# Information Technology and the Performance of Japanese SMEs

*Masayuki Morikawa*

ABSTRACT. This paper examines the impact of investment in information technology (IT) on the performance of Japanese firms. My findings imply that there is a positive and statistically significant relationship between IT and firm profitability and innovation, but only for small firms. These results underscore the importance of investment in IT for small companies. The acceptance of IT by this sector is fundamental to the success of structural adjustment in the Japanese economy.

## 1. Introduction

This study provides new evidence on the links between the use of information technology (IT) and firm performance, based on a survey of Japanese companies.[1] It uses both innovation and profitability as indicators of firm performance.

On the relationship between IT and productivity, there are numerous empirical studies in the context of the "New Economy" controversy. In particular, many studies analyze the contribution of IT to U.S. macroeconomic performance in the 1990s. Recent examples include Gordon (2000), Oliner and Sichel (2001), and Baily and Lawrence (2001). Jorgenson (2001) ably summarizes the results of these analyses, and emphasizes that IT made a sizable contribution to the high productivity growth of the U.S. economy.[2] On the other hand, there are several studies analyzing empirically the effect of IT on the performance of companies or establishments. For example, Brynjlfsson and Hitt (1995, 1996), Lichtenberg (1995), Greenan and Mairesse (1996), and Mairesse et al. (2001) confirm the positive contribution of computer on productivity by using company-level data. Brynjlfsson and Hitt (2000) briefly summarize these microeconomic researches and conclude that IT positively contributes to company productivity.[3]

It is important to note that there has been no research on the relationship between IT and firm size, as in the "Schumpeterian" literature on whether the returns to R&D or the propensity to invest in R&D is related to firm size.[4] This study seeks to fill this gap. Recent studies with this focus have noted the different nature of innovative activity of large and small firms.[5] Since IT is an essential tool for innovation today, it is important to investigate the different effect of IT investment by small and large firms.

In order to reverse declining economic performance, the Japanese government has eagerly promoted the diffusion of IT. In December 2000, for example, the Basic Law on the Formation of an "Advanced Information and Telecommunications Network Society" was enacted and in January 2001, an "IT Strategy Headquarters" was established in the public sector and then an "e-Japan Strategy" was announced. In the Japanese economy, small and medium-sized businesses account for 99.7% of all businesses and small businesses account for 87.9% of the total number of businesses (Small and Medium Enterprise Agency, 2000).[6] This means that the effect of IT investment in SMEs is crucial for the overall Japanese economy. In recognizing the important role of SMEs, the "e-Japan strategy" has set a target that almost half of Japanese SMEs should be conducting e-commerce using the Internet by March 2004. This strategy is being supported by a public financing programs, as well as tax incentives for the adoption of information technology.

The current study uses a relatively large sample

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*Ministry of Economy, Trade and Industry*
*1-3-1 Kasumigaseki*
*Chiyoda-ku, Tokyo 100-8901*
*Japan*
*E-mail: morikawa-masayuki@meti.go.jp*

of Japanese SMEs to analyze the relationship between both IT and innovative activities in Japan, as well as the relationship between IT and profitability, and the impact of firm size on both productivity and firm performance.

This paper is organized as follows; the second section briefly explains the data used in the study and the method of analysis. The third section presents empirical findings on the relationship between IT and innovation, and the relationship between IT and profitability in the Japanese companies. The fourth section summarizes the findings from these analyses and discusses the limitations of the findings.

## 2. Data and methodology

The data analyzed in this study is derived from the "Survey of Corporate Management Activities" conducted in December 1998 by the Small and Medium Sized Enterprises Agency in Japan. The survey was sent to 18,000 companies and the number of responses was 6,432 (the response rate was 35.7%). The survey items included industry, firm size (number of employees), profitability, years of operation, use of computers, innovative business activities, and R&D activities. The questionnaire was multiple choice and all variables were discrete in nature. For this study, samples that lack some of the information necessary for the analyses have been eliminated and the total number of samples used here is 5,245 companies. The sample includes 2,702 manufacturing firms, 1,470 construction firms, 449 wholesalers, 215 retail firms, 189 service firms and 220 firms in other industries. The use of firm level data of this size appears unique for a study of this type.

The relationship between the key variables was firstly gauged by calculating a number of simple summations, followed by regression analysis, in order to assess the relationship between IT and company performance, after controlling for firm characteristics. The estimation methods used are a probit model for the relationship between the use of IT and innovative activities; and an ordered-probit model for the relationship between the use of IT and profitability. Probit and ordered-probit analysis is used since all of the variables are discrete due to the survey design, as mentioned above.

Among the dependent variables, innovative activities (abbreviated as INNOV) are defined broadly. Specifically, if a firm responded "yes" to the questionnaire "has your firm developed new products or new services during last three years?" or the questionnaire "has your firm entered into new business activities during last three years?" INNOV=1, and otherwise INNOV=0. Profitability (abbreviated as PROF) equals 2, if a firm responded as "profit", equals 1, if a firm responded as "almost balance", and equals zero, if a firm responded as "deficit" to the questionnaire "how is the current profit after depreciation?" The general equations that I estimate are as follows:

$$\mathrm{Prob(INNOV = 1)} = \Phi(\beta'\mathbf{x}),$$
$$\mathrm{Prob(INNOV = 0)} = 1 - \Phi(\beta'\mathbf{x}) \qquad (1)$$

$$\mathrm{Prob(PROF = 0)} = \Phi(-\beta'\mathbf{x})$$
$$\mathrm{Prob(PROF = 1)} = \Phi(\mu - \beta'\mathbf{x}) - F(\beta'\mathbf{x})$$
$$\mathrm{Prob(PROF = 2)} = 1 - \Phi(\mu - \beta'\mathbf{x}) \qquad (2)$$

$\beta$ is a vector of the set of parameters. $\mathbf{x}$ is a vector of independent variables ($\mathbf{x}'$ = [I1, I2, I3, I4, I5, L1, L2, L3, L4, COMP, RD]), where I1 to I5 are industry dummies, L1 to L4 are company size dummies, COMP is a dummy for companies using computer, and RD is a dummy for companies conducting research and development.

Of the independent variables, the most important for the purpose of this study is IT equipment (abbreviated as COMP) which equals 1, if a firm responded as "using computer for business," and zero for a negative response to the questionnaire "are your firm using computer for your business?" The coefficient of COMP is expected to be positive, as most previous studies have found a positive contribution of IT on firm performance. In each estimation equation, I include R&D activity (abbreviated as RD) as an independent variable. RD equals 1, if a firm responded "yes" to the questionnaire "are your firm conducting research and development," and otherwise RD = 0. RD is expected to have a positive coefficient to explain innovation (equation (1)).

To control for the effect of firm and industry characteristics, dummy variables are used. These are manufacturing industry (I1); construction (I2); wholesale (I3); retail (I4); services (I5) and other industries (I6). Firm size dummy variables are also employed to indicate employment of respondents, these being: L1 (1–4 employees); L2 (5–19 employees); L3 (20–49 employees); L4 (50–99 employees) and more than 100 employees (L5). The dummy variables used are I1 to I5 and L1 to L4 because I6 and L5 are used as benchmarks. Larger firms are expected to be more likely to engage in innovative activity. Hence, the coefficients of L1, L2, L3 and L4 are expected to be negative and a larger figure is anticipated for smaller size classes in the equation (1). A similar result is expected for equation (2), because the ratio of unprofitable firms in Japan is usually higher for smaller size classes. Finally, to compare the effect of COMP among different size classes, the sample is divided into the five classes mentioned above so as to conduct a similar examination. In these estimations the dummies for firm size are eliminated so as to assess the significance and size of the COMP coefficients in different size classes.

Finally, to compare the effect of COMP among different size classes, I divide the sample into five size classes as mentioned above and conduct a similar estimation separately. In these estimations, I eliminate the dummies for company size. The focus here is the significance and the size of the COMP coefficients in different size classes.

## 3. Results

### 3.1. *Company size and IT equipment*

The existence of a positive relationship between firm size and the propensity to use computers is shown in Table I. The hypothesis of insignificant differences between any two-size classes is easily rejected, using *t*-test, although the significance level between the largest two size classes is relatively low.

### 3.2. *Use of IT and innovation*

With regard to the relationship between IT investment and innovative activities, firms using computers are found in Table II to be more likely to engage in innovative activities than firms without R&D. The hypothesis of no difference in the ratio of innovative firms between the two groups can be easily rejected from the results of the *t*-test. Further, firms with R&D are found to be more

TABLE I
Company size and the use of computers

| Company size (number of employee) | Number of companies | Number of companies using computers | Ratio |
|---|---|---|---|
| 1–4 (L1) | 2,702 | 628 | 23.2% |
| 5–19 (L2) | 1,470 | 859 | 58.4% |
| 20–49 (L3) | 449 | 386 | 86.0% |
| 50–99 (L4) | 215 | 201 | 93.5% |
| 100– (L5) | 409 | 396 | 96.8% |
| Total | 5,245 | 2,470 | 47.1% |

*Source:* Small and Medium Enterprise Agency (1999), Survey of Corporate Management Activties.

TABLE II
Computers, R&D and innovation

| | Number of companies with innovation | Total number of companies |
|---|---|---|
| Companies using computers | 975 (39.5%) | 2,469 (100.0%) |
| Companies not using computers | 424 (15.3%) | 2,776 (100.0%) |
| Companies with R&D | 566 (63.0%) | 898 (100.0%) |
| Companies without R&D | 833 (19.2%) | 4,347 (100.0%) |

*Source:* Small and Medium Enterprise Agency (1999), Survey of Corporate Management Activties.

positive in innovative activities than firms without R&D, using a *t*-test.

The results of estimation of equation (1) reveal that the coefficient for COMP is positive and significant (Table III). Even if RD is included as an independent variable, the coefficient of COMP is still significant. This means that the use of computers by Japanese SMEs has a positive relationship with innovative activity, after controlling for basic firm characteristics and R&D activity. Note that the coefficient on RD is larger than the coefficient on COMP, with the probability of innovation 11 per cent higher for firms with IT equipment and 28 per cent higher for firms with R&D. The coefficients on firm size are, as expected, more negative for smaller size classes. This implies that there is an inverse relationship between firm size and the probability of engaging in innovative activity.

According to the results estimated by company size classes, a positive and significant relationship is found between IT equipment and innovation for small size classes (1–4 and 5–9 employees, respectively) but the COMP coefficient becomes insignificant for larger size classes, with over 20 employees (Table IV). In addition, the coefficient for COMP is larger for the smallest size class (1–4 employees) than that for 5–19 employees. Notably, the coefficients for RD are significant for all size classes and the size of the coefficients does not differ markedly.

The finding of a strong linkage between the use of IT and innovative activities for only smaller firms is a remarkable result. One possible interpretation is that most of the innovations conducted by small companies are characterized as entries into various niche markets or the creation of small markets through minor modifications of prevailing products or services. In contrast, large and medium firms need to invest in formal R&D in order to actualize innovation and a mere investment in general computers is insufficient for innovation to occur. This result is consistent with the idea that the innovation activity of small and medium firms occurs in a different technological environment (Acs and Audretsch, 1988; Breschi et al., 2000).

### 3.3. *Use of IT and profitability*

Japanese companies that invested in IT were found to be more profitable than those that did not – suggesting that more flexible firms capable of embracing technological change were able to maintain their competitiveness in a difficult economic environment in Japan (Table V). Over 30 per cent of firms that use IT equipment were found to be profitable, whereas only 15 per cent of firms without IT equipment were profitable. The hypothesis of no difference in the ratio of profitability between the two groups can be easily rejected from the *t*-test results.

Further support for the link between IT investment and profitability is found in Table VI. According to the estimation results of the ordered-probit model (equation 2), the coefficient on COMP is positive and highly significant, after

TABLE III
Estimation results for innovation

| | Coefficient | *t*-statistic | *P*-value | Coefficient | *t*-statistic | *P*-value | Coefficient | *t*-statistic | *P*-value |
|---|---|---|---|---|---|---|---|---|---|
| L1 | –0.8041 | –10.3553 | [0.000] | –0.5156 | –6.2984 | [0.000] | –0.7979 | –10.5940 | [0.000] |
| L2 | –0.5806 | –7.7647 | [0.000] | –0.3197 | –4.0649 | [0.000] | –0.4563 | –5.9272 | [0.000] |
| L3 | –0.3412 | –3.8964 | [0.000] | –0.1336 | –1.4573 | [0.145] | –0.1684 | –1.8407 | [0.066] |
| L4 | –0.4962 | –4.6033 | [0.000] | –0.2868 | –2.5519 | [0.011] | –0.2958 | –2.6338 | [0.008] |
| COMP | 0.5111 | 11.0501 | [0.000] | 0.4219 | 8.8104 | [0.000] | | | |
| RD | | | | 1.0322 | 19.5185 | [0.000] | 1.0801 | 20.5891 | [0.000] |
| Number of observations | | | 5245 | | | 5245 | | | 5245 |
| Log likelihood | | | –2739.6 | | | –2545.1 | | | –2583.9 |

*Note:* Estimated by Probit model. Dependent variable is innovation (INNOV).
L1–L4: company size; COMP: companies using computers; and RD: companies with R&D.
Regressions include a constant and industry dummies (results are not indicated in the table).

TABLE IV
Computers, R&D and innovation (by company size)

| | | Coefficient | *t*-statistic | *P*-value |
|---|---|---|---|---|
| All size | COMP | 0.5811 | 14.0825 | [0.000] |
| | RD | 1.0919 | 21.0826 | [0.000] |
| L1 (1–4) | COMP | 0.5129 | 7.7678 | [0.000] |
| | RD | 1.0990 | 12.2941 | [0.000] |
| L2 (5–19) | COMP | 0.3112 | 4.0110 | [0.000] |
| | RD | 1.0071 | 10.5662 | [0.000] |
| L3 (20–49) | COMP | 0.1518 | 0.7852 | [0.432] |
| | RD | 1.1465 | 7.5473 | [0.000] |
| L4 (50–99) | COMP | 0.6070 | 1.4588 | [0.145] |
| | RD | 1.0671 | 4.9149 | [0.000] |
| L5 (100–) | COMP | 0.5703 | 1.3892 | [0.165] |
| | RD | 0.8871 | 5.9704 | [0.000] |

*Note:* Estimated by Probit model. Dependent variable is innovation (INNOV).
L1–L4: company size; COMP: companies using computers; and RD: companies with R&D.
Regressions include a constant and industry dummies (results are not indicated in the table).

TABLE V
Using computers and profitability (number of companies)

| | Profit | Roughly balance | Loss | Total |
|---|---|---|---|---|
| Companies using computers | 757 | 675 | 1,037 | 2,469 |
| | 30.7% | 27.3% | 42.0% | 100.0% |
| Companies not using computers | 425 | 831 | 1,520 | 2,776 |
| | 15.3% | 29.9% | 54.8% | 100.0% |

*Source:* Small and Medium Enterprise Agency (1999), Survey of Corporate Management Activties.

TABLE VI
Estimation results for profitability

| | Coefficient | *t*-statistic | *P*-value | Coefficient | *t*-statistic | *P*-value |
|---|---|---|---|---|---|---|
| L1 | –0.8465 | –12.2295 | [0.000] | –0.8170 | –11.5358 | [0.000] |
| L2 | –0.7029 | –10.4397 | [0.000] | –0.6766 | –9.8528 | [0.000] |
| L3 | –0.4497 | –5.6955 | [0.000] | –0.4293 | –5.3900 | [0.000] |
| L4 | –0.5203 | –5.3557 | [0.000] | –0.4992 | –5.1066 | [0.000] |
| COMP | 0.1903 | 4.9589 | [0.000] | 0.1810 | 4.6829 | [0.000] |
| RD | | | | 0.0904 | 1.9594 | [0.050] |
| Number of observations | | | 5245 | | | 5245 |
| Log likelihood | | | –5298.6 | | | –5296.7 |

*Note:* Estimated by Ordered-Probit model. Dependent variable is profitability (PROF).
L1–L4: company size; COMP: companies using computers; and RD: companies with R&D.
Regressions include a constant and industry dummies (results are not indicated in the table).

controlling for industry and firm size. The coefficient for RD is also positive and significant. Surprisingly, if COMP is included as an explanatory variable, the size and significance level of the RD coefficient falls substantially. However, the size and significance of the COMP coefficient is not affected by the inclusion of RD as an explanatory variable.

With respect to the estimation results by company size classes, a similar result is found in that a significant relationship between the use of computers and profitability is exists only for small firms There is a positive and significant relationship between IT equipment and profitability for smaller size classes (1–4 and 5–19 employee classes). However, the COMP coefficient becomes insignificant for larger size class, such as firms with more than 20 employees (Table VII). It therefore appears that the introduction of computers is an effective strategy for smaller firms seeking to become more profitable.

## 4. Conclusion

This study examined the relationship between IT diffusion, innovation and firm performance in a relatively large sample of Japanese SMEs. The major finding of the study was a positive relationship between IT equipment and firm performance, after controlling for industry, firm size and R&D effort. It appears that these results hold uniformly for small firms only and underscore the importance of IT investment as a determinant of the performance of small firms, with IT diffusion a reliable indicator of better performing firms.

The finding of the positive link for small firms between IT, innovation and profitability appear to be especially important for Japan, where small firms account for a huge share of economic activity. As described in the introduction, the Japanese Government has been eagerly promoting the diffusion of IT among Japanese businesses and the results of this study support this policy approach, especially for IT diffusion among SMEs. The circumstances of severe domestic financial constraints in the Japanese economy, with falling bank lending to small business, also suggest the need for government-led IT-promotion policies.

Some limitations are embedded in the study's methodology because of the nature of the data used and because the original survey was multiple choice in nature and all variables are discrete. Consequently, the relationship between IT and firm performance should not be interpreted as a quantitative relationship. The results do not necessarily imply that the more a firm invests in IT, the more it becomes profitable. The results only

TABLE VII
Computers, R&D and profitability (by company size)

| | Independent variables | Coefficient | *t*-statistic | *P*-value |
|---|---|---|---|---|
| All size | COMP | 0.3735 | 11.2276 | [0.000] |
| | RD | 0.2073 | 4.6372 | [0.000] |
| L1 (1–4) | COMP | 0.1923 | 3.5868 | [0.000] |
| | RD | –0.0362 | –0.4528 | [0.651] |
| L2 (5–19) | COMP | 0.1792 | 2.8580 | [0.004] |
| | RD | 0.1775 | 2.1431 | [0.032] |
| L3 (20–49) | COMP | 0.1241 | 0.7806 | [0.435] |
| | RD | –0.0590 | –0.4565 | [0.648] |
| L4 (50–99) | COMP | –0.2993 | –0.9589 | [0.338] |
| | RD | 0.2777 | 1.4748 | [0.140] |
| L5 (100–) | COMP | 0.3755 | 1.1379 | [0.255] |
| | RD | 0.1624 | 1.2275 | [0.220] |

*Note:* Estimated by Ordered-profit model. Dependent variable is profitability (PROF).
Regressions include a constant and industry dummies (results are not indicated in the table).

indicate that a small firm with IT equipment tends to be a profitable firm. The other limitation of the study is that the survey was conducted only in one year and that the positive relationship between IT and firm performance does not necessarily mean a causal relationship.

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## Notes

[1] The author was responsible for drafting the White Paper on Small and Medium Enterprises in Japan (Small and Medium Enterprise Agency, 1999), when he was working with the Agency. The study uses a survey conducted in the process of drafting the White Paper.

[2] Gordon (2000) is skeptical of the contribution of IT to U.S. macroeconomic performance.

[3] In Japan, the number of such analyses is small, although Matsudaira (1998) finds some positive links between IT and firm performance based on a small sample of large companies.

[4] Cohen and Levin (1989) is a representative survey on the Schumpeterian hypothesis. Symeonidis (1996) also presents a comprehensive survey on this topic. Wakasugi et al. (1997) is an example to test empirically the Schumpeterian hypothesis by using Japanese company data.

[5] Acs and Audretsch (1988) and Breschi et al. (2000) present evidence on this point.

[6] The definitions of "small and medium business" and "small business" here are from the Small and Medium Enterprise Basic Law. According to the Law, "small and medium business" is defined as (1) For manufacturing, mining and transport, companies and individuals with regular employees of 300 or less and companies with a maximum of 300 million yen in capital; (2) For retail and service industries, companies and individuals with no more than 50 regular employees and companies with a maximum of 10 million yen in capital; and (3) For wholesale industry, companies and individuals with no more than 100 regular employees and companies with a maximum of 30 million yen in capital. Similarly, "small business" is defined as (1) For manufacturing, mining and transport, companies with no more than 20 regular employees and individuals; and (2) For wholesale, retail and service industries, companies with no more than 5 regular employees and individuals.

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