

## Graphical modeling analysis of how investment in ICT pays off: Evidence from nationwide survey data in Japan

Shinozaki, Akihiko  
Faculty of Economics, Kyushu University

Washio, Satoshi  
InfoCom Research, Inc.

Kubota, Shigehiro  
InfoCom Research, Inc.

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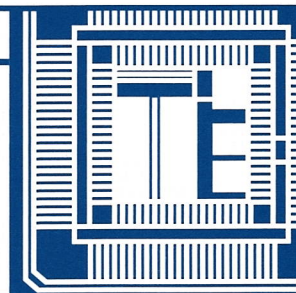
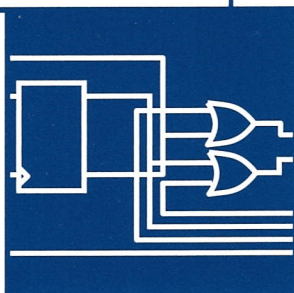
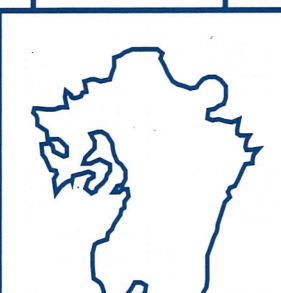
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## Discussion Paper Series

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Evidence from nationwide  
survey data in Japan

Akihiko Shinozaki, Satoshi Washio, Shigehiro Kubota

# Graphical modeling analysis of how investment in ICT pays off:

## Evidence from nationwide survey data in Japan

Akihiko SHINOZAKI, Satoshi WASHIO, Shigehiro KUBOTA

### Abstract

The purpose of this study is to analyze how investment in information and communications technology (ICT) and related corporate reforms affect business performance depending on corporate size. To accomplish this, we implemented a nationwide questionnaire survey in Japanese workplaces. The questionnaire categories were the introduction of ICT, effective use of ICT, corporate reforms accompanying the investment in ICT, and resultant business performance in terms of changes in sales revenues, operating profits, and number of full time jobs. Based on the data from 4,016 valid responses, we conducted a graphical modeling analysis by corporate size to illustrate how each factor interacts with the others, and by what routes they exert their respective effects on business performance. Our study yields three observations. First, introduction of ICT, effective use of ICT, and related corporate reforms positively affect each other and improve business performance. Second, for larger firms whose organizational structures are complicated and sometimes redundant, corporate reforms have the most direct effect on the increase in sales revenues and operating profits, while introduction of ICT and effective use of ICT have direct effects on job creation. Third, for small and medium sized enterprises (SMEs) whose organizational structures are relatively simple, the most important factor is the effective use of ICT, because SMEs often have difficulty retaining highly skilled employees or experts in new technology when they invest in ICT.

Keywords: ICT, Business Performance, Job Creation, Corporate Reform, Graphical Modeling, Large Enterprise, SMEs

JEL classification codes: D22, D25, M15, O32

## [Executive Summary]

This study aims to analyze how investment in information and communications technology (ICT) and related corporate reforms affect business performance. For this purpose, we conducted a graphical modeling analysis by corporate size, using data from a nationwide questionnaire survey of Japanese workplaces. The questionnaire was conducted by InfoCom Research and NTT Com Research in March 2014, and was designed in two stages: a pre-survey and a main survey. The pre-survey, asking about the firms and industries respondents belonged to, received 9,082 responses, a response rate of 20.6%. The main survey was implemented with more detailed questions, with a set number of target responses for each corporate size and industry classification. The categories of questions in the survey are: the introduction of ICT, effective use of ICT, corporate reforms accompanying the investment in ICT, and the resultant business performance in terms of changes in sales revenues, operating profits, and number of full time jobs.

Based on the data from 4,016 valid responses, we conducted a covariance structure analysis, or graphical modeling analysis, which graphically expresses conditional independent relationships among the factors. We then illustrate by corporate size how each factor interacts with the others and by what routes they exert their respective effects on business performance. Our study yields three observations. First, introduction of ICT, effective use of ICT, and related corporate reforms positively affect each other and improve business performances. Second, for larger firms, corporate reforms have the most direct effect on the increase in sales revenues and operating profits, while introduction of ICT and effective use of ICT have direct effects on job creation. Third, for small and medium sized enterprises, effective use of ICT is the most important, because it is the sole factor that directly affects not only increases in sales revenues and operating profits but also job creation.

These results demonstrate that corporate reform is the key factor for large enterprises because their organizational structures are complicated and sometimes redundant. In contrast, for SMEs, whose organizational structures are relatively simple, the most important factor is effectively using ICT, because SMEs often have difficulty retaining highly skilled employees or experts in new technology when they invest in ICT.

## **1. Introduction: Background and Objectives**

Investment in information and communications technology (ICT), or the introduction and effective use of ICT, is often accompanied by related corporate reforms such as business process engineering. The purpose of this study is to illustrate how investment in ICT and related corporate reforms in workplaces in the Japanese private business sector affect business performance in terms of sales revenues, operating profits, and job creation. To accomplish this, we conducted a graphical modeling analysis by corporate size using data from 4,016 valid responses to a nationwide questionnaire survey of Japanese workplaces.

Numerous studies have been carried out about the effects of investment in ICT and related corporate reforms on business performance in Japan.<sup>1</sup> Previous studies have found the following major results. First, corporate reforms are imperative for improving business performance leveraged by ICT investment. Second, two or three years are required to achieve positive results from corporate reforms. Third, Japanese firms' efforts to conduct corporate reforms have fallen short in comparison with those in the United States, Germany, and South Korea.

However, these studies have some limitations because they have mainly focused on the introduction of hardware technology, especially personal computers and servers for Internet access. In recent years, however, new hardware technologies such as smart phones and/or tablets, as well as new software application and services such as cloud computing and social network services (SNS), have been spreading so rapidly that they have entered

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<sup>1</sup> See Shinozaki (2005, 2007), Shinozaki and Yamamoto (2008), Miyagawa, et al. (2009), Kim and Kwon (2015), Kawakami and Asaba (2015).

into general use in the workplace. Moreover, the effective use of new technologies becomes more important than their mere introduction for private business to make the technology pay off. Therefore, these technological changes in hardware, software, and service should be taken into account when we measure the economic impact of ICT in workplaces. On top of that, little is known about the mutual effects of such factors as introduction of ICT, effective use of ICT, related corporate reforms, and resultant business performance, especially job creation. Thus, it is necessary to investigate how each factor interacts with the others, and by what routes they exert their respective impacts on business performance in terms of sales revenues, operating profits, and, in particular, job creation.

To address these questions, we conduct a graphical modeling analysis, breaking the data down by firm size. We use data from 4,016 valid responses to a questionnaire survey for employees in private business sectors of 11 industries. The questionnaire pertained to the introduction of new ICT, including software and service, observed in the spread of smart phones and cloud computing; the effective use of ICT, such as SNS and big data; the implementation of corporate reforms accompanying the introduction and effective use of ICT; and business performance such as sales revenues, operating profits, and creation or reduction of jobs.

The next section describes the collection and observation of survey data, followed by a section on the graphical modeling analysis by corporate size. The final section summarizes the study.

## **2. Data Collection and Processing**

### *Questionnaire Survey*

Our study employed the results of a web questionnaire survey conducted by InfoCom Research and NTT Com Research in March 2014 for employees in private business sectors of 11 industries, as shown in Table 1. The questionnaire was designed in two stages: a pre-survey and a main survey. The pre-survey received 9,082 responses, a response rate of 20.6%, asking about the firms and industries respondents belonged to. The main survey was implemented with more detailed questions, with a set number of target responses for each corporate size and industry classification, which reflects the aggregate population of the Japanese business sector.

The categories of questionnaire items in the survey are: the introduction of ICT in respondents' workplaces (13 questions); effective use of ICT in respondents' workplaces (15 questions); corporate reforms accompanying the introduction and effective use of ICT (24 questions); and resultant business performance in terms of changes in sales revenues, operating profits, and number of full time jobs in the corporations where the respondents were employed. The main survey received 4,147 responses, and excluding the contradictory responses, the data used in this study represent 4,016 valid responses.

Table1

In the survey, questions about sales revenues, operating profits, and the creation or reduction of full-time jobs considered the most recent business year of the corporation, which the respondents were asked to compare with the two previous business years. The rationale for using two business years is that, based on Miyagawa et al. (2009) and Kawakami et al. (2015), it is believed that two years are required to achieve desired results leveraged by the investment in ICT and related corporate reforms. The specific items on the questionnaires are shown in the Appendix 1.

The basic question items are in conformity with Shinozaki (2005), in which the first large-scale nationwide survey was undertaken by the Economic and Social Research Institute (ESRI), Cabinet Office, Government of Japan. However, to capture and analyze the latest technological trends in ICT, the survey employs a number of new question items that address technologies such as smart phones and tablets, as well as new services, such as cloud computing technologies, Software as a Service (SaaS), Platform as a Service (PaaS), and application of big data.

#### *Scoring and Observations*

The response results were scored by according one point for a “yes” answer and zero points for a “no” or “unknown” answer. The scores were then aggregated for the introduction of ICT, effective use of ICT, and related corporate reforms, where the maximum scores are 13, 15, and 24, respectively. Figure 1 presents the response percentages of the scores for sales increases, profit increases, job creation, and job reduction.

Figure 1

Examining the introduction of ICT and business performance, similar tendencies were observed for sales revenues and operating profits. In other words, the response percentages of “increase in sales” and “increase in profits” rose as the score for the degree of ICT introduction increased. The response percentage also rose for job creation as the score for the degree of ICT introduction increased, although the percentage level was lower than those of sales revenues and operating profits. On the other hand, the response percentage for “job reduction” rose only in the lower scores (ranging from 0 to 4) for the



degree of ICT introduction, while the response percentage leveled off or even decreased in the higher scores (ranging from 5 to 13).

Thus, it seems appropriate to interpret that the degree of ICT introduction affects both “job creation” and “job reduction” at the lower levels of ICT introduction, and then effects on “job creation” accelerate while those on “job reduction” level off at the higher levels of ICT introduction. As Figure 2 shows, similar relationships are observed between the effective use of ICT and “increase in sales,” “increase in profit,” “job creation,” or “job reduction,” just as in the case of ICT introduction.

Figure 2

Regarding the corporate reforms and business performance shown in Figure 3, relationships and tendencies were relatively unclear because the response percentages were widely dispersed compared to those for ICT introduction or effective use of ICT. Nevertheless, in terms of sales and operating profits, the percentages of respondents indicated that they increased as the score for corporate reforms increased. The response percentages of job creation and job reduction both increased when the score for corporate reforms was low, whereas no clear relationships or tendencies can be observed when the score for corporate reforms is high.

Figure 3

#### *Logit model analysis*

Using the above-mentioned questionnaire survey data, Washio et al. (2016) conducted a logit model analysis to verify whether each variable exhibited statistically significant effects on business performance. The results of the logit model analysis shown in Table 2 indicate that all variables exhibited a significantly positive coefficient with

respect to the increase in sales, and introduction of ICT and effective use of ICT exhibit a significantly positive coefficient with respect to the increase in operating profits and job creation.

Table 2

Logit model analysis, however, has some limitations, because the mutual relationships between the respective variables are unclear, leaving open questions regarding how each factor interacts with the others, and by what routes they exert their respective effects on business performance.

To address these questions, we need to investigate the mutual relationships among the respective factors and clarify which factor influences the others and how, and through what route sales revenues, operating profits, and job creation are affected.

### **3. Graphical Modeling Analysis**

#### *Methodology*

To analyze the mutual effects between the categorized factors of introduction of ICT, effective use of ICT, corporate reforms, and business performances in terms of sales revenues, operating profits, and job creation, we conduct a covariance structural analysis, or graphical modeling analysis, which graphically expresses a simpler model, which has a conditional independent relationship among the variables.<sup>2</sup>

In this study, we employ reduction methodology of the covariance selection, which guides several contraction models and consequently selects the optimal model.<sup>3</sup> More

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<sup>2</sup> See Miyagawa (1997) for the concept and methodology of graphical modeling.

<sup>3</sup> Kubota and Shinozaki (2016) use this method to analyze the role of human resource networks for the expansion of service export to the U.S.

specifically, we start with the full model in which all the variables are connected by a line, and then one-by-one sever the connections between variables whose partial correlation coefficients are relatively small. Finally, the optimal model is selected using the Bayesian information criterion (BIC),<sup>4</sup> where the degree of deviation from the full model and the simplicity of the model are measured to determine the optimal model<sup>5</sup>.

### *Results and Implications*

The results of the graphical modeling analysis are shown in Figure 4. The effective use of ICT and corporate reforms directly and positively affect sales revenues, while the introduction of ICT affects sales revenues positively but indirectly through the path of effective use of ICT or corporate reforms.

Figure 4

To breakdown by corporate size,<sup>6</sup> corporate reforms have a direct relationship with sales revenues for large enterprises, while the introduction and effective use of ICT have indirect relationships with sales revenues via the path of corporate reforms. This result indicates that corporate reform is the most important factor for sales increases in large firms. On the other hand, effective use of ICT has a direct relationship with sales revenues for small and medium enterprises, (SMEs), while introduction of ICT and corporate reforms have indirect relationships via the path of effective use of ICT. This result indicates that effective use of ICT is the most important factor for sales increases in SMEs.

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<sup>4</sup> Akaike's information criterion, or AIC, is another criterion. Yamamoto (1998) states that BIC is more likely to select a simpler model than AIC.

<sup>5</sup> See the Appendix 2 for partial correlation matrix in the full model and in the reduced model.

<sup>6</sup> For the definition of corporate size, we employ the classification of the Small and Medium Enterprise Agency. In the commerce and services industry, enterprises with 100 or more full-time employees are defined as large enterprises. In other industries, those with 300 or more full-time employees are defined as large enterprises.

From these results we can derive that, because large enterprises have complicated organizational structures and sometimes redundant business processes, corporate reforms accompanying ICT investment are the key factor to an increase in sales. On the other hand, for SMEs whose organizational structures are relatively simple and who have some difficulty retaining highly skilled employees or experts, the key factor for adapting new technology is how to use ICT effectively.

Effective use of ICT is the only factor that directly affects operating profits, while the introduction of ICT and corporate reforms affect operating profits indirectly through the path of effective use of ICT. To breakdown by corporate size, the results are identical to those obtained in the case of sales revenues. Corporate reforms have a direct relationship with operating profits for large enterprises, which indicates that corporate reform is the most important factor for increasing operating profits. For SMEs, on the other hand, effective use of ICT has a direct relationship with operating profits, which indicates that effective use of ICT is the most important factor for increasing their operating profits, just as in the case of increases in sales revenues.

Introduction of ICT affects job creation by a direct path for large enterprises, which suggests that introduction of ICT accompanies business expansion, consistent with the generation of new jobs for full-time employees. On the other hand, for SMEs, the effective use of ICT affects job creation by a direct route, as in the case of increases in sales revenues and operating profits. These results for SMEs suggest that effective use of ICT requires skilled personnel and leads to the expansion of their sales and profits, generating more jobs for full-time employees.

#### **4. Conclusion**

Based on the data from 4,016 valid responses to a nationwide questionnaire survey in Japan, we analyzed how corporate reforms, along with the introduction and effective use of ICT in workplaces, affect business performance in terms of sales revenues, operating profits, and job creation. We conducted a graphical modeling analysis, which graphically expresses a conditional independent relationship among the factors. Using this methodology, we investigated how each factor interacts with the others and by what routes they exert their respective effects on business performance, depending on corporate size.

The results were as follows. First, introduction of ICT, effective use of ICT, and related corporate reforms positively affect each other and improve business performance. Second, for large enterprises, corporate reforms have the most direct effect on the increase in sales revenues and operating profits, while introduction of ICT and effective use of ICT have direct effects on job creation. Third, for SMEs, effective use of ICT has the most important and direct effect on all business performance, since it is the sole factor that directly affects not only increases in sales revenues and operating profits but also job creation.

These results demonstrate that corporate reform is the key factor for large enterprises, because their organizational structures are complicated and sometimes redundant. In contrast, for SMEs, whose organizational structures are relatively simple, the most important factor is effectively using ICT, because SMEs often have difficulty retaining highly skilled employees or experts on new technology when they invest in ICT.

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## Tables and Figures

Table 1: Number of valid responses by industry and by corporate size

	All industries	Agriculture, forestry, and fisheries	Manufacturing	Construction	Mining and utilities	Commerce	Finance and insurance	Real estate	Transportation	Telecommunications	Services
Large Enterprises	1,007	4	250	71	38	135	106	19	55	112	217
SMEs	3,009	96	488	381	87	377	258	219	245	257	601
Total	4,016	100	738	452	125	512	364	238	300	369	818

Note: Corporate size defines by the classification of the Small and Medium Enterprise Agency.

Figure 1: Introduction of ICT and Business performance

(Percentage of respondents)

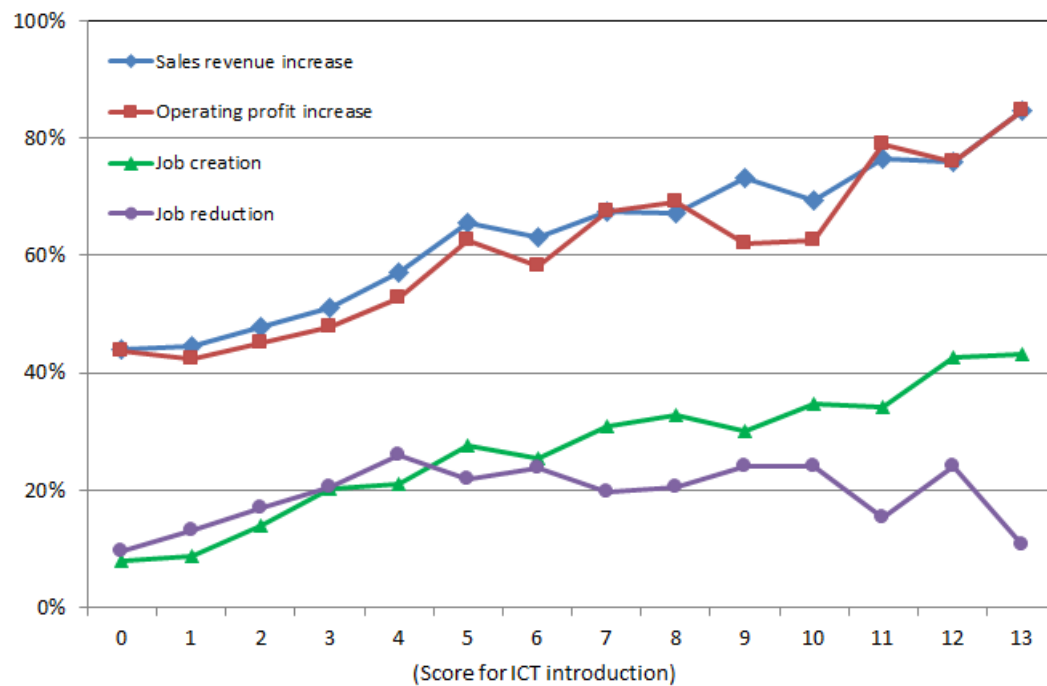




Figure 2: Effective use of ICT and Business performance

(Percentage of respondents)

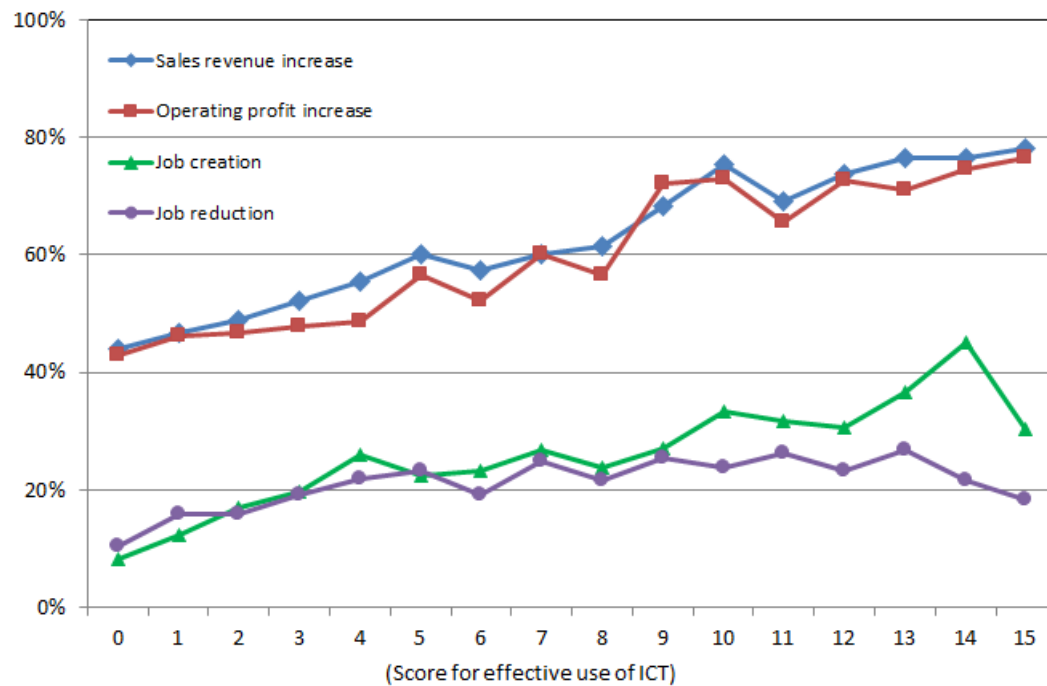


Figure 3: Corporate reforms and Business performance

(Percentage of respondents)

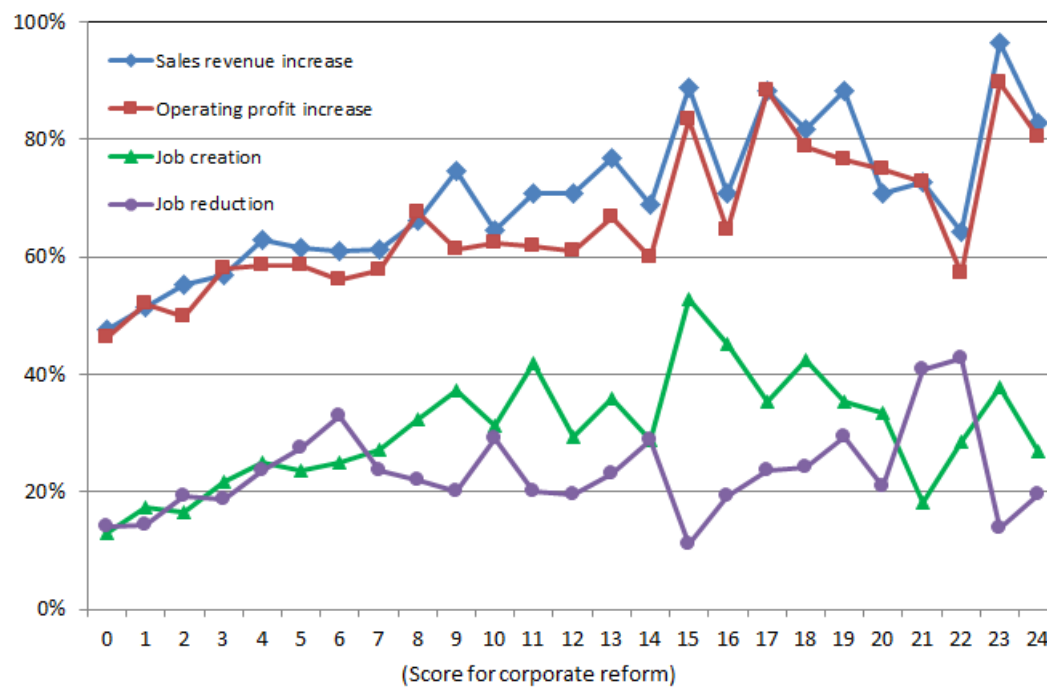


Table 2: Results of logit model analysis

Business Performances Variables	Sales Revenue	Operating Profit	Job Creation	Job Reduction
Constant Term	-0.3591 -4.45 *** 0.000	-0.4551 -5.66 *** 0.000	-2.1140 -19.70 *** 0.000	-2.1191 -18.54 *** 0.000
Introduction of ICT	0.7067 0.1632 3.08 *** 0.002	0.7428 0.1739 3.29 *** 0.001	1.5706 0.2254 5.97 *** 0.000	-0.0974 -0.0137 -0.35 *** 0.727
Effective Use of ICT	0.6344 0.1465 3.17 *** 0.001	0.7904 0.1850 4.00 *** 0.000	0.0487 0.0699 2.10 ** 0.035	0.7912 0.1117 3.31 *** 0.001
Corporate Reforms	0.7078 0.1634 3.16 *** 0.002	0.1801 0.0422 0.84 *** 0.401	0.1333 0.0191 0.58 *** 0.559	0.1226 0.0173 0.51 *** 0.611
Industry Dummy_Agriculture	-0.1230 -0.0284 -0.56 0.5750	-0.1021 -0.0239 -0.46 0.6430	-1.1883 -0.1705 -2.50 ** 0.0120	-1.1690 -0.1650 -2.24 ** 0.0250
Industry Dummy_Manufacture	0.0831 0.0192 0.77 0.4380	0.0691 0.0162 0.65 0.5150	0.1262 0.0181 0.98 0.3250	0.5047 0.0712 3.70 *** 0.0000
Industry Dummy_Construction	0.3188 0.0736 2.59 *** 0.0090	0.3069 0.0718 2.52 ** 0.0120	0.2206 0.0317 1.48 0.1390	0.2316 0.0327 1.40 0.1620
Industry Dummy_Utility	0.2317 0.0535 1.17 0.2440	-0.1034 -0.0242 -0.52 0.6000	-0.6204 -0.0890 -1.99 ** 0.0470	0.4480 0.0632 1.79 * 0.0740
Industry Dummy_Commerce	-0.2133 -0.0493 -1.83 * 0.0680	-0.2217 -0.0519 -1.90 * 0.0570	0.0515 0.0074 0.35 0.7240	0.3089 0.0436 2.00 ** 0.0460
Industry Dummy_Finance	0.2466 0.0569 1.86 * 0.0620	0.3655 0.0856 2.77 *** 0.0060	-0.3762 -0.0540 -2.12 ** 0.0340	0.5399 0.0762 3.30 *** 0.0010
Industry Dummy_Real estate	-0.0677 -0.0156 -0.45 0.6560	-0.0701 -0.0164 -0.46 0.6440	-0.0800 -0.0115 -0.39 0.6950	-0.3185 -0.0449 -1.31 0.1910
Industry Dummy_Transportation	0.0121 0.0028 0.09 0.9310	0.1821 0.0426 1.32 0.1880	-0.1026 -0.0147 -0.54 0.5900	0.7634 0.1077 4.45 *** 0.0000
Industry Dummy_Telecom	-0.2913 -0.0673 -2.22 ** 0.0260	-0.2285 -0.0535 -1.75 * 0.0800	-0.3498 -0.0502 -2.06 ** 0.0390	0.1859 0.0262 1.07 0.2850
Firm Size Dummy	0.3847 0.0888 4.70 *** 0.0000	0.3631 0.0850 4.51 *** 0.0000	0.1613 0.0231 1.68 * 0.0940	0.1729 0.0244 1.77 * 0.0760
Sample	4,016	4,016	4,016	4,016
Pseudo R <sup>2</sup>	0.0514	0.0458	0.0661	0.0284
Log likelihood	-2,622.2	-2,650.9	-1,826.3	-1,814.3

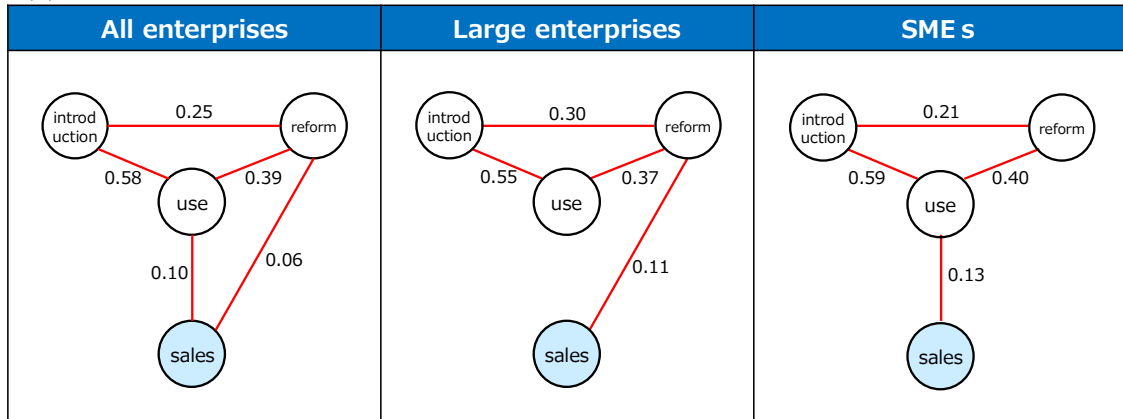
Source: Washio, et al., (2016) p.31 Table 7.

Note: Figures represent coefficient, marginal effect, t-value, and p-value in order from the top.

Significance level: 5% \*\* and 1% \*\*\* respectively.

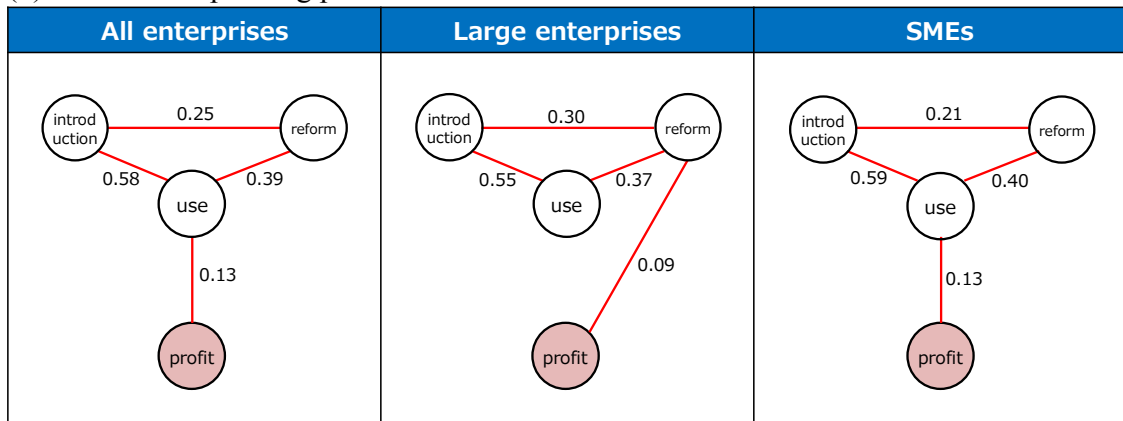
Figure 4: Route of effects on business performance

(1) Increase in sales revenue



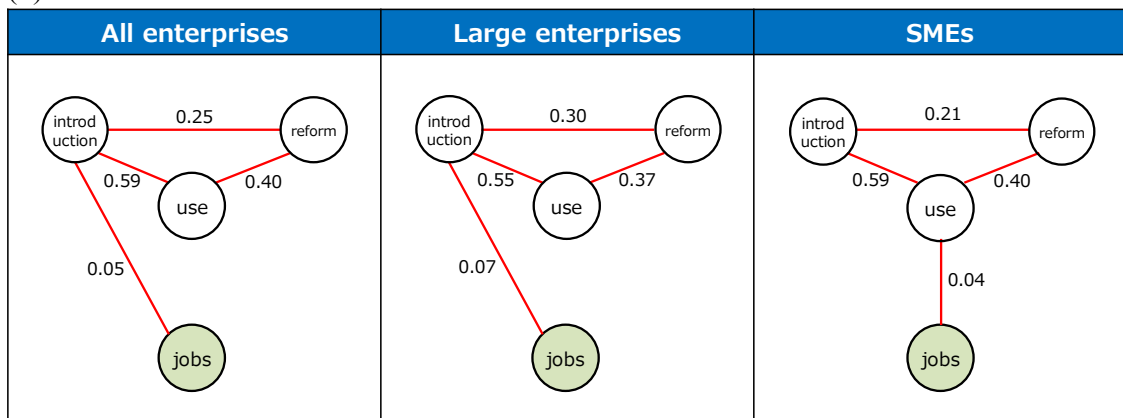
— Figures are partial correlation coefficient

(2) Increase in operating profit



— Figures are partial correlation coefficient

(3) Job creation



— Figures are partial correlation coefficient

## Appendix 1: Questionnaire Items

### Business performances

	Questions
Sales	Increase or decrease in most recent sales revenues from the past three business years
Operating profits	Increase or decrease in most recent operating profits from the past three business years
Job creation	Number of full-time employees in the last three business years respectively.

### Introduction of ICTs in the workplace

Questions (answer choices: yes, no, or unknown)
(1) Networking between the jobs inside a department
(2) Networking between the departments in a company
(3) Networking outside the company, i.e., clients and customers
(4) Providing PCs (desktops, laptops) for employees
(5) Providing cell phones (excluding smart phones) for employees
(6) Providing smart phones for employees
(7) Providing tablet devices (iPads, etc.) for employees
(8) Introducing package software for financial accounting, payroll, etc.
(9) Introducing software service such as e-mail and business applications via SaaS
(10) Introducing platforms such as OS, hardware, and middleware via PaaS
(11) Introducing ICT infrastructure via IaaS
(12) Outsourcing ICT management and business process (BPO)
(13) Developing ICT system from the scratch provided by solution vendors

### Effective use of ICTs in the workplace

Questions (answer choices: yes, no, or unknown)
(1) Using in-house servers for e-mail, data sharing, and web management
(2) Using outside servers, e.g., data centers and/or hosting services
(3) Using housing service for entrusting maintenance and monitoring of ICT systems
(4) Using groupware for sharing information internally
(5) Using an internal portal site
(6) Using mobile devices for accessing information from outside the company
(7) Opening the homepage (HP) for providing information outside the company
(8) Opening SNS (Twitter, Facebook, Line, etc.) for providing information outside the company
(9) Using SNS for collecting and communicating with customers
(10) Using business information which is collected and analyzed irregularly at necessary time
(11) Using business information which is collected and analyzed regularly and periodically
(12) Using business information which is collected and analyzed continuously in real time
(13) Using the collected data to make business process visible for the efficient management
(14) Using the collected data to forecast the business and make effective management plans
(15) Using the collected data to automate business tasks

### Corporate reforms along with ICT investment

Questions (answer choices: yes, no, or unknown)
(1) Concentration of decision making (centralized authority)
(2) Distribution of decision-making (decentralized authority)
(3) Revision of authority between the top-management and mid-level managers
(4) Revision of tasks and duties between mid-level managers and general employees
(5) Making organizational structures flatter
(6) Making in-house operations paperless
(7) Clarifying the in-house ICT strategy
(8) Sharing of business knowledge by using ICT system
(9) Separations and spin-offs of business units
(10) Business process outsourcing inside Japan
(11) Business process outsourcing outside Japan
(12) Revision of existing relationships in supply chain
(13) Making business operations paperless in trade with outside the company
(14) Sharing business knowledge with outside the company
(15) Enhancing on-the-job training and/or external training for employees
(16) Hiring new graduates as a specialist for development and/or operation of ICT
(17) Hiring mid-career specialists for development and/or operation of ICT
(18) Using temp-staffs as a specialist for development and/or operation of ICT
(19) Introduction of flexible work rules, e.g., teleworking or flextime
(20) Facilitation of human resource mobility inside the company
(21) In-house evaluation of the ICT investment and/or effective use of ICT
(22) Quantitative in-house evaluation of the ICT investment and/or effective use of ICT from cost-benefit performance
(23) Professional evaluation of the ICT investment and/or effective use of ICT by consulting firms, vendors, etc.
(24) Establishment of a chief information officer (CIO) and/or a board member in charge of ICT

## Appendix 2: Partial Correlation Coefficient Matrix and Covariance Selection

One problem with multivariate analyses such as logit model in Washio, et al. (2016) is that the coefficients of independent variables include both the direct impact of independent variables on dependent variables and that of other factors. Therefore, we need to remove pseudo-correlations and rigorously distinguish between direct and indirect relationships for a detailed examination.

One way to do this is by observing the partial correlation coefficient matrix and comparing to the correlation matrix. Then we can replace some of partial correlation coefficients with zero if they are extremely small, concluding that there are no direct correlations between those variables.<sup>7</sup> Consequently, we can simplify the inter-variable relationships and illustrate clear diagrams. Table A-1, A-2, and A-3 represent the partial correlation matrix in full model and resulting reduced model.

Table A-1 Covariance selection and partial correlation matrix regarding sales revenue

### All enterprises in sales revenue

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.58	—		
C	Corporate reforms	0.25	0.39	—	
D	Sales revenue	0.01	0.09	0.06	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.58	—		
C	Corporate reforms	0.25	0.39	—	
D	Sales revenue	<u>0.00</u>	0.10	0.06	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

### Large enterprises in sales revenue

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.55	—		
C	Corporate reforms	0.30	0.37	—	
D	Sales revenue	0.00	-0.00	0.11	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.55	—		
C	Corporate reforms	0.30	0.37	—	
D	Sales revenue	<u>0.00</u>	<u>0.00</u>	0.11	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

<sup>7</sup> See Dempster (1972) for the theoretical background.

SMEs in sales revenue

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.21	0.39	—	
D	Sales revenue	0.01	0.10	0.04	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.21	0.40	—	
D	Sales revenue	<u>0.00</u>	0.13	<u>0.00</u>	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

Table A-2 Covariance selection and partial correlation matrix regarding operating profit  
All enterprises in operating profit

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.58	—		
C	Corporate reforms	0.25	0.39	—	
D	Operating profit	0.02	0.10	0.03	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.58	—		
C	Corporate reforms	0.25	0.39	—	
D	Operating profit	<u>0.00</u>	0.13	<u>0.00</u>	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

Large enterprises in operating profit

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.55	—		
C	Corporate reforms	0.30	0.37	—	
D	Operating profit	0.03	0.01	0.06	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.55	—		
C	Corporate reforms	0.30	0.37	—	
D	Operating profit	<u>0.00</u>	<u>0.00</u>	0.09	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

SMEs in operating profit

-Full model		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.21	0.40	—	
D	Operating profit	0.01	0.12	0.01	—

-Reduced model		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.21	0.40	—	
D	Operating profit	<u>0.00</u>	0.13	<u>0.00</u>	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

Table A-3 Covariance selection and partial correlation matrix regarding job creation  
All enterprises in job creation

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.25	0.40	—	
D	Job creation	0.04	-0.00	0.02	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.25	0.40	—	
D	Job creation	0.05	<u>0.00</u>	<u>0.00</u>	—

Note: Underlined figures are converted to zero based on BIC standard statistics.

Large enterprises in job creation

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.55	—		
C	Corporate reforms	0.30	0.37	—	
D	Job creation	0.09	-0.04	0.02	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.55	—		
C	Corporate reforms	0.30	0.37	—	
D	Job creation	0.07	<u>0.00</u>	<u>0.00</u>	—

Note: Underlined figures are converted to zero based on BIC standard statistics.



# SMEs in job creation

<Full model>		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.21	0.40	—	
D	Job creation	0.02	0.02	0.01	—

<Reduced model>		Graphical modeling			
Variables		A	B	C	D
A	Introduction of ICT	—			
B	Effective use of ICT	0.59	—		
C	Corporate reforms	0.21	0.40	—	
D	Job creation	<u>0.00</u>	0.04	<u>0.00</u>	—

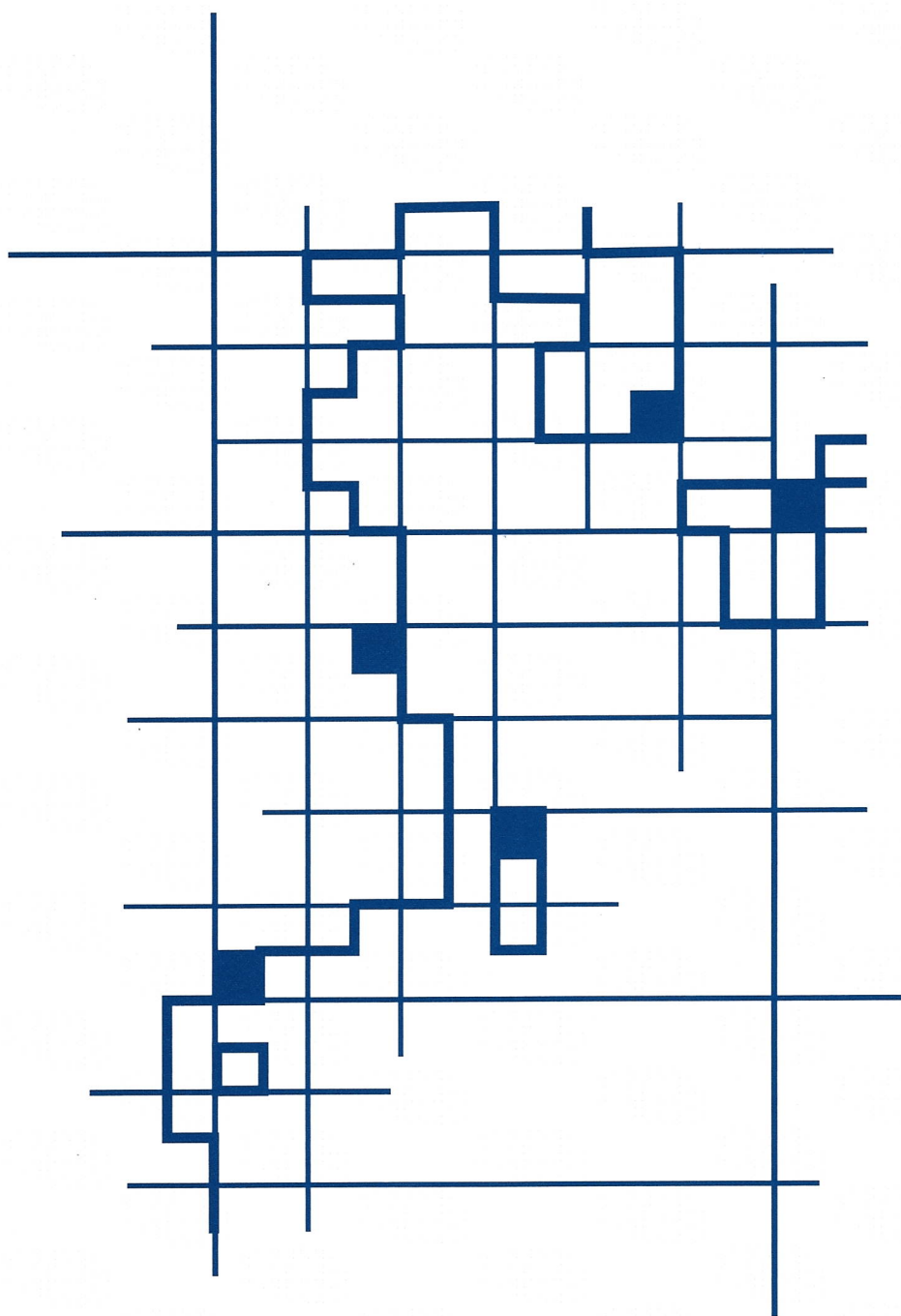
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**System LSI Research Center  
Kyushu University**

Fukuoka Institute of System LSI Design Industry  
3F, 3-8-33 Momochihama,  
Sawara-ku, Fukuoka 814-0001

**<http://www.slrc.kyushu-u.ac.jp/>**