



Cloud computing and its impact on economic and environmental performance: A transaction cost economics perspective



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ABSTRACT

For many organizations, managing both economic and environmental performance has emerged as a key challenge. Further, with expanding globalization organizations are finding it more difficult to maintain adequate supplier relations to balance both economic and environmental performance initiatives. Drawing on transaction cost economics, this study examines how novel information technology like cloud computing can help firms not only maintain adequate supply chain collaboration, but also balance both economic and environmental performance. We analyze survey data from 247 IT and supply chain professionals using structural equation modeling and partial least squares to verify the robustness of our results. Our analyses yield several interesting findings. First, contrary to other studies we find that collaboration does not necessarily affect environmental performance and only partially mediates the relationship between cloud computing and economic performance. Secondly, the results of our survey provide evidence of the direct effect of cloud computing on both economic and environmental performance.

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1. Introduction

Optimizing economic and environmental performance initiatives has received increasing attention among researchers and professionals [25,33,83]. The increasing need to examine ways to balance and optimize economic and environmental performance is especially prevalent given the emergence of regulatory and market pressures to monitor and reduce the impact of businesses on the natural environment [111]. For example, the US government in the past decade has placed a heightened emphasis on organizations reducing carbon emissions as a way to mitigate global climate change. This has led large organizations, including ExxonMobil, to disclose their carbon emissions data regularly on their websites [31]. Further, consumer groups such as Green America, a US based non-profit, have successfully attempted to persuade consumers to boycott products due to an organization's lack of environmentally friendly production or supply chain operations [101]. These examples illustrate the importance for organizations to manage environmental as well as economic performance. However, current research lacks actual examples of tools and strategies that organizations can use to balance both types of performance.

Some studies suggest that economic and environmental performance can be managed by enhancing relationships among suppliers. Relational capabilities including forging proper incentives, sharing

information and setting common goals tend to align behaviors among supply chain partners, thereby leading to greater social and environmental performance [69]. By managing environmental performance a firm can positively enhance aspects of economic performance as well [69]. Ultimately, this may lead to a reciprocal relationship between firms investing greater economic resources in environmental initiatives. However, in order for relationships to enhance both economic and environmental performance, organizations must strategically develop and align technical and relational capabilities. When firms use information technology (IT) to explore and exploit relational opportunities, greater strategic and operational benefits arise [81]. Limited research has been conducted on specific IT like cloud computing, which has benefits associated with not only optimizing relational capabilities between firms, but also increasing economic and environmental performance. The evidence of these benefits has prompted organization to switch from on-premise installations to cloud based services [37].

This study builds on transaction cost economics (TCE) to examine ways in which cloud computing can help firms develop greater relationships within their supply chain networks and how it can directly and indirectly impact economic and environmental performance by reducing transaction costs throughout the supply chain. TCE is driven by the central concept that transactions take place in a context where actors are limited by bounded rationality and must work to make transactions in an economically efficient manner [99,102]. Economic efficiency refers to the actor's ability to minimize transaction costs as much as possible [105]. We build on TCE to hypothesize the effects of cloud computing on both economic and environmental performance. In addition, we examine the effects of collaboration (via cloud computing) on both

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economic and environmental performance. We also assess the reciprocal relationship between both economic and environmental performance.

Our study seeks to answer the question of how to enhance both a firm's economic and environmental performance through the use of the cost saving IT cloud computing. Current research in supply chain management suggests that while the majority of literature seeks to answer the question of whether or not environmental initiatives pay, more research is needed to address the question of how to actually enhance environmental performance [67]. To the best of our knowledge this will be one of the first empirical studies to examine cloud computing's direct impact on environmental performance. Further, although some research exists on cloud computing, the majority of this research is conceptual in nature. We wish to provide researchers a theoretically driven model through TCE and empirically validate it through survey evidence. We propose that cloud computing provides a new way of enhancing and balancing not only economic, but environmental performance as well. This also provides researchers an insight into the use of cloud computing to facilitate collaboration.

In addition to our research contributions, we also provide several managerial insights into how cloud computing can be used to reduce transaction risk within the supply chain. First, this study provides supply chain professionals an empirically validated tool to balance both economic and environmental performance initiatives. Second, with increasing supply chain complexity due to globalization it is now more important than ever for organizations to understand how to effectively manage collaboration with their supply chain partners. We provide empirical validation for the effectiveness of cloud computing to enhancing collaboration via enhanced information sharing, goal congruence, incentive alignment, resource sharing, collaborative communication and joint knowledge creation.

This study is structured as follows: first, we describe TCE as well as background literature on cloud computing, collaboration, economic and environmental performance. Then we develop our hypotheses and research model. Subsequently, we detail our methodology and results. Finally, we conclude with a discussion of the results, limitations and directions for future research.

2. Theoretical background

TCE, often associated with Williamson's [102,104] work, is an empirically supported theoretical paradigm known for analyzing transaction risks among organizations [99]. TCE assumes actors of transactions are limited by "bounded rationality" and are subject to the strategic behavior of others [103]. Bounded rationality suggests that while human behavior is intentionally rational, it is often constrained by the capacity to process and communicate [88,99]. Due to these constraints actors have a difficult time communicating changes to circumstances surrounding a transaction in advance [104]. They inevitably run the risk that circumstances could change, thus causing problems with information flow between parties. According to TCE, parties need to find ways to reduce transaction complications in an economically efficient manner [105]. Economic efficiency refers to the ability of parties to minimize costs of a transaction so that value is maximized for both parties in comparison with the next best alternative for each party [27].

Over the past few decades TCE has been operationalized and examined through a variety of platforms [80]. These platforms include organizational make-or-buy decisions [9,57,59,106], contractual solutions [64,99], buyer and supplier relationships [10,13,52,66,79,93] and sourcing strategy [32]. As indicated above, our aim in this study is to analyze how cloud computing reduces transaction risks associated with supply chain network collaboration and improves both economic and environmental performance.

Because TCE is driven by the central concept that actors in organizations are limited by bounded rationality, and these actors work to reduce transaction complications in an economically efficient manner,

we base our hypotheses on the TCE framework. This explains how the economic efficiency of cloud computing reduces the effects of bounded rationality through cost advantages. More specifically, we build on the components of TCE that are crucial to understanding how cloud computing increases collaboration among organizations, and balances economic and environmental performance through economic efficiency.

3. Literature review

3.1. Cloud computing

Cloud computing is a massively scalable, virtualized IT resource that can be scaled according to the type of service, payment options and privatization. The difference between cloud computing and more traditional IT, is through what is referred to as technology brokering. Technology brokering is the practice of exploiting existing technology efficiencies into one single model [32]. Cloud computing, provides the benefits of traditional in-house IT and web-based IT into one large scale utility model that provides massively scalable service and cost savings attributed to rapid deployment of information, and the reduction of expenditures on in-house data storage. Cloud computing is massively scalable in its service, payment and privatization options. Service options include the widely used software-as-a-service (SaaS) and to a lesser extent platform-as-a-service (PaaS) and infrastructure as a service (IaaS) [19]. Payment options can also be scaled to include elastic or pay-per-minute models or fixed and subscription-based pricing. Users can also choose to privatize the cloud with a select few organizational partners or use the public cloud that can be accessed by a variety of users. The scaling options of cloud computing provide various ways that organizations can tailor IT in order to fit service, payment and privatization needs of a variety of different supply chain partners. Further, the allowable hybrid strategies that cloud computing offers have been shown to outperform one service only strategies that web-based IT offers [34].

Perhaps more notable to cloud computing is the potential cost savings it offers organizations. Cloud computing is characterized by rapid deployment of information as well as reduced support infrastructure needs [37,107,114]. Rapid deployment of information refers to the capability of organizations to provide supply chain partners with real-time information in large quantities with very little processing time involved. The lack of processing time not only provides users with a fast information sharing capability, but also decreases transaction processing and potentially reduces energy expenditures by processing large amounts of data in a smaller period of time. This allows organizations to become more adaptive and agile [17]. Additionally, cloud computing allows organizations to reduce capital expenditures involved in maintaining individual data centers. Cloud computing stores and processes data with ease of access on a cloud infrastructure either managed by a user or controlled by a third party. The costs involved in organizations maintaining their own data centers far exceed that of third party management companies.

Cloud computing is currently in its infancy in supply chain management research. Some studies have eluded to various supplier relationship and performance benefits including rapid deployment and on-demand access to information [5], massively scalable services [56], and green computing potential [36]. However, the vast majority of this research is conceptual in nature. While some empirical cloud computing studies have been conducted on the adoption of cloud computing [i.e., 107], very little empirical research exists on analyzing cloud computing's implications with regard to improving collaboration and economic or environmental performance.

In this study we focus on the use and reliance on cloud computing in an organizational context. Specifically, we describe the extent of its use to conduct business transactions with supply chain partners and monitor business processes relative to industry standards and key

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