European Journal of Information Systems (2010) 19, 153–167

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Evaluating cross-organizational impacts of information technology – an empirical analysis

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Abstract

This paper documents information technology (IT) impacts that extend across organizational boundaries based on the economic theory. It evaluates how a firm's production cost is affected by the IT decisions of its business partners, over which it has no direct control. Using cross-sectional data on 100 audit engagements for the 100 largest continuing clients of a leading international public accounting firm's main office, it empirically evaluates the impact of the clients' IT choices on their supplier's (the public accounting firm's) production costs, professional allocations and product prices. The results indicate, other things being equal, that the higher intensity or complexity a client's IT exhibits, the more effort public accounting professionals need to exert, thus, the higher the production cost incurred by the public accounting firm. In contrast, the better documentation or security a client's IT furnishes, the lower the cost the public accounting firm sustains. Furthermore, such differences in production cost are eventually passed on to the client via differences in product price.

European Journal of Information Systems (2010) **19,** 153–167.
doi:10.1057/ejis.2010.9; published online 2 March 2010

Keywords: cross-organizational impacts; externalities; information technology value; translog cost function; seemingly unrelated regression; public accounting

Introduction

The use of information technology (IT) has transformed the way business is done in many industries, thus creating a virtual business environment of digital signals that mediate business activities and transactions. In addition to facilitating the production and information-sharing processes within an organization, recent trends in business and technology have focused on inter-organizational collaboration and information systems that enhance them. As a result, a new business arena for competition is the virtual value chain created by information-based linkages. The new virtual value chain expands and modifies the traditional value chain created by tangible resource-based linkages (Porter & Millar, 1985; Rayport & Sviokla, 1995). The use of IT can impact the production costs of the firm that adopts the technology as well as those of other firms with which it is collaborating and linked to its value chain. Therefore, the evaluation of IT impacts across organizational boundaries is crucial in the current network economy.

In this study, we view collaboration as 'joint effort toward achieving a mutual goal' (Chen *et al*., 2006) and broadly define cross-organizational IT collaboration as any joint inputs from different organizations toward a common goal that involves the use of information systems. In some cases, the information system involved in cross-organizational collaboration is an interorganizational system (IOS) that is mutually adopted by the related organizations. In other cases, the information system is owned by

Received: 1 April 2009
Revised: 4 October 2009
2nd Revision: 31 November 2009
3rd Revision: 6 December 2009
Accepted: 11 December 2009

only one of the organizations and is granted access to the other for the purpose and duration of the collaborative project. The prior literature has looked into the impacts of IOS on both adopting organizations (Robey *et al*., 2008). However, the way an organization's own IT can affect the organization with which it is collaborating remains an open question.

To fill the gap in literature, we explore the cross-organizational impacts of non-interorganizational IT in this study. Based on economic theory, we approach the problem by evaluating the potential externality created by a firm's IT decision. An externality emerges when the production (or consumption) decision of a firm is affected by the action of another agent, and when such an impact is not accounted for in the market. Although economists have addressed various aspects of externalities (Varian, 1992), this concept has hitherto not been applied to an empirical study of IT impacts. We evaluate IT impacts that transcend organizational boundaries in two phases. First, we investigate how a firm's production is affected by the IT decisions of the other organizations with which it does business. Next, we assess the economic outcomes of such impacts in terms of the prices of the products exchanged between the two organizations. While prior IT business value literature has focused primarily on IT impacts within organizations, our externality-based analysis of IT impact moves beyond organizational boundaries to enable a more thorough evaluation of IT value.

Our research domain is a leading international public accounting firm (hereafter referred to as the FIRM to conceal its identity). In the absence of prominent relationships with suppliers, a public accounting firm's relationships with its clients comprise the dominant external links in its value system. Therefore, we focus on how the IT used by the FIRM's clients can impact the FIRM's production. As public accounting firms play a critical role in maintaining the financial integrity of their client firms, they way IT affects their performance in discharging this function is of considerable interest to both business and academic communities. Our single-firm research design allows for greater control over organizational variables and a more in-depth examination of the issues outlined.

We examine the impact of a clients' IT decisions on their auditor's production cost for auditing service and evaluate whether the differences in prices are commensurate with differences in costs. A translog cost model and a hedonic price model are estimated to address these research questions. Our results confirm the cost and price impact of clients' IT choices in the public accounting industry. The work of public accounting professionals was significantly affected by its clients' IT decisions, and these cost impacts were fully reflected in the prices they charged for the engagements. Therefore, the clients must be aware of this indirect linkage between their IT choices and the fees they pay for audit engagements. The results provide implications for firms that choose to outsource some of their operations to other companies. The outsourcers should recognize that their IT settings may influence the work of the outsourcees and the prices of the outsourced projects.

The remainder of this paper is organized as follows. Theoretical Foundation section reviews the research literature on IT impacts and related economic analysis. Research Background and Hypotheses section describes the research site and develops the research hypotheses. Empirical Analysis section presents the data and empirical model. Estimation Results section describes the estimation results. Conclusion and Implications section provides concluding remarks and research implications.

Theoretical foundation

Externalities

An externality emerges when 'the decision variable of one economic agent enters into the utility function or production function of another', and 'the private economy lacks sufficient incentives to create a potential market in some good and the nonexistence of markets results in losses in Pareto efficiency' (Heller & Starrett, 1976). In short, externalities occur when interdependencies are unaccounted for by existing market mechanisms. In the context of accounting, the existence of externalities in financial reporting has been studied extensively and referred to as intra-industry information transfer (Foster, 1980). That is, the timing and content of one firm's announcement may lead to abnormal changes in share prices or trading volumes of its industry competitors. A great number of studies have examined how a firm's decision on information release enters into another firm's (usually a competitor) capital asset pricing model (e.g., Foster, 1981; Han & Wild, 1990; Kim *et al*., 2008; Thomas & Zhang, 2008). Similarly, in the context of information systems and public accounting, we investigate how a firm's IT decision can enter into its auditor's production function. Using a sample collected from the public accounting industry, we first examine whether the IT decisions of an audit client significantly impact the auditor's production cost and resource allocation. Further, considering the cost impact, we examine whether the price of a client engagement changes in accordance with what is predicted by economic analysis.

IT and firm production performance

Numerous studies in the past few decades have examined how a firm's IT investment impacts its own production performance. Recent studies following Brynjolfsson (1993) have documented the positive impact of IT on firm performance. Based on production economics theory, one important stream of IT research considers a firm's IT capital as a production factor and empirically demonstrates that a firm's IT makes a positive contribution to the firm's production output (revenue) (e.g., Brynjolfsson & Yang, 1996; Dewan & Min, 1997; Kudyba & Diwan, 2002). Another stream of literature empirically

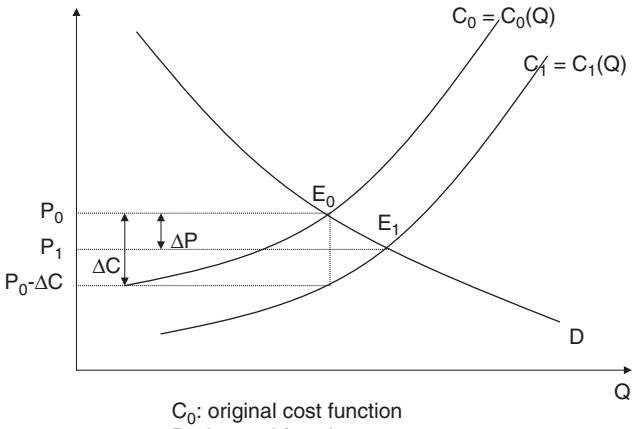
documents a positive relationship between a firm's IT investment and financial performance measures such as profitability (Hitt & Brynjolfsson, 1996; Sircar *et al*., 2000) or market value (Bharadwaj *et al*., 1999).

Some studies also found that a firm's IT investments can lead to cost savings for the firm. For example, Alpar & Kim (1990) identified a negative relationship between a bank's IT spending and its total operating costs. Banker *et al*. (1990) demonstrated that restaurants deploying cash register point-of-sale and order-coordination technology are more cost efficient than those without such technology. Pennings's (1995) study of 107 banks found that banks with a certain computer hardware/software configuration incurred less operating expenses. Lucas *et al*. (1996) conducted a case study of the introduction of a financial imaging system in Merrill Lynch and found cost reduction benefits from the new application. Lee & Menon (2000) also found that hospitals with greater IT investment intensity have incurred less operating costs. Overall, these studies demonstrated that IT investment in a firm helps reduce its own production cost.

Prior research documented that adoption of IOS such as electronic data interexchange (EDI) and supply chain management systems can be beneficial for both upstream and downstream firms. The study by Mukhopadhyay *et al*. (1995) indicated that the EDI program that Chrysler used with its suppliers led to cost reductions of $100.89 per vehicle in inventory, document handling and transportation. Clark & Stoddard's (1996) survey showed that a grocery retailer's adoption of EDI technology in relation to suppliers, especially combined with a continuous replenishment process, could dramatically improve its inventory management efficiency. Subramani (2004) demonstrated the suppliers' benefits of participating in the supply chain management network initiated by other network leaders. Ko *et al*. (2009) noted that electronic cooperation and information exploitation capability enabled by IOS foster improved firm performance. Even though the IOSs examined in previous studies traverse organizational boundaries, their adoptions are joint decisions by both of the related parties. Thus, prior findings have documented only the direct impacts of a firm's IT decisions. To the best of our knowledge, the impact of a firm's unilateral IT decision on its suppliers or customers has not yet been examined empirically. This research will address the issue by evaluating how a public accounting firm's production function and costs are impacted and altered by its clients' IT decisions.

Market mechanisms

If a firm's production function is impacted by the IT choices of its customers (or suppliers), then its unit production cost is likely to be altered. Consequently, the change in its production may lead to a shift in its supply (or demand) function, thus resulting in a different equilibrium price and quantity. Depending on the competitive nature of the market and characteristics of the demand and supply functions, the change in the equilibrium price may be different from the change in the production cost. In general, the burden of a cost increase (or the benefit of a cost decrease) is shared between the supplier and customer, depending on the relative elasticities of their supply and demand functions. Figure 1 illustrates a common case in which the supply function is shifted downward by reduced production cost ΔC and leads to a new equilibrium price P_1. The change in the equilibrium price, ΔP, is less than the change in the production cost, ΔC. In the next section, we discuss the supply and demand functions for the market of audit engagement and identify the relationship between ΔC and ΔP.



C_0: original cost function
D: demand function
E_0: original equilibrium
P_0: original equilibrium price
ΔC: change in unit cost
C_1: new cost function
E_1: new equilibrium
P_0: new equilibrium price
ΔP: change in equilibrium price

Figure 1 Relation between change in cost and change in price (general case).

Research background and hypotheses

Research site

Our research site was chosen carefully based on firm characteristics that were pertinent to our research objectives. The FIRM is a Big Four public accounting firm. As an industry leader, its business practices and IT strategy are akin to those of other large accounting firms in the market. For a public accounting firm, a major potential source of IT externalities is its clients' IT choices experienced through the performance of audit engagement. The FIRM has realized the impact of the IT programs adopted by its clients on its auditing production process. Accordingly, it developed a training course to introduce its audit professionals to recent trends in its clients' IT environments (e.g., enterprise resource planning (ERP), workflow management, intranet, extranet

and electronic commerce) and how those trends would affect auditing tasks.

With access to the FIRM's senior management, we obtained confidential data, both qualitative and quantitative, for our analysis. To collect qualitative information, we conducted individual interviews sessions with the FIRM's professionals to understand their production and billing processes, and to explore how a client's IT environment impacts their work. To gather quantitative data, we obtained data from the FIRM's accounting and services records to measure its production cost and price for each audit engagement. We also distributed a questionnaire to obtain measurements of clients' IT and financial characteristics.

Research hypotheses

The audit service provided by public accounting firm is an information-intensive process that gathers and evaluates evidence regarding assertions about clients' economic activities and related events (Messier, 1997, p. 8). Therefore, to work efficiently, the FIRM's professionals should consider how their clients process accounting information (AICPA, 1984, p. 2). Since firms today have adopted thousands of IT applications, we first sort the IT applications by shared characteristics. Our identification of IT characteristics was informed by a number of Statements on Auditing Standard issued by the American Institute of Certified Public Accountants (AICPA). First, 'the extent to which computer processing is used in significant accounting applications, as well as the complexity of that processing, may also influence the nature, timing and extent of audit procedures (AICPA, 1984, p. 2)'. That is, the intensity and complexity of computer processing applied at the client site can have a significant impact on audit procedures. Second, when computerized systems are utilized, 'the auditor should obtain evidential matter about the effectiveness of both the design and operation of controls to reduce the assessed level of control risk (AICPA, 2001, p. 1)'. Therefore, whether a client's IT provides auditable and properly controlled systems may affect the audit professionals' work. In addition, better IT personnel at the client site can provide direct support to the auditor's IT-related questions and enhance the performance of information systems related to audit process (DeLone, 1988; Montazemi, 1988; Choe, 1996).

In summary, we conclude four client characteristics that may impact the audit professionals' tasks:

- *IT intensity* refers to the proportion of the client's business processes that are computerized. It should be easier for the professionals to access related information when a business function is computerized, as the data is only a few clicks away (Wilkinson *et al*., 2000). However, online real-time applications and integrated information systems are likely to increase the difficulty of the audit task and lead to a higher risk in assuring the integrity of information. In addition, transactions may be authorized by controls embedded in computer programs that are difficult for the audit professionals to verify (Messier, 1997, p. 229). It has been found that inadequate controls are more frequently associated with potential financial misstatements in computerized systems than manual systems (Bell *et al*., 1998).
- *IT complexity* considers the complexity level of the computerized processes. An information system can be complex for auditing purposes in various ways. Its interface and functionality can be complex when they are not standard package software. The control points can be complex when the system is connected to another entity. The data can be complex when the number of transactions is high. Since a high level of IT complexity increases the audit task complexity, it may also diminish the auditors' judgment performance (Bonner, 1994).
- *IT assurance* is the level of assurance provided by the design, scope and processes of the client's computer systems. The assurance level can be increased by superior systems documentation and security. Good systems documentation may allow the professionals to understand the computer system quickly and determine the required work process easily (Moscove *et al*., 1997). For example, operating manuals can provide instructions for systems operation and data access. Data flow diagrams depict system interactions involving inputs, outputs and the underlying processes. Also, a high level of systems security (data and transactions security) reduces the possibility of fraud.
- *IT support* reflects the level of support provided by the client's IT personnel. The IT personnel at the client site can impact the professionals' work in two ways. First, they can provide direct support for the professionals' questions regarding the systems. Second, they can facilitate the audit process indirectly by providing high quality maintenance of the computer systems. A high level of IT support saves the professionals the time they spend on understanding and solving problems, and makes it easier for them to perform their tasks.

Audit cost impact of IT characteristics In a public accounting firm, each audit engagement is performed by a team composed of two categories of professionals with different responsibilities: managers are the supervisors, chief planners and final reviewers of engagements; staff are the subordinates who execute the plans, perform audit procedures and prepare working papers. The effort required for each category to accomplish an engagement depends on the client's IT and other characteristics. Since a public accounting firm's production decision is to optimally assign its managers and staff for each engagement (O'Keefe *et al*., 1994), the production cost of an engagement is determined by the number of input hours accrued by the two professional categories multiplied by their corresponding wage rates. Therefore, the total

production cost of an engagement can be divided into cost shares of managers and staff. As managers and staff have different job responsibilities, changes in some IT characteristics of the client may impact their tasks differently and require changes in their work hours to different extents, which can lead to changes in cost shares as well as total cost. On the other hand, changes in other IT characteristics may require changes in their work hours proportionally and therefore, total cost for an engagement may change with cost shares remaining constant.

We will examine the cost impact of client IT characteristics by means of total production cost and cost share. The related hypotheses are discussed as follows:

(1) IT intensity

For a client with high IT intensity, financial data and other information are transmitted with electronic records. Controls points for transaction authorization are also embedded in computer programs. In the absence of traditional paper trails and control points, higher risk is induced for professionals to assure the integrity of information (Bell *et al.*, 1998; Helms & Mancino, 1998). To alleviate this higher risk, the team needs to exert more effort to understand and review the client's IT and make careful decisions trading off risk and effort (Tucker, 2001). Since managers are responsible for planning and reviewing, the decision-making in assuring information from highly computerized systems imposes a relatively greater workload on the managers compared to that on the staff. In the FIRM, several managers agreed that performing audit engagements with clients who implemented fully integrated ERP systems required longer work hours than clients with unintegrated, functional IT applications. One manager explained:

> Successful implementation of ERP in a company can improve its production efficiency and provide accurate and real-time information to facilitate managerial decision-making. However, it does not necessarily facilitate the auditor's work procedures. An ERP system is very large, with numerous processes and controls embedded. It emphasizes on online operations and paperless procedures, and that challenges the traditional audit approach. The traditional paper trails we used to rely on for audit decision do not exist with ERP applications. Instead, we need to follow the operating procedures behind ERP to reconstruct the required audit trails, which takes lots of effort and knowledge about the system.

On the other hand, working with a client with a high level of IT intensity may potentially enhance the timeliness, availability and accuracy of information, which facilitate the staff's task in information gathering (Tucker, 2001).

Overall, we expect that a higher level of IT intensity will increase the managers' work hours due to new risk exposures. However, high level of IT intensity may make relatively no impact on the staff's work hours since its two opposite effects (increasing hours for risk alleviation and decreasing hours for easy information access) cancel out. Therefore, the proportion of manager cost in the total audit cost (managers' cost share) may increase and the proportion of staff cost in the total production cost (staff's cost share) may decrease. We also expect the total production cost will increase due to the increase in the managers' work hours. We hypothesize:

H1a: Ceteris paribus, *the higher the level of a client's IT intensity, the higher is the managers' cost share for the audit and the lower is the staff's cost share.*

H1b: Ceteris paribus, *the higher the level of a client's IT intensity, the higher is the total production cost for the client's engagement.*

(2) IT complexity

Increased complexity of a client's computerized information systems can increase the number and ambiguity of the information cues the professionals need to process in their tasks and increase audit complexity. The level of audit complexity is negatively associated with professionals' performance in risk evaluation (Bonner, 1994). When a client's IT is very complex, the staff in the audit team needs to spend more time on understanding and performing related audit procedures and the managers need to plan more carefully. The following two statements from our field interviews reveal the impact of IT complexity on audit professionals' work:

> *A staff*: Sometimes I found it difficult to work with clients who had not adopted standard software package solutions. Their computer systems were customized to better fit their business requirements, but with unique interface, functions and procedures that are tough for an external person to understand. I also found it difficult to work with clients with extensive data exchanges among their business units or branches. It always takes me a long time to trace the information flow and conduct substantive tests on those transactions.
>
> *A manager:* I always pay more attention to clients with heavy network activities within and outside their organizations. Intra-organizational networking increases the vulnerability of computer systems and implies a decentralized decision making style. Consequently, I need to evaluate the client's internal controls more carefully. Similarly, inter-organizational networking activities require more attention to reduce potential risk. In addition, new business models and transactional types enabled by e-commerce are challenging to external auditors.

Therefore, the presence of high IT complexity is likely to require audit managers and staff to increase their effort proportionally. As a result, the total production cost for an engagement will increase without changes in the cost shares. We posit:

H2a: Ceteris paribus, *the level of a client's IT complexity is not significantly associated with the cost share of either managers or staff.*

H2b: Ceteris paribus, *the higher the level of a client's IT complexity, the higher is the total production cost for the client's engagement.*

(3) IT assurance

The assurance level of information systems can be enhanced by extensive systems documentation and security. Complete and clear systems documentation enables the FIRM's professionals to understand the computer systems quickly and determine the required audit processes easily (Moscove *et al*., 1997). A manager expressed:

> Documentation is a vital part of all kinds of information systems. Good documentation provides us the required understanding of the system for appropriate auditing and saves time. However, in my work experience, not many organizations have paid attention to this.

Also, a high level of data and transactions security implies lower risk of fraud.

Another audit manager described his viewpoints:

> When I meet with the client's key personnel, I always ask them about their security policy and planning to get an idea about how much effort the company has taken to ensure the security of its programs, files and data. A high level of security usually implies low control risk, and consequently eases our work.

Overall, we expect that the required effort of managers and staff for an engagement to be reduced when the client's IT is provided with better assurance. Consequently, an increase in IT assurance may result in a proportional decrease in the costs of the two professional categories, thus not affecting their cost shares. We hypothesize:

H3a: Ceteris paribus, *the level of a client's IT assurance is not significantly associated with the cost shares of either managers or staff.*

H3b: Ceteris paribus, *the higher the level of a client's IT assurance, the lower is the total production cost for the client's engagement.*

(4) IT support

Many studies have documented that strong IT personnel support can improve the performance of accounting information systems (DeLone, 1988; Montazemi, 1988; Choe, 1996) and reduce the frequency of potential financial misstatements (Bell *et al*., 1998). As the audit staff work directly with the client's information systems, good support from the client's IT professionals may reduce their work. Also, when there are more IT personnel to maintain the client's systems, the staff may find it easier to perform the detailed tests of the systems. In the words of a staff:

> Other than the accounting and internal control personnel, I have the most frequent contacts with the computer personnel at the client site. These computer professionals are like the live help files for the client's computer systems. They help me get acquainted with the functions and operations of the systems. They also help me extract the information and data I need from the systems.

Since the audit managers do not have much chance to work directly with the clients' information systems, a high level of IT support at the client site may reduce effort of the staff but make relatively no difference on that of managers. We expect the staff's cost share to decrease, and consequently, managers' cost share to increase to balance the decrease in the staff's share. We posit:

H4a: Ceteris paribus, *the greater a client's IT support, the higher is the managers' cost share and the lower is the staff's cost share.*

More IT professionals at the client may also imply that the client's information systems function better. Therefore, we expect that better IT support leads to substantial cost reduction for staff and hypothesize:

H4b: Ceteris paribus, *the higher the level of a client's IT support, the lower is the total production cost for the client's engagement.*

Relation between cost impact and price impact If the client's IT characteristics make an influence on the FIRM's production cost, we next examine whether the change in the cost is reflected in a commensurate change in the price as suggested by economic theory. The demand for audit services by large companies is relatively inelastic with respect to price because they are either statutorily required or have strong economic incentives to be audited by a public accounting firm (Wallace, 1980). In contrast, the supply of audit services is relatively elastic for a large public accounting firm since its total staffing level is quite flexible at the margin. That is, in such market conditions with relatively inelastic demand and relatively elastic supply, the supplier can adjust the price of the offering to fully reflect the change in the production cost, provided it is aware of the full extent of the cost change. The relation between the cost and price changes in the audit market is depicted in Figure 2, showing that the increase in production cost, ΔC, is similar to that in equilibrium price, ΔP.

The FIRM maintains a work hour information system to record the number of hours its professionals (at different levels) input for each client. Interviews with its senior management indicate that the fee charged for each engagement is based on the professional cost incurred for the engagement in the past year. At the beginning of each fiscal year, the FIRM estimates its audit cost with each existing client based on its prior experience auditing that client and the changes in the client's financial characteristics over the past year.

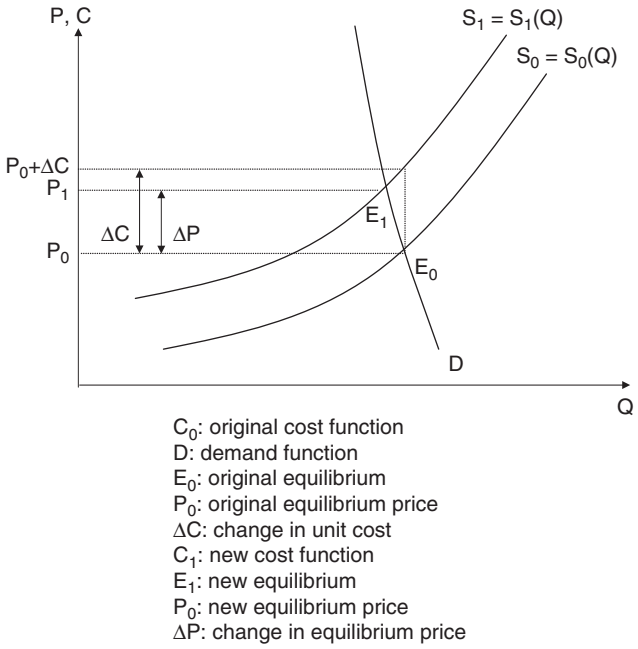


Figure 2 Relation between change in cost and change in price (with inelastic demand function and elastic supply function).

Accordingly, the FIRM negotiates with each client a fixed price for the engagement to be performed in the following year. During the fiscal year, the FIRM may negotiate an additional fee with the client when it finds its actual audit cost for the audit will substantially exceed the pre-estimated audit cost. However, as a partner pointed out:

> We keep close track of our professional cost for each assignment. And our cost estimation based on previous records is quite accurate. Its deviation from the actual cost is usually very small, within an acceptable range.

The FIRM monitors the overall cost for each client, even though it does not estimate the marginal cost impact of each of the client's IT characteristics. Therefore, we expect that when the FIRM adjusts the audit price to fully reflect its estimated cost changes, it implicitly covers the cost changes resulted from the client's IT characteristics. In addition, since the FIRM's competitors possess similar technology and professional experience to audit their clients' information systems, we do not expect the FIRM to be able to charge a price premium for its audit services in this competitive market (Simunic, 1980). That is, the change in the FIRM's fee charge will reflect no more than the cost changes influenced by its client's IT characteristics. Overall, we expect:

H5: *A client's IT characteristics (IT intensity, IT complexity, IT assurance, IT support) generate similar impacts on the price of the client's engagement as on the production cost of the engagement.*

Empirical analysis

Data description

Our sample includes data regarding 100 audit engagements for the largest 100 continuing clients of the FIRM's main office in the same fiscal year. We focus on engagements for large clients because they are the FIRM's major sources of revenue. The FIRM's senior management is interested in learning how the clients' IT characteristics can impact audit costs and prices. The FIRM identified the largest clients based on total assets, audit fee and potential business value. The prior auditing literature has found that accounting firms tend to offer price discounts for new clients to attract more clients (Simon & Francis, 1988), but they usually need to spend more time on new clients due to learning requirements (O'Keefe *et al.*, 1994). Therefore, to avoid this new client effect in our research design, we limited our sample to the FIRM's continuing clients (i.e., the FIRM had performed the audit engagements for these clients for the previous fiscal year as well). Since the regression model we plan to estimate includes 11 predictors, a minimum sample size of 59 is needed with a large effect size at 0.35 (Cohen, 1988) and level of significance at 0.05 to obtain a power of 0.8. Therefore, a sample size of 100 is sufficient to validate the model. Using data from an office enables better control for differences in organizational characteristics such as the production technology and work style that may affect audit production. Since no empirical study has evaluated IT impacts from the standpoint of externalities, this study provides a groundbreaking case (Yin, 1984, p. 43), which analyzes IT impacts beyond organization boundaries. The single case study also allows for qualitative information gathered from field interviews to ensure that our research questions (discussed in the next subsection) were relevant to practice and fit the FIRM's organizational settings (Benbasat *et al.*, 1987). On the other hand, such a case study limits the generalizability of our results, which will be discussed in the last section.

To measure the cost of each engagement, we collected data on the FIRM's actual work hours input by audit managers (*MGRHRS*) and staff (*STAFFHRS*), as well as its wage rates for the three labor categories (*MGRRATE*, *SNRRATE* and *JNRRATE*). We also gathered its actual fee charged (*PRICE*) for each engagement. According to our discussions with the FIRM's professionals, we designed a questionnaire to collect information on the client's IT intensity, complexity and assurance. A pilot test was conducted with one of the managers to evaluate the viability of an initial draft of the questionnaire. The questions were modified based on the feedback from the pilot test to insure greater clarity. Since the FIRM maintains detailed internal documentation for each large client's IT profiles to facilitate the work of its professionals, the managers were advised to respond to the questionnaires by referring to that documentation rather than relying only on memory alone. Since the

100 engagements in our data set were performed by nine different teams in the FIRM, nine managers have participated in the survey.

The 11 items included in the questionnaire are listed in Table 1. The first four items are intended to measure the construct of IT intensity. They measure the proportion of the business functions that is computerized at the client site and whether the computerized components are integrated. The next four items measure the construct of IT complexity. They assess the system complexity in user interface, system functionality, information load and related entities. The last three items measure the construct of IT assurance. They include aspects such as the client's presence on the Web, and the managers' evaluation of the systems documentation and security at the client's location. In addition, we constructed the variable *ITSUPPORT* as the number of IT professionals divided by the number of computer users at the client site.

To ensure internal validity of our model, we control for other factors that may affect audit costs and prices. A stream of accounting literature has documented the impacts of clients' non-IT business characteristics on audit production (Simunic, 1980; Palmrose, 1986; O'Keefe *et al*., 1994; Ferguson & Stokes, 2002). Therefore, we include these previously identified characteristics in our model to control for their effects. These control variables include *ASSETS* (client's total assets), *PUBLIC* (coded 1 if client's shares are publicly traded, and 0 otherwise), *BUSRISK* (client's inventory plus receivables normalized by total assets) and *SUBSIDIARIES* (square root of number of the client's subsidiaries), as well as *SPECIALTY* (coded 1 if client's industry is the FIRM's specialty, and 0 otherwise) for the impact of the client's industry. Since our sample includes engagements in the same year, we do not need to control for the impact of market trends over time.

Measuring clients' IT characteristics

We performed confirmatory factor analysis (CFA) on the 11 questionnaire items to validate the grouping of the items using LISREL 8.52. Before conducting the analysis, all items were rescaled to a range of between 0 and 1 for mutual consistency. Since the observed variables of the 11 items are of mixed of scale types (*ECOMMERCE* and *WEBSITE* are dichotomous variables while the rest are on an interval scale), a polychoric correlation matrix of the variables was input for the factor analysis (Bollen, 1989, pp. 441–445). The results of our initial analysis suggested that *INTERNET* and *WEBSITE* were not good indicators of their corresponding factors, IT intensity and IT assurance, due to their low (less than 0.4) standardized factor loadings. Consequently, we dropped the two items in our remaining analysis. The elimination of *WEBSITE* resulted in only two items for the IT assurance factor. However, a factor represented by only two indicators is not recommended because of frequent problems with identification and convergence (Anderson & Gerbing, 1988). Our analysis also found that the *ITASSURANCE* factor exhibited weak association with the *DOCUMENTATION* item (factor loading = 0.30) when assessed with only two indicators. The correlation between *DOCUMENTATION* and *SECURITY* was as low as 0.20 and was statistically insignificant. Therefore, *DOCUMENTATION* and *SECURITY* may measure two different dimensions of IT assurance. Therefore, we decided to retain the two observed items as two separate variables, *ITDOCUMENTATION* and *ITSECURITY*, in our final model.

We performed CFA once again on the remaining seven items to validate and construct IT intensity (to be measured by *COMPUTERIZATION*, *INTEGRATION* and *ERP*) and IT complexity (to be measured by *CUSTOMIZATION*, *DATASERVERS, NETWORK* and *ECOMMERCE*) variables. The results of our final CFA are summarized in Table 2. The ratio of chi-square to the degrees of freedom falls in the acceptable range of between 2 and 5 (March & Hocevar, 1985). Both the goodness-of-fit index and the adjusted goodness-of-fit index are higher than 0.90 and 0.80, respectively (Joreskog & Sorbom, 1989, pp. 122–123). Therefore, the final model demonstrates reasonable fit to the data set.

To ensure each of the items measures what it was intended to measure, we examined the convergent and discriminant validity of the measures. Since all of the factor loadings for the items (shown in the right-most column of Table 2) are significant at the 0.1% level ($t > 3.29$), the items are effectively measuring their corresponding constructs and convergent validity is supported (Anderson & Gerbing, 1988). In contrast, discriminant validity of these measures is confirmed by a chi-square difference test (Bagozzi & Phillips, 1982), which is summarized in Table 3. Our final model is considered as a standard measurement model, in which the two factors (IT intensity and IT complexity) are allowed to correlate without restriction. We imposed a unidimensional model (similar to our final model except that the correlation between the two factors is fixed at 1) on the seven items and obtained its chi-square value. The difference in the chi-squares of the two models is significant at the 0.1% level. Therefore, the items in our model do not measure the construct they were not designed to measure, indicating discriminant validity. In addition, Cronbach's alpha coefficients of the two factors are both greater than 0.60 (0.71 and 0.65 for IT intensity and IT complexity, respectively), thus demonstrating an acceptable level of reliability (Nunnally, 1978).

Based on the CFA results, we constructed two variables for each client that correspond to the IT intensity and IT complexity for subsequent analysis. *ITINTENSITY* represents the extent to which the business functions in a company are processed by online computer applications and the extent to which those applications are linked together. *ITCOMPLEXITY* represents the complexity in applications, network scope, inter-organization activity and server load. We utilize two separate variables, *ITDOCUMENTATION* and *ITSECURITY*, to measure two

Table 1 Survey item definitions

Item	*Name and description*	*Scale and anchor points*
1	*COMPUTERIZATION* Proportion of business functions that utilize computer systems	10 = all of the *major business functions*[a] utilize *online*[b] computerized information systems 5 = half of the major business functions utilize online computerized information systems 0 = none of the major business functions utilize computerized information systems
2	*INTEGRATION* Proportion of computerized information systems that are integrated	10 = the computerized information systems for all of the business functions are integrated online 5 = the computerized information systems for half of the business functions are integrated online 0 = none of the computerized information systems for the business functions are integrated
3	*ERP* Proportion of business functions that utilize enterprise resource planning (ERP) software	10 = all of the major business functions utilize ERP software 5 = half of the major business functions utilize ERP software 0 = no ERP software is used in the company
4	*INTERNET* Internet access for headquarters computer users	10 = all of the computer users in the headquarters have internet access 5 = half of the computer users in the headquarters have internet access 0 = none of the computer users in the headquarters have internet access
5	*CUSTOMIZATION* Proportion of computerized information systems that are customized	10 = the computerized information systems for all of the business functions are *custom developed*[c] 5 = the computerized information systems for half of the business functions are custom developed 0 = none of the computerized information systems are custom developed
6	*DATASERVERS* Size of data servers	10 = all of the major applications/data servers are mainframe computers 5 = all of the major applications/data servers are minicomputers 0 = there are neither mainframe nor minicomputers
7	*NETWORK* Network connectivity between the headquarter and branches	10 = the headquarter is connected with all branches and all branches are connected with each other 5 = the headquarter is connected with all branches 0 = there is no network connection between the headquarter and the branches
8	*ECOMMERCE* Whether the client engages with electronic commerce activities	1 = Yes 0 = No
9	*DOCUMENTATION* Auditor's rating of the completeness of IT documentation	10 = the completeness of the documentation for the computerized information systems is perfect 6 = the completeness of the documentation for the computerized information systems is good 0 = there is no documentation for the computerized information systems
10	*SECURITY* Auditor's rating of the security awareness of key users	10 = the users are very conscious about systems security 6 = the users are reasonably conscious about systems security 0 = the users do not pay attention to systems security at all
11	*WEBSITE* Whether the client has an official website	1 = Yes 0 = No

[a]There are four major business functions: finance (including general ledger, receivables and payables etc.), distribution (including sales orders, invoices, customer relationships etc.), manufacturing (including inventory management, purchase management, production management etc.) and human resource (including payroll, work hours etc.).

[b]Half the score should be assigned if a batched computer system is used instead of an online real-time system.

[c]A custom-developed system is defined as a system that is completely designed and developed (in-house or outsourced) for the specific company. It does not include a system that is modified from a package software.

Items 1–7 and 9–10 above are scored on a 0–10 point scale.

Additional instructions about the italicized terms are provided following this table.

Table 2 Results of confirmatory factor analysis

Construct	*Observed item*	*Initial model*	*Final model*
		Standardized loading (t-statistic)	*Standardized loading (t-statistic)*
IT intensity	*COMPUTERIZATION*	0.7415 (4.60*)	0.7117 (4.91*)
	INTEGRATION	0.7879 (4.47*)	0.7849 (4.27*)
	ERP	0.4687 (4.67*)	0.5357 (4.28*)
	INTERNET	0.2367 (2.63)	—
IT Complexity	*CUSTOMIZATION*	0.4175 (4.87*)	0.4690 (4.37*)
	DATASERVERS	0.5654 (6.20*)	0.6390 (5.18*)
	NETWORK	0.5065 (5.82*)	0.5355 (5.04*)
	ECOMMERCE	0.7841 (8.23*)	0.6497 (5.02*)
IT Assurance	*SECURITY*	0.5970 (5.73*)	Viewed as an individual variable
	WEBSITE	0.3291 (3.14*)	—
	DOCUMENTATION	0.4505 (3.92*)	Viewed as an individual variable
Goodness of fit measures			
Chi-square (df)		182.97 (41)	53.14 (13)
Chi-square/df		4.46	4.08
Goodness-of-fit index		0.84	0.91
Adjusted goodness-of-fit index		0.75	0.81

Sample size = 100.
*indicates statistical significance at 0.1% level.

distinct aspects of IT assurance. Together with the *ITSUPPORT* variable, we include five variables to measure the clients' IT characteristics in our estimation model.

Estimation model

Since the cost for each client's engagement is determined by the client's IT and business characteristics, and comprises two professional categories, we specify the following translog cost equation:

$$\begin{aligned}\ln COST = {} & \beta_0 + \alpha_1 \ln ASSETS + \frac{1}{2}\alpha_2 (\ln ASSETS)^2 \\ & + \sum_{i=1}^{2} \lambda_i \ln ASSETS \ln WAGERATE_i \\ & + \sum_{i=1}^{2} \delta_i \ln WAGERATE_i + \frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2} \delta_{ij} \\ & \ln WAGERATE_i \ln WAGERATE_j \\ & + \sum_{k=1}^{5} \beta_k ITCHAR_k + \sum_{k=1}^{5}\sum_{i=1}^{2} \\ & \beta_{ki} ITCHAR_k \ln WAGERATE_i \\ & + \sum_{s=1}^{3} \gamma_s BUSCHAR_s + \sum_{s=1}^{3}\sum_{i=1}^{2} \\ & \gamma_{si} BUSCHAR_s \ln WAGERATE_i + \varepsilon,\end{aligned} \tag{1}$$

where $WAGERATE_i$ = *MGRRATE*, *STAFFRATE*; $ITCHAR_k$ = *ITINTENSITY*, *ITCOMPLEXITY*, *ITDOCUMENTATION*, *ITSECURITY*, *ITSUPPORT*; $BUSCHAR_s$ = *PUBLIC*, *BUSRISK*, *SUBSIDIARIES*; $TOTALCOST = MGRHRS \times MGRRATE + STAFFHRS \times JNRRATE$.

Client size has been identified as the major determinant of the amount of purchased audit services for an audit engagement (Palmrose, 1986). Therefore, we use client's total assets (*ASSETS*) as the output measure for audit services produced for a client. The cost equation represents the minimal cost for an engagement given a combination of input prices ($WAGERATE_i$), output level (*ASSETS*) and client characteristics ($ITCHAR_k$, $BUSCHAR_s$). Since the FIRM will optimally assign its auditors to each client audit given the relative wages of each professional level, the work hours for the audit managers and staff should be endogenous to the model. To incorporate the endogeneity of these variables, we employ Shephard's lemma (Shephard, 1970) to derive the following two cost share equations:

$$\begin{aligned}COSTSHARE_i = {} & \delta_i + \sum_{j=1}^{2} \delta_{ij} \ln WAGERATE_j \\ & + \sum_{k=1}^{5} \beta_{ki} ITCHAR_k + \lambda_i \ln ASSETS \\ & + \sum_{s=1}^{3} \gamma_{si} BUSCHAR_s + \varepsilon,\end{aligned} \tag{2}$$

where $COSTSHARE_i$ = *MGRSHARE*, *STAFFSHARE*; *MGRSHARE* = (*MGRHRS* × *MGRRATE*)/*TOTALCOST*; *STAFFSHARE* = (*STAFFHRS* × *STAFFRATE*)/*TOTALCOST*.

For empirical estimation, it is important to include the cost share equations embedded in the optimal decision of

Table 3 Chi-square difference test for determinant validity

	Factor	*Item*	*Correlation between factors*	*Chi-square (df)*	*Test statistic*
Standard measurement model	IT Intensity	*COMPUTERIZATION* *INTEGRATION* *ERP*	Unrestricted, estimated as 0.37	53.14 (13)	(119.73–53.14)/(14–13) = 66.59*
	IT Complexity	*CUSTOMIZATION* *DATASERVERS* *NETWORK* *ECOMMERCE*			
Unidimensional model	IT Intensity	*COMPUTERIZATION* *INTEGRATION* *ERP*	Fixed at 1	119.73 (14)	
	IT Complexity	*CUSTOMIZATION* *DATASERVERS* *NETWORK* *ECOMMERCE*			

*indicates statistical significance at 0.1% level.

input mix under different input prices in the model to prevent from information loss (Walters, 1963). Since the cost shares sum to one, only one of the two cost share equations is used for estimation to avoid a singular disturbance covariance matrix. Since the professional wage rate information we obtained is the average of our research site, $WAGERATE_1$ and $WAGERATE_1$ are constant across clients in our model. As a result, the total cost and the cost share equations can be presented in a reduced form. In addition to the cost model, we specify a price equation to relate the logarithm of the audit fee to the client's IT and business characteristics. The system of three equations for empirical estimation is specified as follows:

$$\begin{aligned}\ln PRICE = {} & \rho_0 + \rho_1 ITINTENSITY \\ & + \rho_2 ITCOMPLEXITY \\ & + \rho_3 ITDOCUMENTATION \\ & + \rho_5 ITSECURITY \\ & + \rho_6 ITSUPPORT + \rho_7 \ln ASSETS \\ & + \frac{1}{2}\rho_8 (\ln ASSETS)^2 + \rho_9 PUBLIC \\ & + \rho_{10} BUSRISK + \rho_{11} SUBSIDIARIES \\ & + \rho_{12} SPECIALTY + \varepsilon_1,\end{aligned} \tag{3}$$

$$\begin{aligned}\ln TOTALCOST = {} & \rho_0 + \beta_1' ITINTENSITY \\ & + \beta_2' ITCOMPLEXITY \\ & + \beta_3' ITDOCUMENTATION \\ & + \beta_4' ITSECURITY \\ & \times \beta_5' ITSUPPORT + \alpha_1' \ln ASSETS \\ & + \frac{1}{2}\alpha_2 (\ln ASSETS)^2 \\ & + \gamma_1' PUBLIC + \gamma_2' BUSRISK \\ & + \gamma_3' SUBSIDIARIES \\ & + \gamma_4' SPECIALTY + \varepsilon_2,\end{aligned} \tag{4}$$

$$\begin{aligned}MGRSHARE = {} & \delta_1' + \beta_{11} ITINTENSITY \\ & + \beta_{21} ITCOMPLEXITY \\ & + \beta_{31} ITDOCUMENTATION \\ & + \beta_{41} ITSECURITY \\ & \times \beta_{51} ITSUPPORT + \lambda_1 \ln ASSETS \\ & + \gamma_{11} PUBLIC + \gamma_{21} BUSRISK \\ & + \gamma_{31} SUBSIDIARIES \\ & + \gamma_{41} SPECIALTY + \varepsilon_3,\end{aligned} \tag{5}$$

where $PRICE$ = Fee charged for the engagement

$$\alpha_1' = \alpha_1 + \sum_{i=1}^{2} \lambda_i \ln WAGERATE_i,$$

$$\beta_k' = \beta_k + \sum_{i=1}^{2} \beta_{ki} \ln WAGERATE_i,$$

$$\gamma_s' = \gamma_s + \sum_{i=1}^{2} \gamma_{si} \ln WAGERATE_i,$$

$$\delta_i' = \delta_i + \sum_{j=1}^{2} \delta_{ij} \ln WAGERATE_j.$$

The model allows us to examine the impact of the client's IT characteristics on the FIRM's production costs, product prices and the optimal allocation of different professional resources. The error terms of the three equations are likely to be correlated, as they relate to the same engagement. Consequently, we employed seemingly unrelated regression (SUR) to obtain consistent and efficient estimation for the system of three equations (Zellner, 1962). The SUR estimation results are summarized in Table 4. The effect size for the overall system of equations is estimated by the computation of the system weighted R-square as 0.49 (Warner, 2007).

Table 4 SUR estimation results

Explanatory variables	*Dependent variables*					
	lnPRICE		*lnCOST*		*MGRSHARE*	
	Predicted sign	*Estimated coefficient*	*Predicted sign*	*Estimated coefficient*	*Predicted sign*	*Estimated coefficient*
ITINTENSITY	+	0.3750 (2.08**)	+	0.5231 (2.52**)	+	0.0758 (1.62**)
ITCOMPLEXITY	+	0.5390 (3.18***)	+	0.6013 (3.08***)	0	−0.0460 (1.05)
ITDOCUMENTATION	−	−0.5505 (−1.84*)	−	−0.3698 (−1.50*)	0	−0.0539 (0.51)
ITSECURITY	−	−0.7479 (−1.91**)	−	−0.8339 (−1.85**)	0	−0.0342 (0.34)
ITSUPPORT	−	−0.5343 (0.52)	−	−0.0106 (−0.08)	+	0.6681 (2.51***)
PUBLIC		0.9579 (7.33***)		0.9853 (6.565***)		0.0108 (0.32)
BUSRISK		0.5461 (3.58***)		0.3327 (2.52**)		−0.0186 (−0.47)
SUBSIDIARIES		−0.0449 (−0.76)		0.0096 (0.14)		−0.0168 (−1.09)
SPECIALTY		0.0928 (0.77)		0.0106 (0.08)		0.0129 (0.42)
Ln*ASSETS*		0.9373 (1.69**)		−0.0677 (−0.11)		0.0038 (0.32)
1/2(ln*ASSETS*)^2		−0.0171 (−1.39*)		0.0026 (0.19)		

Sample size = 100.
System weighted $R^2 = 0.49$.
*, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively (one-tailed test).

Since the two cost shares sum to one, the impact of the client's IT characteristics on the audit staff cost share will be the reverse of that on the manager cost share. That is, the staff cost share equation can be expressed as follows:

$$\begin{aligned} STAFFSHARE = {} & \delta_2' + \beta_{12} ITINTENSITY \\ & + \beta_{22} ITCOMPLEXITY \\ & + \beta_{32} ITDOCUMENTATION \\ & + \beta_{42} ITSECURITY \\ & + \beta_{52} ITSUPPORT \\ & + \lambda_2 \ln ASSETS + \gamma_{12} PUBLIC \\ & + \gamma_{22} BUSRISK + \gamma_{32} SUBSIDIARY \\ & + \gamma_{42} SPECIALTY + \varepsilon_4, \end{aligned} \tag{6}$$

where $\beta_{k2} = -\beta_{k1}$ for $k = 1, 2, 3, 4, 5$; $\lambda_2 = \lambda_1$; $\gamma_{s2} = \gamma_{s1}$ for $s = 1, 2, 3, 4$.

Estimation results

Impact of clients' IT on audit cost

Observing cost-side impacts of IT characteristics, we found that other than that of the IT support in the cost equation, coefficients of the IT variables are statistically significant (or insignificant) as we hypothesized.

The level of the client's IT intensity is significantly and positively associated with the manager cost share. Therefore, H1a is supported, indicating that the managers need to expend more effort when the client has higher proportion of its business processes computerized. IT intensity also has a significant and positive impact on the total cost of an engagement, confirming H1b. Consistent with H2a, IT complexity does not have a significant impact on the cost share. The costs of two levels of professionals increase proportionally with the IT complexity. H2b is also confirmed, since IT complexity is significantly and positively associated with the total audit cost.

The coefficients of IT documentation and security are not significant at the conventional levels in the cost share equation. Therefore, H3a that the IT assurance does not affect the cost shares is supported. As for the cost equation, both IT documentation and IT security make a significant and negative impact on audit cost, confirming H3b that high IT assurance level can reduce the professionals' work. Next, IT support has a significant and positive impact on the audit manager cost share, supporting H4a. IT support has a slight negative impact on the total cost, but it is not statistically significant. Therefore, H4b is not confirmed.

The relation between cost change and price change

We then observe the relationship between the client's IT characteristics and prices of engagements. For the four IT variables (*ITINTENSITY*, *ITCOMPLEXITY*, *ITDOCUMENTATION* and *ITSECURITY*) that make significant impacts on production cost, their coefficients in the price equation show statistically significant values that are similar to those in the cost equation. Moreover, increase in the client's scores in IT documentation and security leads to a significant decrease in the price. To verify our hypothesis that the differences in production costs resulted from the IT characteristics are fully reflected in the differences in prices, we conducted statistical tests for the following hypotheses: $\overline{PRICE} \cdot \rho_k = \overline{TOTALCOST} \cdot \beta_k'$ for $k = 1, 2, 3, 4$, where $\overline{PRICE}$ = the sample mean of the audit fee, and $\overline{TOTALCOST}$ = the sample mean of the audit cost. None of the hypotheses can be rejected at conventional levels of significance, supporting our research hypothesis (H5) regarding the relationship between the cost and price impacts of IT characteristics. That is, a client's IT

characteristics generate similar impacts on audit price as on audit cost. The results indicate the existence of market mechanism that carries the cost impacts of client IT. The audit clients eventually pay for the audit cost impacts resulted from their information systems. Therefore, even though the client's IT characteristics enter into the auditor's production function, their impacts do not constitute externalities by definition. However, the clients should be aware of such indirect prices they pay for their IT and consider them in the IT decisions.

Conclusion and implications

In this paper, we present a novel perspective to evaluate the IT impacts that transcend organizational boundaries. We demonstrate such cross-organizational IT impacts by analyzing data collected from the public accounting industry. From the standpoint of externalities, we examine the impacts of clients' IT characteristics on a public accounting firm's production cost, professional allocation and product price. This study empirically illustrates how a firm's own IT choice can impact the production of another firm. At the substantive level, we contribute to the related literature by documenting the cross-organizational impacts of non-interorganizational IT and including IT variables in the audit production model. At the methodological level, our contribution is the application of the externalities theory and translog cost model in examining IT impacts.

The results of our study provide several managerial implications. First, firms should be aware of the existence of such cross-organizational IT impacts when they plan and invest in IT. A firm's IT investments may influence not only the firm's own production performance but also that of the firm's collaborating partner. That is, an outsourcer's own IT investments may significantly impact its outsourcee's production process and thus influence the price charge for the outsourcing project, even when the outsourcing project is not an IT project. The outsourcer shall consider such cross-organizational IT impacts when it performs *ex ante* IT investment evaluation (Irani & Love, 2002). The scope of information systems evaluation (Irani & Love, 2001) should be extended beyond the organizational boundary.

Second, in the digital economy, auditors are facing technological challenges because their production costs are influenced by their clients' IT characteristics. Specifically, our study shows that the total audit cost incurred for a client increases with both the client's IT intensity and IT complexity. The accounting profession needs stronger IT skills and new audit methodologies that work efficiently with clients' digital environments and new e-business models (Elliott, 2002). On the other hand, the total audit cost decreases with the level of a client's IT assurance. When a client maintains high quality IT documentation and high consciousness about systems security, it actually helps audit professionals perform their audit tasks and reduces their total effort for an engagement. In addition, in order to minimize the production cost (with a certain quality level maintained), an auditor's professional allocation for audit engagement should be adjusted in response to its client's IT intensity and IT support levels. Our results show that both the levels of the client's IT intensity and IT support increase the audit managers' cost share while decreasing the audit staff's cost share.

Lastly, audit clients eventually bear the aforementioned outcomes of their IT choices through the payment of audit fees. Our estimation indicates that the impact of clients' IT on the audit cost is passed on fully to the client in the form of a corresponding impact on the audit price. Thus, clients should consider these impacts when making IT decisions, especially when the impacts are significant. Otherwise, their IT decisions are not optimized.

We acknowledge limitations of this research. Since our findings are based on data from audit engagements performed by a single accounting firm, readers should be cautious before generalizing them to other public accounting firms or other types of projects. In the future, audit engagement data from other public accounting firms can be collected and analyzed carefully using a quasi-experimental design to generalize our results to the entire public accounting industry. In addition, data related to other types of cross-organizational collaboration projects can be tested to verify the existence of similar cross-organizational IT impacts in other contexts. Multiple case studies can be conducted for detailed exploration of the processes and mechanisms that support those external relationships.

Through an innovative evaluation of cross-organizational IT impacts based on the concept of economics, our study provides novel implications for IT impacts in the modern economy. The previous IT business literature suggests that a firm's performance is affected by its own IT investment (see Theoretical Foundation section for a brief review). Our results suggest that a firm should further consider how its performance is affected by the IT investments of other firms with which it collaborates.

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