search Engine Conference. In the CC model, the development, deployment, update, maintenance, and payment of IT services undergo fundamental changes (Marston et al., 2011). With the rapid development, the business value of CC, which has always been a topic of great concern in the IT domain (Anandhi et al., 1999; Dewan & Ren, 2011; Steelman et al., 2019; Weill, 1992), has attracted the interest of academic and industry. CC is believed to have the advantages of reducing the cost of information infrastructure, providing fast and convenient access to hardware and software, lowering the barriers to IT innovation, facilitating the expansion of the service scale, and promoting new applications and services (Marston et al., 2011). However, the centralized nature of CC also causes some shortcomings (Bayramusta & Nasir, 2016; Joe-Wong & Sen, 2018; Euripidis et al., 2019; Marston et al., 2011). The primary obstacles of cloud adoption are

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the privacy and security issues, which bring risks to the adopters and hinder the dissemination of CC (Wang et al., 2019). The essential high speed internet access brings additional cost to cloud adoption (Bayramusta & Nasir, 2016). Further, the migration of the legacy system to the cloud increases the integration requirement because of the unified data and interface standards that are different from that of the legacy system (Joe-Wong & Sen, 2018; Loukis et al., 2019). It was reported that, for instance, Symantec clients were prevented from administering some email and web security services lasted for 24 hours due to the disruption caused by integration defect (Tsidulko, 2015). Another example is that the data entered by Salesforce customers into Customer Relationship Management (CRM) systems were wiped out also resulted from integration issues and took days to fix it (Lauchlan, 2016).

These positive and negative studies and reports focusing on the impact of CC just show one side of the coin. The regular pattern of CC value achievement in the long-run is still not clear. Since firms invest an amount of capital on CC, maybe at the cost of the legacy systems, it is fair to question *what will a firm experience after investing in CC and whether the firm receives its investment's worth?* Therefore, considering the uncertainty, the CC pay-off in the long-run needs more empirical investigation.

In particular, firms may invest in CC for efficiency or innovation (Berman et al., 2012; Loukis et al., 2019). Due to the low-cost and extensible IT services, CC is leveraged to improve the IT efficiency and enhance the operational efficiency (Iyer & Henderson, 2012). Some legacy systems migrate to the cloud to build cloud-based systems such as cloud desktop and cloud storage during this process. This relatively uncomplicated process does not affect the core business significantly. Alternatively, as an important technical base for innovation, CC may be leveraged to create cloud-based new business model such as cloud ecosystem, which is an important competitive advantage source to the focal firm (Berman et al., 2012). This innovative process impacts the focal firm profoundly (The Boston Consulting Group, 2009) and brings more benefit opportunities and competitive advantages together with more risks than that for efficiency. The standard processes and interfaces provided by CC service vendors are different from the focal firms' internal information systems. Besides, a CC vendor generally limited its service to a single domain such as project management service or CRM system and does not provide integrated enterprise information system (Li et al., 2011). As a result, the more complex the cloud-based business system, the more cloud vendors and more participants and stakeholders need to be collaborated and integrated. The adopters are under regulatory, technological, and collaborative risks in this new multi-partner business model (Dellermann et al., 2017). To sum up, how different cloud adoption purposes influence the performances of the focal firms is not clear. It is essential to empirically exam how is CC investment for innovation benefits the adopters different from that for efficiency.

Motivated by these gaps, this paper examines the long-run impact of CC adoption on corporate financial performance. It makes up for the shortage by empirically analyzing the differences on how CC adoptions for efficiency versus innovation purposes affect the performance based on the data of Chinese listed companies. The CC industry in China has shown rapid growth in recent years, reaching RMB 133.4 billion at the end of 2019, and is expected to reach RMB 400 billion by 2023 (CAICT, 2019). In 2015, the Chinese State Council issued a national policy to actively promote strategic adoption of CC. Thus, China provides appropriate context for this study.

To the best of the authors' knowledge, this paper departs from the prior literature by being the first to empirically examine the long-run payoff of CC based on archival data. This research makes two notable contributions. First, it enriches the research stream of IT value by shedding light on the controversy over the business value of CC due to the lack of empirical evidence (Brynjolfsson et al., 2010). The analysis of the performance data helps to verify the long-run payoff of CC. Second, the paper revealed the value realization difference between efficiency- and innovation-oriented adoptions of CC through their impact on the focal firms' financial performance. The findings of this study can help enterprises clarify the payoff of CC and make rational cloud adoption decisions.

LITERATURE REVIEW AND HYPOTHESIS

This study follows Armbrust et al. (2010) and defines CC as "both the applications delivered as services over the Internet and the hardware and system software in the data center that provides those services" (p.50). The moderating effect of CC types classified into IaaS, PaaS and SaaS, which is from the technical perspective, is eschewed for three reasons. First, "the accepted definition for them is still vary widely. The line between low-level infrastructure and higher-level platform is not crisp" (Armbrust et al., 2010, p.50). Second, most of the CC vendors in China, such as ALI (aliyun.com), TENCENT (cloud.tencent.com) and BAIDU (cloud.baidu.com), provide overall solutions, instead of XaaS, for various industries and domains such as Internet of Things, Artificial Intelligence and cloud-safety. Third, almost no searching result was collected with XaaS as the keywords (see below). Instead, most of the CC investment announcements focus on the business strategies without paying much attention to the technical issues, which is conductive to separate efficiency oriented CC adoption from innovation. Additionally, from the perspective of deployment models, since private cloud is essentially the same to traditional enterprise information system, this paper focus only on public cloud.

Business Value of IT and CC

The business value of IT is investigated by a rich stream of studies that largely focus on the relationship between IT investment and performance (Masli et al., 2011). Although the academic has reached a consensus that IT enhances the productivity, improves market performance and financial performance, also brings intangible benefits to the enterprise (Melville et al., 2004), the early studies about IT business value sought to explain the "productivity paradox", which means IT investments during the 1980's did not result in significant productivity increases (Brynjolfsson, 1993). Brynjolfsson et al. (1996) find firms with substantial IT investments reported significant increases in firm value after 1991. The subsequent empirical studies fully investigate the long-run payoff of IT investments and whether the impact is lagged over long period of years in firm organization, financial structure or activities (Bharadwaj et al., 1999; Korovnikov et al. 2013; Mithas et al., 2012; Sedera & Lokuge, 2019; Shea et al., 2019). These studies concluded that it takes long time to realize the effect of IT investments on productivity, and the financial benefits are more likely to materialize in the long-term rather than short-term (Shea et al., 2019; Wang, 2010). Markus argues that the enterprise system experiences four stages from adoption to success: Chartering, Project (Configure & Rollout), Shakedown, and Onward and Upward (Markus & Tanis, 2000). According to this 4-stage framework, from adoption to success, an enterprise system will experience 1) decisions defining the business case and solution constraints, 2) getting the system and end users "up and running", 3) stabilizing, eliminating "bugs", and getting to normal operations, and 4) maintaining the system, supporting users, getting results, and upgrading (Markus & Tanis, 2000). Only in the fourth stage can the enterprise benefits from IT investment.

There is no unified definition about the term of *long-term*. Nevertheless, all studies focus on long-term business value of IT explore the performance changes over several years (typically 1–5 years) (Bremer et al., 2010). Further, different types of IT artifacts vary greatly on so called *long-run*. For instance, Mahmood et al. (2005) find that 3 years pass before an organization achieve value from its IT investments. Brynjolfsson and Hitt (2003) find the productivity and output contributions associated with computerization are up to 5 to 7 years. Chang and Gurbaxani (2012) observe the impact of IT-related spillovers on long-run productivity based on the panel data set over 8 years. Hendricks et al. (2007) examine the long-term stock returns and profitability changes over a 5-year period for Enterprise Resource Planning (ERP) systems and a 4-year period for Supply Chain Management (SCM) and CRM system implementations and yield mixed results. As to the CC payoff in this study, which has not been fully studied, on the account of short time frame of CC adoption on large-scale, the performance changes from adoption to when the data was collected is explored to indicate the long-run business value of CC.

As a specific type of IT investment, CC significantly impacts the focal firms' IT strategies in many ways (Ge et al., 2014). Compared to the general IT forms, the rental model of CC transforms the utilization of IT resources into IT services. CC brings the adopters lower IT costs (The Boston Consulting Group, 2009; Accenture, 2010; Mohammed et al., 2009; Son et al., 2011), better IT services (The Boston Consulting Group, 2009), and higher IT performance (Marston et al., 2011) that derived from flexible IT resources and a pay-as-you-go model (Mohammed et al., 2009; Son et al., 2011). The enterprises also can optimize or create the business processes using public and extensible CC (The Boston Consulting Group, 2009), which enhances the agility of enterprise operations (Accenture, 2010; Iyer & Henderson, 2012), help managers focus more on business strategy issues (Malladi & Krishnan, 2012), assist managers in making decisions (Accenture, 2010), improve business process performance and organizational performance. It also enhances, expands, and redefines products and services in an integrated manner (Kathuria et al., 2018), which help the adopters create new business models, increase customer engagement and better access to new markets (Chen & Wu, 2013; Etro, 2011; Accenture, 2010) by connecting, sharing, and pooling of resources throughout the business ecosystem (The Boston Consulting Group, 2009).

Some researchers have found that the market significantly and positively reacts to CC adoption and the market value is increased, thus demonstrated the high expectation of future returns from shareholders (Che & Liu, 2014; Parameswaran et al., 2011; Son et al., 2011; Son et al., 2014). However, the market performance represents the reactions and expectations of the investors to an event and reflects the short-run value of the event. IT does not fully explore the long-run regularity of performance changes. In contrast, there is few study on the return of investment in CC focus on the ultimate realized payoff based on financial performance measures, which reflect the performance enhancing effects of CC in the long-run (Barua & Mani, 2018).

Exploration and Exploitation Through IT and CC

One notable research stream about business value of IT, among many others, is the impact on efficiency and innovation performance (Winarno & Tjahjadi, 2017; Xue et al., 2012). The business strategies of firms involve two distinctive processes of exploitation and exploration based on the organizational learning theory (March, 1991). Firms use existing knowledge to improve organizational efficiency in the process of exploitation (Benner & Tushman, 2003). On the other hand, firms search for new knowledge to develop new products and services for emerging customers and markets and improve their innovative performance in the exploration process (Benner & Tushman, 2003). Accordingly, the companies invest in IT to improve the efficiency of their operations through exploitation by, such as, eliminating waste and reducing inventory. Alternatively, firms invest in IT to innovate through exploration by supporting developing new products or processes for the new markets (Xue et al., 2012).

Existing empirical research has investigated the impact of IT investments on increasing efficiency output such as increased inventory turnover ratio (Banker et al., 2006) and labor force saving (Brynjolfsson & Yang, 1996) while some other studies also reported the impact of IT on organizational innovation (Kleis et al., 2012). Some studies also have contradictorily noticed the efficiency and innovation payoff of IT investments. Xue et al. (2012) and Winarno et al. (2017) argue that the IT assets portfolios are related to efficiency improvement when the environment is relatively stable and less complex and to innovation growth in complex environment. Weill (1992) reports that there is a significant and consistent correlation between the transactional IT investment and corporate performance while the strategic IT is found to be neutral in the long-run.

CC can also be adopted with efficiency or innovation (Loukis et al., 2019). Firms adopt CC to improve the IT efficiency and enhance the operation agility (Iyer & Henderson, 2012) by low-cost and extensible IT services (The Boston Consulting Group, 2009; Mohammed et al., 2009) resulted from flexible IT resource and a pay-as-you-go mode (The Boston Consulting Group, 2009). This is an operational level efficiency improvement realizing CC value through exploitation. Alternatively, firms invest in CC to build the cloud-based business models by connecting, sharing and combining information resources from connected people and organizations (The Boston Consulting Group, 2009). It increases the customers' participation and drives innovation of customer value proposition and industry value chains (Berman et al., 2012). It also facilitates the inter-organizational innovations that completely change the competition patterns (Loukis et al., 2017). This, contrast to the former, is a strategic innovation achieving the value of CC through exploration.

CC is one of the important technical basis of strategic innovation. Because of the unified interface and service standards in CC environment, more enterprise systems can be integrated and coordinated, thus to build cloud-based business model such as business ecosystem. Consequently, CC functionally distinguishes from traditional IT in promoting innovation. CC adoptions with efficiency improvement and innovation purposes are differently affect the operations of the focal firms. How the firms benefit from CC adoptions with efficiency or innovation is also supposed to be different. However, existing empirical literatures have not provided evidence of such contingent effects.

More precisely, efficiency and innovation are not mutually exclusive (Wang et al., 2019; Xue et al., 2012). Firms do not invest in CC either for efficiency or innovation, but to balance them. Existing research has confirmed firm's ability to balance efficiency and innovation (Gibson & Birkinshaw, 2004). However, efficiency is separated from innovation in this study according to the firm's strategic focus that declared in the CC adoption announcements.

Long-Run Payoff of CC

The enterprises adopt CC to cope with the mismatch between current information systems and business development. The legacy systems are usually customized to address idiosyncratic structural and operational issues of the organization. Fragmentation, redundancy, and process and data uncertainty are common in these legacy systems (Karunakaran, 2014). The migration process to the cloud requires an overall reconstruction of the legacy system on a unified platform. In order to adopt CC, the previous business processes and the responsibility of the IT department need to be adjusted. The adopters have to adapt to the new routines, which will increase the cost of conversion. Lack of uniform standard between cloud-based system and legacy system increases the complexity of integration (Borgman et al., 2013). There are difficulties in data model construction, IT governance structure transformation, and finding human resources with experience in both the traditional information systems and the cloud systems (Benlian & Hess, 2011; Markus & Tanis, 2000). Overall, the adoption of CC redefines the functions of the IT department and changes the business process of the adopters. The challenges enterprise facing in the initial stage of CC migration process hinder the value achievement. CC implementation hence also goes through the shakedown stage, when the financial performance is likely to decline. Overtime, as the organization gradually gains experience and expertise with the features and functions of the new cloud-based system due to the learning curve, users can routinize their tasks in the cloud. The firm enters the onward and upward stage that CC can realize its full potential advantages and eventually improves the overall performance. Altogether, when the adopters successfully implement the cloud migration, the enterprises go from a period of abrupt changes to stability and the performance is improved in the onward and upward phase. It therefore hypothesizes that:

H1: CC adoption initially leads to decline on the performance for a period of time and then increases it.

Long-Run Payoff of Cc With Efficiency Versus Innovation

The implementation processes and the challenges organizations might face are different between CC adoption with efficiency and innovation. The main tasks during the CC implementation process include cloud migration planning, cloud vendor selecting, migrating and relationship governing (Salim, 2016). The firm needs to clarify the necessity of cloud migration considering the internal and external environmental factors and makes migrating plan in the first phase. Then, selects a qualified cloud vendor and signs service contracts. After that, migrates the data to the cloud and transforms the function of IT department. Finally, maintains and governs the cloud vendor relationship. In contrast, in the implementation process of CC with innovation, a wide range of Internet-based infrastructure for economic and social development it built (Loukis et al., 2017), which creates cloud-based business model that enables ecosystem connectivity (Hyunsun & Sanghyun, 2014) including providers, customers, employers, administrators and other participants (Berman et al., 2012). These disparate groups and people are brought together to collaborate and share resources, information and processes so as to reshape traditional industries by revolutionizing business processes and models and forming new value chains among enterprises. This process is accompanied by both technological and management reform, the enterprises need to focus not only on their core businesses, but also on integrating with partners network, new markets, customer relationships and value propositions, supply chains and distribution channels (Stamas et al., 2014) that need to be reconstructed.

CC adoption with efficiency and innovation is accompanied by different opportunities and hindrances that lead to different performance changes eventually. This adopts the Technology–Organization–Environment (TOE) framework to explain the opportunities and constrains in the process of CC implementation with efficiency versus innovation. TOE framework is an organization-level theory that "explains the different elements of a firm's context influence adoption decisions" (Baker, 2011, p.232). Each context contains both constraints and opportunities for the adoption of innovative technology (Tornatzky & Fleischer, 1990) such as CC. In turn, some of the inherent attributes of technology, organization and environment contexts promote or hinder the value achievement of CC. Table 1 lists the hindrances and promotors of CC value achievement with efficiency versus innovation based on TOE framework.

CC implementation with innovation impacts the core business process more profoundly than that with efficiency. The hindrance factors indicate that, compared with CC adoption with efficiency, innovation-CC adoption is a disruptive transaction that requires more complementary resources and capabilities to cope with the challenges. Due to the hindrances, the firms undergo more chaotic experiences in the shakedown phase (Eden et al., 2014) caused by substantial disruptions to the existing business process (Lokuge et al., 2019), organizational structure and business model. The limited knowledge and experience of the new business model's features further hamper the firm's overall performance (Polites & Karahanna, 2012). Therefore, in the context of cloud adoption with innovation, the shakedown phase of the cloud migration process is more pronounced and the performance decline is more severe in magnitude than that with efficiency. In contrast, the opportunity factors indicate that cloud-based business model, which is built in the process of innovation-CC adoption, brings more competitive advantages to the focal firm than efficiency-CC adoption (Dehning et al., 2003; Kyriakou & Loukis, 2017). With the transparent, flexible and agile business model, the industry chain expands from the core enterprise to the upstream and downstream by innovating the business process, thereby creating and sharing value through a dynamic and two-way interactive value network coordinating with other stakeholders (Benlian et al., 2018). It therefore hypothesizes the following:

H2: Compared with efficiency-CC adoption, innovation-CC adoption leads to more severe decline and then more substantial increase on the performance.

Research Design

Methodology

The performance volatility of a cloud-adopted enterprise in a given period is not necessarily caused by the adoption of CC but a combination of many factors. Therefore, it is necessary to take an enterprise that did not adopt CC as a reference. The reference enterprise is similar in all aspects to the adopter except CC adoption. The Propensity Score Matching (PSM) method is leveraged to match samples, and then used the Difference in Differences (DID) and OLS regression to analyze the effect of CC

Table 1. Hindrances and promotors of cc value achievement with efficiency versus innovation

		Efficiency	Innovation
Technological context	Hindrances	Migration of legacy systems to the cloud, data and interface standards (Armbrust et al., 2010), security and privacy (N. Wang et al., 2019)	Integration requirements (Marston et al., 2011), multiple cloud vendors, multiple stakeholders, higher security and privacy requirements,relatively simple single cloud service (Dellermann et al., 2017)
	Promotors	Flexible and extendable IT resources, wide Internet access, less IT maintenance (Marston et al., 2011)	More information and knowledge from the other participants (Kathuria et al., 2018)
Organizational context	Hindrances	Sunk cost of legacy systems (N. Wang et al., 2019), additional internet cost, benefit uncertainty, transformation of IT department (Benlian et al., 2018)	Loose inter-organization connections, radical and complex transformation including business model, processes and operational environment (Brook, Feltkamp, & van der Meer, 2014), more complex management requirement (Kathuria et al., 2018), complementary investments including human resources, capital, organization culture construction,R&D investment (Basole & Park, 2018)
	Promotors	IT cost advantages, limited impact on the core business process (Marston et al., 2011), convenient inter communication, flexible business process (Joe-Wong & Sen, 2018)	More connections across organizations, wider organization boundaries, decentralized organization structure (Benlian et al., 2018), innovative business model and competitive advantages (Berman et al., 2012)
Environmental context	Hindrances	Relationship governance with cloud vendors (N. Wang et al., 2019)	More complex relationships of competition and cooperation (N. Wang et al., 2019)
	Promotors	Development of cloud industries, more cloud vendors, government support	Wider market, social innovation, cooperation advocation (Euripidis Loukis et al., 2019)

adoption and the moderating effect of efficiency/innovation on financial performances (Rishika et al., 2013). The Matched Sample Comparison Group (MSCG) method has been used to analyze the sources of variation between the treatment and control groups based on specific events in such areas as accounting, finance, and marketing (Bharadwaj, 2000; Chae et al., 2014; Santhanam & Hartono, 2003). The PSM was based on multiple factors, and the nearest control group was selected by the propensity score (PS value) because it resulted in the lowest mean differences between groups. The paired control group could be used as a benchmark for comparison, which eliminated the influence of exogenous variables on financial performance and selection bias. 1-to-1 matching method is used for the control group. The treatment group consisted of enterprises adopting CC. Following the prior IT value literatures (Bharadwaj, 2000; Hendricks & Singhal, 2005; Santhanam & Hartono, 2003; Wu et al., 2017), the samples in the control group were paired in terms of size, industry type, market-to-book ratio, and prior performance close to that of the treatment samples. Because these factors are considered to be the important predictors of stock returns according to the consensus on appropriate factors that one should control for in computing long-run abnormal returns (Hendricks & Singhal, 2005). The DID model was based on data from natural experiments to construct a difference in differences estimator. The results of the event were separated by the combination of a simple before-and-after intervention comparison and a simple cross-section comparison (the treatment and control groups). The DID method was used to evaluate the difference between the treatment group and the control group before and after the event. The combination of the PSM and DID methods was selected because it simulates a randomized controlled experiment, reduces the confounding effect of the observable and unobservable factors on the dependent variable, improves the consistency of the validation results, and produces unbiased estimate of performance improvement resulted from CC adoption (Rishika et al., 2013).

Measurements

The overall performance, instead of direct performance, is measured to investigate the payoff of CC investment. Following prior research on the business value of IT (Bharadwaj, 2000; Chae et al., 2014; Che & Liu, 2014; Wang, 2010; Wu et al., 2017), return on assets (ROA), return on equities (ROE), return on sales (ROS), operating income to assets (OI/A), operating income to sales (OI/S), and operating income to employees (OI/E) are selected to measure the financial performance. ROA is the return on an assets unit investment that is a widely used to measure the profitability of an enterprise (Bharadwaj, 2000). ROE is the ratio of net profit to stockholders' equity, which is an important index to measure the profitability of an enterprise. ROS is the ratio of the net profit to operating income and is another measure of a firm's net profit margin. Operating income is the profit before interest and tax (EBIT). OI/A and OI/S ratios focus on operating returns only and exclude incomes earned by the firm from other sources. The OI/E ratio is used as a measure of the relative profitability per employee (Bharadwaj, 2000).

Sample and Data Collection

The samples in the treatment group are companies that adopted CC and operated normally between January 1, 2010 and October 31, 2016. According to the regulations of China Securities Regulatory Commission, the listed companies should halt the stock trading if they are running poorly and have financial problems or there are some major events to the focal firms such as restructuring and new stocks issuance. Consequently, in order to minimize the impact of other factors on long-run performance, some sample companies were excluded if they have had halted trading through adopting CC to their data was collected.

The following criteria were used to select the control group samples: 1) did not adopt CC from early 2010 to the end of June 2019 (different from the time frame of treatment group so as to exclude the firms adopting CC through November, 2016 to the end of June 2019); 2) had the same industry category code as the counterpart in the treatment group (The Guidance Note on Industry Classification of Listed Companies was used and the samples were classified by the Second Level Code of China Securities Regulatory Commission Industry and represented with 1 letter and 2 digits); 3) showed the closest PS value (implemented with the MatchIt package of R) to the counterpart in the treatment group based on the feature variables, including the total assets, total number of employees, and revenue of the year before CC adoption (Bharadwaj, 2000; Chae et al., 2014; Santhanam & Hartono, 2003).

The adoption behavior (or lack thereof), the adoption time, and the adoption types were from the widely used search engine, CC portals, China Knowledge Resource Integrated Database, and the companies' official websites using *cloud computing, cloud services, cloud platform, IaaS, PaaS, or SaaS*, together with the firms' names as the keywords. The industry codes, financial performance, and other control variables data were obtained from the China Stock Market & Accounting Research Database (CSMAR). The outliers were removed according to the Pauta Criterion. Observations with missing or uncertain values for the key independent variables were discarded. Missing values for other independent variables are replaced by industry average. The final sample consists 253 pairs of listed companies. The adoption year and industry distribution of the samples is reported in Table 2.

The purposes of CC adoptions were stated in the announcements or news. The quantitative and qualitative methods were combined to distinguish efficiency- and innovation-oriented CC investments. Quantitatively, text analysis was conducted as follows to separate exploration from exploitation in the company's business activities following the prior study (Uotila et al., 2009). Since the efficiency

Table 2. Year and industry distribution of samples (in pairs)

Code and Industry	2010	2011	2012	2013	2014	2015	2016	Total
B-Mining		1				1		2
C-Manufacturing	2	4	6	7	24	73	43	159
D-Electricity, Heat, Gas, and Water Production, and Supply						1	1	2
E-Construction			1		3	3	3	10
F-Wholesale and Retail Trade		1		2	4	12	3	22
G-Transport, Storage, and Postal Services		1	1	2	1	3	2	10
H-Accommodation and Catering						1		1
I-Information Transmission, Software, and IT Services			1		2	2	1	6
J-Financial					2	2		4
K-Real Estate			2	1	1	3	2	9
L-Leasing and Business Services					1	2	3	6
M-Scientific Research and Technology Services							2	2
N-Water, Environment, and Utilities Management					1		1	2
O-Residential Services, Repairs, and Other Services			1					1
Q-Health and Social Work					1	1		2
R-Culture, Sports, and Entertainment		1		2	1	5	4	13
S-Synthesis			1		1			2
Total	2	8	13	14	42	109	65	253

and innovation are separately associated with the process of exploration and exploitation, based on the quoted conceptual definition of exploration as ‘things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation’ (March, 1991) and exploitation as ‘such things as refinement, choice, production, efficiency, selection, implementation, execution’ (March, 1991), these lists of words, after being translated into Chinese and together with their synonyms according to a authoritative dictionary, were used to operationalize exploration versus exploitation orientation of firms’ CC investments by the appearance amount of corresponding words in the investment announcements. The CC investment was classified into innovation if there were more words from the definition of exploration than that from exploitation in the announcement, vice versa. The samples were removed if none of these words was in the announcements (there is no announcement sample groups with the same amount of words related to efficiency and innovation). Qualitatively, each announcement was read carefully by three well-recognized scholars who both research and teach in IT strategy area. Each judge was required to divide the cloud investments into innovation or efficiency separately. The principles for the classification are as follows: the investments that do not essentially transform the firms are classified as efficiency. Such as cloud desktop, cloud storage, cloud printing (fax, scanning) and other new office tools that can effectively improve the use of resources and operational efficiency. Alternatively, the investments were classified as innovation if they are for expanding the industrial chain, providing value-added services and changing the traditional profit model. Such as cloud-based online shops that reform the profit model and cloud-based intelligent products that provide value-add services to the customers.

Metrological Model

The following DID model is established for all performance indicators for each sample of the treatment and control groups to determine the main effect of CC adoption (Pippel & Seefeld, 2016; Rishika et al., 2013):

$$Y_{ijt} = \alpha + \beta_1 * adopt_{ij} + \beta_2 * after_{ijt} + \beta_3 * adopt_{ij} * after_{ijt} + \delta X_{ij} + \varepsilon_{it}$$

where Y is the indicator to measure an enterprise's financial performance, i denotes a matched pair of companies, j denotes a treatment group or a control group company, and t denotes the time. $adopt_{ij}$ is a treatment dummy variable (that equals 1 if the company is in the treatment group and 0 in the control group), $after_{ijt}$ indicates a binary variable before or after adoption (the value after adoption is 1, otherwise 0). X_{ij} stands for control variables. The adoption purposes, enterprise size, research and development (R&D) investment, and industry type are controlled in this DID model, where adoption purpose is a dummy variable (1 means the company adopted CC with innovation and 0 means with efficiency), firm size is measured as the logarithm of the total assets, R&D investment is the ratio of R&D input to operating income, and the industry type is a binary variable (1 for service industries, 0 for others) (Oh et al., 2006). The coefficient mainly concerned with is the significance of β_3, which represents the difference between the treatment group and the control group in firm performance improvement after controlling for other factors. The annual performance data is regarded as occurring after the adoption if the adoption time was in or before June, while it is regarded as before the adoption if the adoption time was in or after July, so as to distinguish the data of the cloud-adoption year. As the small sample size that have adopted CC more than 5 years by late 2019, the annual performance data 2 years before and up to 5 years after adoption is analyzed.

Results

DID Analysis

Table 3 provides the raw difference-in-differences values of the treatment and control groups for the previous year and 5 years after adoption. The $year_{1\text{-}5}$ rows are the average of the measurements from 1 year through 5 years after adoption, the $year_{-1}$ rows are the average of the indicators for the previous year, and the $Diff_{1\text{-}5}$ rows are the differences between each year after adoption and the previous year. The $DID_{1\text{-}5}$ lines are the DID values between each year after adoption and the previous year. The sample size decreases as the adoption period get longer. The samples corresponding to the reduced ones are also excluded from the previous year's, so the data in the $year_{-1}$ line is also slightly different.

All the measurements of DID values, except OI/E, keep falling from 1 year through 4 years after adoption. However, the downward trend of the DID values slowed down in the fourth year except OI/S. The fifth year's DID values, though still negative, show an upturn trend (Figure 1). This lends prima facie credence to the fact that adopting CC decreases the adopter's performance.

After considering the multiple collinearity, heteroscedasticity and sequence correlation, to benchmark the results and statistical fit of the DID model, the control variables are added step by step to analyze the DID of each indicator. In view of the results analyzed above, the dependent variables in the DID regression analysis are the measurements from the previous 2 years to 4 years after adoption so as to better analyze the main factors of the negative impact. The analysis of ROA shows the process of gradually adding control variables as shown in Table 4. Model 1 is the basic DID model without any control variables. Model 2 is the analysis result of adding demographic variables of sample enterprises, and model 3 is the analysis result of adding demographic variables

Table 3. Difference in differences: performance measurements of treatment and control groups

		Treatment Group					Control Group				
		year$_1$	**year$_2$**	**year$_3$**	**year$_4$**	**year$_5$**	**year$_1$**	**year$_2$**	**year$_3$**	**year$_4$**	**year$_5$**
ROA	year$_{1-5}$	5.361	4.643	3.789	2.943	2.522	3.967	3.956	2.957	2.233	1.162
	year$_{-1}$	6.036	6.053	6.174	6.290	6.640	4.245	4.326	4.114	4.279	4.030
	n	241	235	230	189	113	241	235	230	189	113
	Diff$_{1-5}$	-0.811	-1.410	-2.217	-3.347	-4.117	-0.278	-0.370	-1.157	-2.045	-2.868
	t-test	-3.862***	-5.116***	-6.657***	-9.285***	-8.732***	-1.033	-1.198	-2.935***	-5.764***	-7.046***
	DID$_{1-5}$	-0.534	-1.040	-1.228	-1.302	-1.249					
ROS	year$_{1-5}$	10.758	10.850	7.992	7.388	9.711	8.500	8.615	7.570	6.941	6.826
	year$_{-1}$	11.776	9.470	10.907	11.111	11.851	8.656	8.533	8.168	8.361	8.893
	n	228	225	201	153	54	228	225	201	153	54
	Diff$_{1-5}$	-1.018	-1.379	-2.914	-4.898	-2.141	-0.156	-0.081	-0.598	-1.419	-2.067
	t-test	-2.546**	-2.286**	-4.317***	-5.561***	-1.504	-0.298	-0.152	-1.046	-2.039**	-1.655
	DID$_{1-5}$	-0.863	-1.298	-2.316	-3.479	-0.073					
ROE	year$_{1-5}$	8.925	8.150	6.653	5.173	4.440	7.497	7.242	5.986	4.349	2.566
	year$_{-1}$	10.054	9.767	9.944	10.004	10.608	7.696	7.659	7.548	7.316	7.041
	n	220	216	207	183	105	220	216	207	183	105
	Diff$_{1-5}$	-1.129	-1.617	-3.291	-4.831	-6.618	-0.199	-0.417	-1.562	-2.968	-4.475
	t-test	-3.954***	-3.756***	-6.742***	-8.392***	-8.768***	-0.492	-0.948	-3.069***	-5.515***	-8.202***
	DID$_{1-5}$	-0.929	-1.200	-1.729	-1.863	-1.693					
OI/A	year$_{1-5}$	6.745	6.103	5.025	3.528	2.983	5.469	5.419	4.449	3.340	2.250
	year$_{-1}$	7.730	7.583	7.932	8.058	8.322	5.808	5.917	5.713	5.915	5.698
	n	236	233	225	189	111	236	233	225	189	111
	Diff$_{1-5}$	-0.985	-1.480	-2.907	-4.530	-5.338	-0.339	-0.497	-1.264	-2.575	-3.448
	t-test	-4.243***	-4.896***	-7.282***	-10.328***	-9.648***	-1.114	-1.376	-3.039***	-6.308***	-7.552***
	DID$_{1-5}$	-0.646	-0.983	-1.643	-1.955	-1.891					
OI/S	year$_{1-5}$	13.162	12.252	10.827	10.250	12.095	10.720	10.730	9.914	10.372	10.313
	year$_{-1}$	14.013	13.589	13.561	14.125	14.789	10.685	10.906	10.402	10.446	9.290
	n	226	230	213	189	110	226	230	213	189	110
	Diff$_{1-5}$	-0.851	-1.337	-2.735	-3.875	-2.694	0.035	-0.176	-0.488	0.074	1.023
	t-test	-1.81*	-2.085**	-3.722***	-4.502***	-2.841**	0.051	-0.255	-0.611	-0.098	0.938
	DID$_{1-5}$	-0.886	-1.161	-2.246	-3.801	-3.717					
OI/E	year$_{1-5}$	5.053	5.051	5.013	5.131	5.107	4.959	4.983	4.986	4.971	5.054
	year$_{-1}$	5.078	5.056	5.028	5.065	5.022	4.938	4.914	4.845	4.845	4.869
	n	161	171	136	86	37	161	171	136	86	37
	Diff$_{1-5}$	-0.025	-0.004	-0.015	0.066	0.085	0.022	0.069	0.140	0.126	0.185
	t-test	-1.389	-0.206	-0.468	1.955*	1.219	1.079	2.703**	4.043***	2.448**	2.013*
	DID$_{1-5}$	-0.046	-0.073	-0.155	-0.060	-0.100					

$*p \leq 0.010$, $**p \leq 0.005$, $***p \leq 0.001$.

and behavior variables with the best fit statistics. With the addition of the control variables, the coefficient β_3 in the different models is still negative.

Table 5 presents the analysis results of all performance indicators using Model 3. All the β_3 values of the other indexes are negative except OI/E. Thus, the hypothesis that there is a period of performance decline after the CC adoption is supported. However, the assumption of improved performance is not fully validated due to the limited time frame.

Moderating Effects of Efficiency Versus Innovation

A major focus of this study is to investigate the moderating effect of efficiency/innovation. The samples are divided into two subgroups with one consists of enterprises adopting innovation-CC

Figure 1. Trend chart of the did value of each measurement

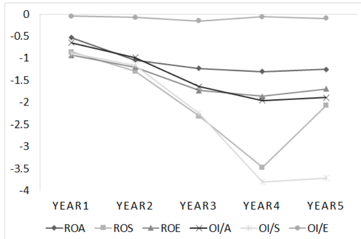


Table 4. Regulation analysis of CC adoption on ROA

Variables	Model 1: No controls		Model 2: Control for demographic variables		Model 3: Control for demographic and behavior variables	
	Estimate	SD	Estimate	SD	Estimate	SD
Intercept	4.255***	0.284	8.310***	2.422	3.278***	3.970
adopt	2.652***	0.402	2.689***	0.419	4.252	0.780
after	-0.968***	0.367	-0.543	0.404	-0.505	0.584
adopt*after	-1.377***	0.518	-1.211**	0.567	-2.083***	0.799
Size			-0.396	0.245	0.101	0.399
Industry			-0.412	0.325	-0.757	0.582
Innovation					-0.105	0.682
R&D					0.011	0.066
Adjusted R^2	0.077		0.085		0.130	
N	1760		1616		1070	
$*p \leq 0.010$, $**p \leq 0.005$, $***p \leq 0.001$.						

and the other with efficiency-CC, together with their counterparts. The DID analysis is conducted to each subgroup. Because the tests detecting the differences in coefficients, which is designed for testing changes in parameters across time series data, assume that there is no heteroscedasticity in the resulting residuals. However, they are not appropriate in this study because the error terms of metrological model above for panel data likely to violate the required assumptions (Sean & Cleary, 1999). Further, the potential heterogeneity between efficiency- and innovation-CC adopting firms is are able to be reduced by splitting the sample based on the adoption orientations (Chang & Gurbaxani, 2012). Conclusions regarding the differences in the interactive item across groups are largely based on observing differences in magnitude and level of significance of the coefficient in regression estimates (Sean & Cleary, 1999).

As shown in Figure 2, the DID values of both groups decreased from 1 to 3 years after cloud adoption, and the decrease of innovation group is more severe than that of efficiency group. However, the decreasing trend of the fourth year's DID values of the most indicators in innovation group is slower and then exceeds that in efficiency group.

Since the DID values for the CC-Innovation adopters are lower than those for the CC-Efficiency adopters, Hypothesis 2 is thus preliminarily partly supported because there is no more substantial performance in the innovation group according to Figure 2 due to time constraints.

Table 5. DID analysis results of performance measurements

Variables	ROA		ROS		ROE		OI/A		OI/S		OI/E	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Intercept	3.278***	3.970	9.253***	3.170	-20.512***	5.052	-3.184	4.569	1.789	8.580	2.465	0.866
adopt	4.252	0.780	8.000***	1.503	4.240***	0.968	3.864***	0.865	7.250***	1.570	0.394	0.157
after	-0.505	0.584	-0.244	1.146	-0.862	0.735	-0.651	0.645	-0.378	1.196	-0.027	0.125
adopt*after	-2.083***	0.799	-3.917**	1.590	-2.133**	1.012	-2.280***	0.877	-3.675**	1.629	-0.114	0.165
Size	0.101	0.399	0.381	0.299	2.845***	0.509	1.014**	0.469	1.150	0.885	0.245	0.093
Industry	-0.757	0.582	-9.344***	1.119	-0.985	0.689	-1.098*	0.655	-7.635***	1.184	-0.202	0.136
Innovation	-0.105	0.682	-2.953**	1.307	0.233	0.841	0.280	0.751	-1.090	1.354	-0.463	0.136
R&D	0.011	0.066	0.927***	0.128	0.274***	0.086	-0.069	0.073	0.886***	0.136	0.010	0.011
Adjusted R^2	0.130		0.210		0.148		0.126		0.188		0.307	
N	1070		1088		1050		1061		1055		841	
*$p \leq 0.010$, **$p \leq 0.005$, ***$p \leq 0.001$.												

The coefficients and significances of the DID analysis results for all the measurements except OI/E listed in Table 6 show that CC with innovation has a significant negative effect on firm performance. The impact of CC with efficiency on firm performance is also negative, but not significant. It hence supports that cloud adoption with innovation will lead to a more significant decline in the performance.

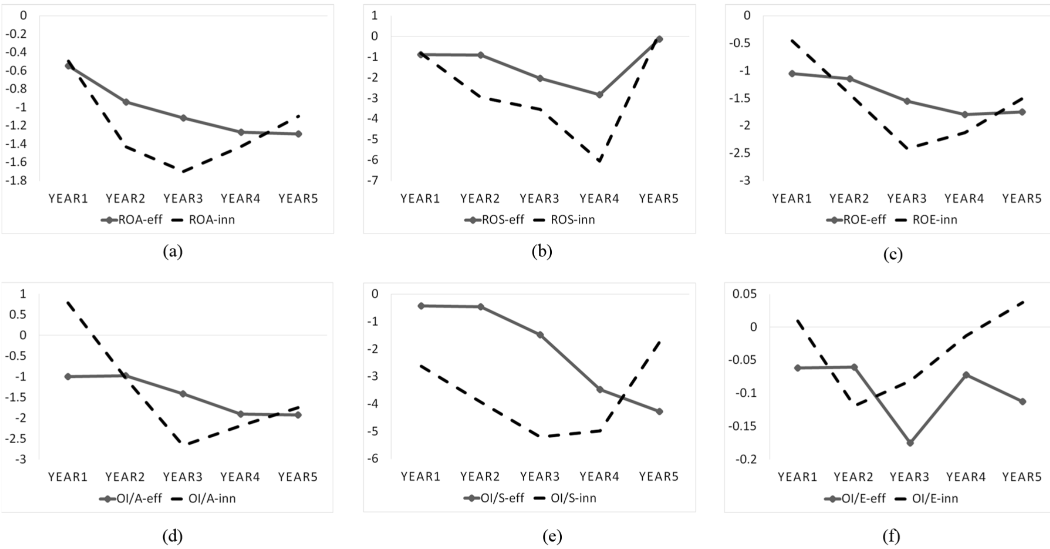
Robustness Checks

Several robustness checks are conducted to address the possible concerns regarding the measurement of the focal variables and a series of potential biases. Considering the importance of sample pairing to this study, some robustness checks focus on the sample pairing from such aspects as feature variable selection and matching mode. The feature variables for matching include industry categories, total assets, number of employees and the operating income. The authors also tried to match by the First Level Code of the China Securities Regulatory Commission Industry, which is a 1-letter code, total assets, and the number of employees in the previous year as the feature variables. The DID analysis results are similar. As to the matching mode, 1-to-3 matching and synthetic control methods (Abadie et al., 2010) are conducted beside 1-to-1 matching. In the 1-to-3 matching process, the mean performance of the three firms with nearest PS value to the treating sample is calculated for the control group. In the synthetic control methods, a virtual control sample is created for each treating sample by giving the feature variables different weights so as to make sure that the virtual control group has the same time trend as the treatment group before the event (Abadie et al., 2010). All the findings of these checks are similar.

In order to test the possible bias caused by sample selection, two robustness checks are conducted. First, the national policy promoting CC adoption with innovation was issued in 4 July, 2015. The samples are divided into two subgroups according to this time point and analyzed separately so as to test the possible bias caused by this policy. Event though the overall duration between these two subgroups varies, the general trends after adoption are similar. Second, as shown in table 2 that 159 out of 253 sample firms are from manufacturing industry. In order to test the potential sample selection bias caused by this dominant industry type, the rest 94 sample firms are analyzed. The results are similar.

Finally, the performance declines continuously since adoption compared with the previous year according to figure 1 and 2. The regression analysis used the performance data from the previous 2 years. The researchers also used performance data from the previous year to 3 years after adoption for the regression analysis, and the findings are similar.

Figure 2. DID Values Trend of Efficiency and Innovation Groups



These robustness tests indicate that the results of this study are neither specific to the sample firms, neither to the matching method, nor to the variable measurements. These consistent robustness results across all tests provide further support and confidence in the findings.

CONCLUSION AND DISCUSSION

More and more enterprises have adopted CC since its advent more than a decade ago. Because of the created IT service mode instead of IT resources ownership, firms may adopt CC for efficiency improvement or innovation promotion. Despite the CC benefit to the adopters in many aspects, there are different voices. Existing literatures neither provide sufficient evidence of the long-run payoff nor investigate the contingent effect of different adoption purposes. This paper mainly argues that the economic, technical, and organizational advantages of CC are not necessarily lead to instant performance achievements. Further, CC adopting orientations impact the performance achievement regular pattern differently.

The results show that cloud adoption leads to a general continuous decline in financial performance for years, but then the trend reverses. The performance decline after the adoption implies that CC, as an innovation of the IT service model, requires the adopters to face a series of challenges in the migration process of legacy systems to the cloud. Among them, the security, privacy and integration are the most important issues. Despite the lowered IT infrastructure cost and flexible IT resources, the adopters need to transform the IT departments' responsibilities and business processes to adapt to the cloud-based IT service model. The subsequent financial performance increase indicates that CC can bring a flexible IT resource utilization mode to the adopters, improve operational performances, enhance enterprise agilities, create more value for customers, and ultimately increase the financial performance. In short, it takes a period of time to achieve the business value of CC. This is consistent with Markus' 4-stage theory from adoption to success (Markus & Tanis, 2000) and also validates the shareholders' positive expectations of the CC adoption announcements (Parameswaran et al., 2011; Son et al., 2011; Son et al., 2014).

Further, based on the TOE framework, this paper displays the promotors and hindrances for the CC value achievement when it is adopted for efficiency versus innovation. The analysis results

Table 6. DID analysis of moderating effect of efficiency/innovation

Variables	ROA		ROS		ROE		OI/A		OI/S		OI/E	
	inn	eff	inn	eff	inn	eff	inn	eff	inn	eff	inn	eff
Intercept	0.005	3.457	9.922***	-34.651**	-24.443***	-13.045	-4.291	-12.752	-1.370	5.042	3.963***	1.675
adopt	4.265***	3.632***	5.469***	6.239***	4.636***	3.190*	4.348***	2.784**	6.008***	7.389***	-0.049	0.337
after	-0.309	-0.712	0.623	-2.802	-0.803	-0.724	-0.303	-1.622	0.292	-1.404	-0.086	0.175
adopt*after	-2.624***	-0.741	-4.951***	-0.928	-2.874***	-0.147	-2.817***	-0.774	-5.074***	0.451	-0.058	-0.288
size	0.455	-0.107	0.099	5.539***	3.304***	1.904	1.126**	1.860	1.590	-0.322	0.079	0.326
industry	-0.508	-1.702	-6.929***	-18.391***	-1.012	-1.856	-0.798	-2.383	-7.736***	-0.724	-0.198	-0.289
R&D	-0.062	0.954***	0.866***	1.812***	0.201**	1.035***	-0.158**	1.068***	0.759***	1.693***	0.008	0.037
Adjusted R^2	0.134	0.291	0.162	0.545	0.179	0.124	0.159	0.172	0.163	0.357	0.009	-0.012
N	451	619	455	633	422	628	450	611	430	625	358	483

Note: *inn* indicates Innovation, *eff* indicates efficiency.

$*p \leq 0.010$, $**p \leq 0.005$, $***p \leq 0.001$.

of the moderating effect show that CC adoption with innovation has a more negative effect on firm performance than efficiency. This implies that when enterprises adopt CC with innovation as a disruptive innovation, new business models are created, the operation environment changes profoundly and the focal firms' core business operations undergo major transformation. In the process of CC implementation with innovation, more information and knowledge are shared between the stakeholders, which help to build the business ecosystem and promote product and service innovation. This enhances the competitive advantage of the focal firms. However, this kind of CC adoption is risky and complex and fiercely shocks the organizations leading to remarkable financial performance decline. Due to the radical and complex transformation related to business model, process and operational environment, the adopters need more effort and complementary investments to cope with the integration requirements, not only the integration between the legacy systems and cloud-based systems, what's more is the integration between the focal firm and other participants in the ecosystem. To summarize, the performance improvement takes more time and is determined by the value co-creation of all the members in the cloud-based ecosystem. Therefore, while Son argued that there were additional benefits from CC when it provides value-added services to customers or results in better collaboration with partners (Son et al., 2011), the conclusions of this paper imply that the adopters need additional resources to cope with the serious performance decline before they get more benefits.

IMPLICATIONS

Implications For Theory

The study makes several contributions to the academia. First, this paper explores the long-run payoff of CC based on the archival data, which enriches the business value studies of CC. Although existing researches have explored the CC benefit to a range of organizational performance indicators, most studies ignored the long-run law of CC value realization. This study compensates the gaps of existing researches that only focus on one side of CC business value. This paper proposed that the positive and negative impacts dominate different stages and CC adoption is likely to be associated with greater performance increase. However, the empirical analysis does not support for the hypothesis clearly. This suggests that it takes more than 5 years to achieve the performance increases on average. Even though this paper only finds the sign of performance rebound and does not prove the positive payoff of CC in the long-run due to the short time frame, it is also important to know the extent to which the firm performance declines. Further, the findings of the performance changes from the shakedown phase to the onward and upward phase help to strengthen the understanding of Markus's theory employed to explain the changing nature of IT performance in CC section (Markus & Tanis, 2000).

Second, drawing upon organizational learning theory of exploitation and exploration processes, this paper argues that CC investments support exploitation and exploration initiatives for efficiency and innovation separately. Prior research has provided evidence that it took a period of time before IT benefit the focal firm's performance, most studies assumed that the trends of value realization were universalistic. Drawing on the TOE framework, the pros and cons of CC adoption are fully expounded when supporting efficiency improvement and innovation promotion specifically. This paper demonstrates that efficiency improving oriented CC adoption causes relative minor performance decline in magnitude and then smaller performance rebound than that with innovation. These results extend the prevailing insights about IT business value achievement pattern (Markus & Tanis, 2000).

Implications for Practice

This paper implies the executives that they need to decide not only whether to adopt cloud, but also the purpose of adoption. This study finds that adopting CC negatively impacts on enterprise performance, which is especially pronounced when implemented with innovation. However, it does not mean to persuade the firms to reject CC or cloud-based innovation. Instead, with the conclusions of this paper about the performance decline in the years after CC adoption, the managers should be fully prepared for the adoption of CC and innovation, which is a major reform but risky strategic decision. Whether to adopt CC is closely related to the development strategies of the enterprises and the managers should make rational decisions based on its actual situation. Taking the advantage and disadvantages of CC into consideration, the CIOs should carefully judge and weigh the business develop requirements and the abilities and resources, such as the IT talent pool with dual IT and business skills, to meet the challenges posed by CC. Once CC is adopted and implemented with innovation, the combination of the IT service model and business model results in a significant strategic transformation, organization and process innovation. Adopting these new models is not a brief process, but a series of related linked actions causing years of performance decline. The managers need to take into account such factors as system flexibility, integration requirement and business complexity before adopting CC and strategy transformation. Adequate integration plans for legacy and cloud-based information systems are needed to clarify the original intent, purpose and procedure of cloud migration and business model innovation. New cloud-based business model increases the business partners, enriches the information and knowledge available to the adopter and quire more R&D investment to take full advantage of it. In addition, the adopter should make more effort to collaborate with the other participants in the ecosystem because the successful implementation of CC requires the joint coordination of all partners in the supply network (Blomqvist et al., 2008). In a word, when an organization decides to adopt CC with innovation, the adopter must undergo process reorganization, cultural reconstruction, or strategic adjustment to match the organizational context to adapt to the new models as quickly as possible to obtain a competitive advantage (Jin et al., 2018).

LIMITATIONS AND FUTURE RESEARCH

This study also has some limitations that need further study based on additional data. First, the conclusions of this paper raise doubts about the suitability of unlisted companies. The unlisted companies may gain the advantage of lower IT costs by adopting CC (), which may affect their financial performance differently. Second, the adoption of CC will affect firm performance may be influenced by many other factors, such as the scale of investment in CC, the ratio of investment to operating costs, the enterprise’s own information technology capability, and the ability to control partner enterprises. Future research needs to control for those factors to get deeper result. Finally, CC may not only brings financial benefits to adopters, but also intangible benefits () that may not necessarily lead to overall firm-level measures of financial performance improvement. Hence, the non-financial impacts on enterprises need further investigation.

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