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An Empirical Evidence for the RelationshipBetween Information Technology and Coordination Costs

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Introduction

Information technology (IT) has profoundly changed the way that business is conducted. With the use of IT, organizations radically redesign their business processes. IT is also radically restructuring the market by altering customer-supplier relationships. These changes are encouraged by the ability of IT that facilitates better information processing, sharing, and faster responsiveness, thereby improving coordination of the economic activities of separate units of an organization and across organizations. Most information systems (IS) research (Malone, Yates, and Benjamin 1987, 1989; Gurbaxani and Whang 1991; Clemons and Reddi 1992; Bakos and Brynjolfsson 1993; Brynjolfsson, Malone, Gurbaxani, and Kambil 1994) has examined the impact of IT on the organization of economic activities based on the theoretical speculation that IT reduces coordination costs both within an organization and between organizations, and improves coordination of the economic activities critical to the best use of resources and the delivery of goods and services. This theoretical speculation, however, has not been empirically analyzed in the IS field.

This paper provides an empirical analysis of the relationship between IT and coordination costs, and presents some implications for how IT contributes to firm output.

Background

Organizations need to process information in order to coordinate various economic activities. According to the information processing theory (Galbraith, 1973, 1977), the primary function of an organization is to process the information for decision making needed for a given level of performance. The information needed to determine the best use of resources, however, is not freely available. Moreover, the amount of information that must be processed for achieving a given level of performance increases as the amount of uncertainty increases. In today's complex and uncertain environment, the costs of information processing and sharing necessary for coordinating various economic activities are enormous. According to the previous studies (Malone, Yates, and Benjamin 1987, 1989; Gurbaxani and Whang 1991), IT greatly reduces information processing costs by providing better means of information gathering and processing, monitoring, negotiating and enforcing contracts.

Coordination costs refer to all the information processing costs necessary to integrate various economic activities of separate units of an organization and between separate organizations. Coordination costs incurred within an organization include the costs involved in acquiring and processing information for decision-making, accounting, planning, monitoring, and control processes. Coordination costs incurred in a market include the costs of searching and selecting suppliers, negotiating, and enforcing contracts (Malone, Yates and Benjamin 1987, 1989; Gurbaxani and Whang 1991).

According to Malone, Yates, and Benjamin (1987), IT is widely used for coordinating economic activities and decreases the unit costs of coordination through the following three effects: electronic communication effect, electronic brokerage effect, and electronic integration effects. Gurbaxani and Whang (1991) also argued that IT can affect the underlying cost structure of a firm because this cost structure is closely related to the acquisition of information. IT reduces transaction processing costs, including order processing costs and inventory related costs. IT reduces costs related to control by providing cost-effective monitoring or performance evaluation devices. IT also decreases the costs of documentation, communication, and decision-making .

There have been numerous IS studies based on the assumption that IT reduces coordination costs (Clemons and Reddi 1992; Brynjolffson, Malone, Gurbaxani and Kambil 1994; Bakos and Brynjolffson 1993). Those studies, however, have provided no empirical evidence to support this assumption. In the next section, we attempt to operationalize coordination costs, and provide empirical evidence for the relationship between IT and coordination costs.

Data and Methodology

Our approach is to use an economy-wide US firm level dataset to examine directly the relationship between IT and coordination costs. For the firm level data on IT, we use a dataset on IT spending by large U.S. firms compiled by International Data Group (IDG). We use IT spending data collected over the five-year period from 1988 to 1992. The total central IS budget is used as a measure of IT spending.

We use selling and general administrative expenses to construct a measure of coordination costs. Selling expenses are referred to as "order-getting" and "order-filling" costs. They include such items as salaries and commissions of sales personnel, advertising, warehousing, customer service, and shipping. General administrative expenses include the costs of integrating the various activities of the organization. Examples of general administrative expenses are top executive salaries, legal fees, general accounting, and research and development (Hansen, 1990). Since coordination costs include the costs involved in managerial decision- making, accounting, planning, and control processes (coordination costs incurred in an organization) and the costs of searching and selecting suppliers, negotiating and enforcing contracts (coordination costs incurred in a market), these costs must be included in the selling and general administrative expenses, which are operating expenses.

We use Compustat, a database of historical financial statement information, to obtain the data needed to construct a measure of coordination costs. We collect data about the firms whose names match the firm names in the IDG data. Because selling and general administrative expenses include other expenses such as expenses on R&D, advertising, software, bad debt, and pension and retirement, we obtain the data for such items in order to construct a measure of coordination costs. We construct a measure of coordination costs by subtracting expenses for advertising, R&D, software, bad debt, and pension and retirement from selling, general and administrative expenses. According to our definition of coordination costs, such expenses are not included in coordination costs. We also collect data for total sales, the number of employees, and the industry classification from the Compustat database.

For analyzing the relationship between IT and coordination costs, we perform an analysis of the combined dataset for all five years. We use an ordinary least-squares (OLS) regression estimate of the correlation between IT and coordination costs, while controlling for other explanatory variables such as advertising expenses and R&D expenses. We use advertising expenses and R&D expenses as control variables because we assume that firms spending a large amount on R&D and advertising must be spending a large amount on coordination. We also use two stage least-squares (TSLS) regressions to correct potential biases caused by the simultaneity problem.

For controlling the firm-size effect, We adjust the firm size by dividing coordination costs by total sales, and by dividing IT spending, advertising expenses and R&D expenses by the number of employees[1].

The Model

The model measures the relationship between the level of IT spending and coordination costs for a given sector in a given year, while controlling for R&D expenses, advertising expenses, and industry- and year-specific effects. The model does not include lag variables because the panel of five years is too short to consider lags, and there is a high serial correlation between lag variables. The basic model is as follows :

$COORDit = {}_0 + {}_1 ITit + {}_2 R\&Dit + \beta_3 ADit + \beta_4 INDUSTRYit + \beta_5 YEARit +$ where

COORDit = Coordination costs per total sales of the ith firm in year t

ITit = IT spending per employee for the ith firm in year t

R&Dit = R&D expenditure per employee for the ith firm in year t

ADit = Advertising expenses per employee for the ith firm in year t.

INDUSTRYit = A dummy for each sector or industry where the ith firm is operating in year t

YEARit = A dummy for year for the ith firm.

= An error term with zero mean

The model is estimated for the full sample with R&D and without R&D since the R&D variable is not applicable for most firms in sectors other than the manufacturing sector. The model is also estimated for each sector separately in order to see if the impact of IT differs across sectors.

Results and Discussion

The results are shown in Table 1. The estimate of IT spending indicates that IT spending is strongly associated with a decline in coordination costs for the full sample and for each individual sector over the five year period ($p < .01$) - except the transport and utilities sector. The coefficients of both advertising expenses and R&D expenses are positive and significant ($p < .01$). The coefficient of IT spending for the transport and utility industry is negative as expected, but not significant. This indicates that the effect of IT on coordination costs might be less significant in the transport and utilities sector than in the manufacturing and trade sectors. The sample size for the transport and utility sector, however, might affect the magnitude of the coefficient of IT spending. The analysis using TSLS regression shows similar results (Table 2)[2].

The results clearly show that IT spending is strongly associated with a decline in coordination costs. This implies that IT improves coordination cost efficiency and facilitates a higher level of coordination since IT reduces coordination costs for a given level of sales. Since coordination of economic activities can contribute to firm output, IT can contribute to firm output by improving coordination cost efficiency. Therefore, we can infer that IT enhances firm productivity by improving both coordination cost efficiency and production cost efficiency such as capital and labor efficiency.

Table 1: OLS Regressions for the Combined Dataset

	Manu	Trans & Util	Trade	Full Sample	Full Sample
IT Spending	-.0036*** (2.864)1	-.0031 (1.319)	-.0039*** (2.693)	-.0085*** (8.304)	-.0063*** (6.819)
R & D	.0052*** (4.774)	NA	NA	.0072*** (8.248)	Not Included
AD	.0013** (2.032)	-.0039 (.605)	.0334*** (6.617)	.0034*** (6.455)	.0040*** (7.407)
Dummy	Industry & Year	Industry & Year	Industry & Year	Sector & Year	Sector & Year
R2	43.8%	62.8%	73.8%	28.8%	17.6%
N(total)	437	35	68	459	549

DW2	**2.00**	**1.93**	**1.93**	**1.81**	**1.54**

Key : *(p<.01), **(p<.05), *(p<.1)**

1 - T Statistics in parentheses.

2 - If Durbin Watson (DW) statistic is close to 2, it indicates no serial correlation. If DW is greater than 2 or less than 2, it indicates high serial correlation. This suggests that the point estimates are correctly estimated but that the standard error estimates may be biased upward or downward.

Conclusion

In this paper, we empirically examine the relationship between IT and coordination costs, using the firm level data. Our results clearly show that there is a significant negative relationship between IT spending and coordination costs for the five years from 1988 to 1992. These results strongly support the hypothesis that IT reduces coordination costs.

The main contribution of this study is the operationalization of coordination costs. By developing a measure of coordination costs, we could provide empirical evidence for the theoretical speculation that IT reduces coordination costs. This study also implies that IT can contribute to an increase in firm output by improving coordination cost efficiency.

References upon request

Endnotes

1. For the robustness of our results, we analyzed the model by dividing coordination costs by the number of employee, and by dividing IT spending, advertising expenses and R&D expenses by total sales. The results are similar to the results of the analysis in this paper.

2. Table 2 is available from the author upon request.