Contributions of ICT to sustainable information society: Managerial, macroeconomic, and environmental impacts in Japan

Toshiya Jitsuzumi, Hitoshi Mitomo, Hajime Oniki

February 21, 2000

Contributions of ICT to sustainable information society: Managerial, macroeconomic, and environmental impacts in Japan

Toshiya Jitsuzumi[1], Hitoshi Mitomo[2], Hajime Oniki[3]

Abstract

We aim at introducing the three-year research project on Information and Communication Technology for Japan (PICTJ) and presenting tentative outcomes from the first-year research. Preliminary findings from our questionnaire inquiry include the continuous growth trend of Japanese ICT investment, a possible sectoral variations of investment objectives, and corporate recognition of ICT's environmental impact. Further research will reveal whether Japan can go on a path of economic recovery and growth if they make more investment in ICT; whether there are any evidence that ICT improves productivity in Japan; and whether ICT plays a substantial role for sustainable development.

1. Introduction: Background and Purposes

The purpose of this paper is twofold: to introduce the scheme and the outline of the authors' three-year research project on Information and Communication Technology for Japan (PICTJ) and to show tentative outcomes from the first-year research. In view of the possibility of joining the Fifth Framework of EU, they formed a work group within the Institute for Posts and Telecommunications Policy (IPTP) in collaboration with the Mitsui Knowledge Industry (MKI), an established research institute in Japan in the economics of information and communication.

Our research was originated from a simple question on the development of ICT: Why has telework and telecommuting (T/T) not become popular in Japan while it has in the United States? T/T, which is a new style of working that utilizes ICT and substitutes virtual commuting for physical one, has been expected to raise workers' well-being, firms' productivity, and the social welfare. Since 1996, Jitsuzumi, Mitomo and Oniki have focused their respective attention on the social consequences of T/T. For example, Mitomo & Oniki (1999) showed how ICT could play important roles in societies pursuing sustainability by using an estimation of CO_2 reduction from the utilization of ICT in Japan. Mitomo & Jitsuzumi (1999) analyzed the impact of telecommuting on mass transit congestion. In these articles, they asserted that, in theory, the actual level of T/T diffusion was less than the socially optimal one, so that some public support for promoting T/T is desirable.

In the early 1990s, metropolitan areas in the United States, especially those in California, were suffering from heavy congestion of automobile traffic and air pollution from exhaust gases. State and local governments planned to promote telecommuting to solve the problem. However, in reality, such attempts did not succeed because people did not choose to telecommute nor did firms choose to have employees telecommute along the line and within the time period laid down by governments. Despite the failure,

[1] MBA, Senior Researcher, Institute for Posts & Telecommunications Policy. E-mail: t-jitsuzumi@mpt.go.jp
[2] Dr., Professor, Senshu University. E-mail: mitomo@isc.senshu-u.ac.jp
[3] Ph.D., Professor, Osaka-Gakuin University. E-mail: oniki@iser.osaka-u.ac.jp

however, the number of telecommuters has gradually increased; in fact, a forecast states that the number of telecommuters will exceed 20 million in the year of 2000 (e.g., see JALA's web site, [http://www.jala.com]).

Our research, after it was started around the analysis of T/T, is being extended to considering T/T and other issues related to ICT. In short, the objective of our research is to understand the overall impacts of ICT in Japan. Comparison with the situation in U.S., where ICT was developed earlier, and is utilized broader, than in other countries, is found particularly useful. Let us explain this.

In the 1990's, the Japanese economy was in a deep and prolonged depression. Since 1992, i.e., after the collapse of "the bubble", the Japanese economy continued to decline. Statistical data showed that the real economic growth rate (annual growth of GDP) fell to a negative level and the unemployment rate reached 5 percent in 1998. Until then, the unemployment rate of Japan was the lowest among advanced countries. Although in 2000 there are some indications that the economy may be recovering, it does not seem to be strong enough to reverse the downward trend completely.

Recently, ICT investment is expected to be a powerful remedy to the depression of the Japanese economy. We may state that not only Japanese but also worldwide opinions support this, although there is a minority objection to this view. Although a great deal of ICT investment has been made so far in Japan, the investment level is not great enough to induce substantial effects for a recovery of the aggregate economy of Japan.

In relation to macroeconomic effects of investment in ICT, we note that certain empirical analyses showed no evidence which supports that ICT investment raises productivity[4]. This is the "Productivity Paradox." From the data used for these analyses, such conclusion may be deduced. However, the authors, as well as the majority of users of ICT products and services, do not agree with this assertion. If ICT investment had not raised the productivity and/or the efficiency of the operations conducted by the users of ICT, on which they spend a great deal of money, no investment in ICT would have been made. People spend on computers and Internet services simply because they are useful to them. The paradox comes from the inability to measure the usefulness of ICT products and services. The authors' view to this issue is as follows: the ICT investment has so far affected implicitly, i.e., in a form which does not directly change the conventional measure of growth such as price and quantity data on corporate activities. ICT investment improves production, transaction with outside organizations, and internal coordination; in effect, it brings about advantages over competitors, reduces transactions cost, raises productivity, and realizes more efficient societies. We will discuss this point in more detail in the following section.

We assert that one of the major reasons that telecommuters in the U.S. increased is that a new mode of economic growth called the "New Economy" required more efficient labor inputs. In a growing economy, the demand for labor exceeds the supply, which may result in a higher wage rate and inflation. However, as long as labor productivity is increasing, it will offset the increased demand for labor. T/T is considered as an important means to increase the efficiency of labor supply. Investment in ICT contributed to increasing

[4] See EPA (1997); and Mizoguchi, et al., eds. (1996) for attempts to measure the contribution of ICT investment in Japan.

the productivity of other factors of production. In fact, the U.S. economy has been characterized by its first achievement of what may be called the non-accelerating inflation rate of unemployment.

Once T/T becomes popular, social benefits such as relieving environmental burden could be realized. This is a case where sustainability is attained through virtual commuting using ICT.

Although, in Japan, the reasoning stated above seemed to hold in the same way as in the U.S., T/T failed to relieve heavy congestion in the metropolitan area or to reduce CO_2 emission. Further, the need for restoring the depression in the 1990s was not a reason for promoting T/T. In fact, according to a survey (SOAJ, 1996), only 0.68 million white-collar workers were telecommuting in 1996, though this figure might be decreased thereafter. Advocates of T/T insist that insufficient telecommunications infrastructure, expensive tariff, poor housing, and the Japanese style of employment and job appraisal are the reasons for the immaturity of T/T. This is in part true. However, our insight suggests that the difference in T/T penetration level between Japan and the U.S. is rather due to the difference in macroeconomic situations.

The U.S. experienced economic stagnation in the 1980s. Emergence of ICT-oriented small business absorbed unemployment, and continuous ICT investment has induced an economic structure with high productivity. In the 1990s, the economy expanded further and more ICT investment was made. Thus, the U.S. economy is considered to be in a positive feedback loop. On the other hand, sufficient ICT investment has not been made to get out of the stagnation since the early 1990s in Japan.

Our goal in this project is to make sure that whether Japan can go on a path of economic recovery and growth if they make more investment in ICT; whether there are any evidence that ICT improves productivity in Japan; and whether ICT plays a substantial role for sustainable development. To achieve these research goals, we have started this three-year project. Below, a further explanation of this project is given in the following section. In Section 3, we show some tentative results of our first-year part of the project. That is, a questionnaire survey on ICT applications on corporate management. Section 4 gives concluding remarks.

2. Project on Information and Communication Technology for Japan (PICTJ)

2.1. Members and Framework

In order to investigate the above mentioned issues and also to contribute to the EU's research initiative, "IT and sustainability", the Institute for Posts and Telecommunications Policy [IPTP], a governmental research institution for the Ministry of Posts and Telecommunications, initiated a research project which is named "Contributions of ICT to sustainable information society: managerial, macro-economic, and environmental impacts in Japan"; and, in April 1999, organized a project team which consists of the following three members: Toshiya Jitsuzumi, Senior Researcher, IPTP; Hitoshi Mitomo, Dr., Professor, Senshu University; and Hajime Oniki, Ph.D., Professor, Osaka-Gakuin University. Since then, chaired by Dr. Mitomo, this team discussed the basic framework of the whole research project which is expected to continue for three years.

Indeed, IPTP has been studying issues associated with ICT's impacts on Japanese society in the last

several years. This project builds on that work, but represented a significant departure from those earlier studies as our focus has been on the investment decision of corporate management and its impact on macroeconomic and environmental circumstances. As it turns out that a nation-wide questionnaire survey is required to satisfy this research interests, IPTP agreed to make an additional financial contribution and called for the Mitsui Knowledge Industry Co., LTD. [MKI] as a partner of this project. Finally, four additional members joined the team: Yoshiaki Kasai, Researcher of IPTP; Osamu Kayasono, Kosuke Nakano, and Takashi Shitomi from MKI. Since August 1999, the expanded team gathered approximately once a month, decided the detailed framework, designed the questionnaire, and evaluated survey results.

The three-year project will be conducted as follows:

- ✓ In the first year (fiscal 1999, that is, April 1999 – March 2000), we carry out a questionnaire survey to collect data on how much and what kind of ICT investment has been made in major Japanese corporations and how it has affected the efficiency of intra- and inter-corporate activities.
- ✓ In the second year (fiscal 2000), we will attempt a statistical analysis on the questionnaire results to make sure whether a significant effect of ICT on corporate management can be seen. In parallel with the analysis, a theoretical model will be formulated to describe how ICT investment in Japan can affect macroeconomic indicators.
- ✓ In the third year (fiscal 2001), a cross-sectional econometric analysis will be conducted on the questionnaire survey data combined with corporate financial data such as those picked up from P/Ls and B/Ss of the year 1999 available in 2001. And the project will be concluded with some policy implications.

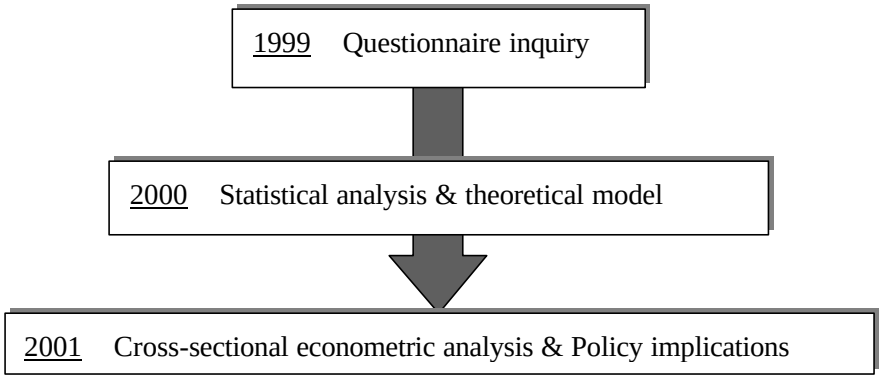


Fig. 2.1. The three-year project

2.2. Key Issues

In this section, we will explain some of the complicated issues and the difficult problems arising in systematic research on ICT and its impacts, particularly when the research is conducted from economic and quantitative aspects. An attempt is made to explain how we intend to approach and hopefully solve them in this research project. We will do this by considering two subjects: the causes and the effects of T/T, and the Productivity Paradox.

Research on ICT is no more difficult than the one on other economic objects when the objective is observation and description of what is taking place with ICT, i.e., when the objective is data collection. Needless to say, data collection is the starting point of any analysis; in our project, most of the research activities during the first-year period was in fact devoted to data collection and fact findings, as explained in a later section.

When it comes to analysis, i.e., finding causes and effects, identifying functional and mutual relationships, and making predictions, the complexity and the difficulty dealing with ICT is far greater than with other objects. When quantitative assertions are sought, the task often seems to turn from being complicated and difficult into impossible. Research scholars all know this. From time to time, they are forced to produce very shaky and imprecise assertions, feeling as if telling a lie. Our first question in this section is "Why is this so? Why is economic and quantitative research on ICT is so difficult?"

An immediate answer which will probably come up to mind is something like the following: the usefulness of ICT arises from the qualitative, as opposed to the quantitative, aspect of research objects such as commodities, services, and the society as a whole. If we use an analogy, we may state, "What ICT is to an economic organization, say, a business firm, is what the brain and nerve system is to a living entity, e.g., a human being." When the functioning of the brain and nerve system of a worker is improved by, say, training, he may become capable of doing a task which he could not at all before the training; a qualitative, discrete progress was achieved. It is quite common that the benefit from this progress far exceeds the conventional cost of training. The value of the school-education system to the whole society can be understood along the same line; thus, people are often generous to bearing the cost of school education. The same is true with the value of ICT investment to a business organization. When an ICT investment successfully improves the production, or other, process of a firm, some qualitative improvement is achieved to the product. A typical example is microelectronic (as opposed to traditional human-controlled) assembly systems for automobiles. The value of such successful ICT investment is often so large that it is beyond conventional measures.

We observe that the cost of the goods and services composing an ICT investment is conventionally measurable. Thus, computers, software products, and networks are sold for prices; the supply side of ICT investment is within the market valuation. What is difficult to evaluate is its "usefulness" side.

Other sources of difficulties in economic and quantitative research on ICT may also be mentioned. First, we observe that ICT can affect almost every aspect of the function of, say, a business firm. It may improve machine operations, human works, team coordination, top management, etc. ICT may be useful for internal operations of a firm, for marketing and customer relations, and for procurement. Note that a single ICT commodity, say a personal computer(PC), may be used for all of these operations; the monetary value of the usefulness of a PC must be quite different depending on the way it is used.

Second, although the cost of goods and services of ICT investment is determined in the market and it is thus measurable conventionally, the composition of the cost is often indeterminate and unstable. Let us explain. As is well known, the major component of the cost of ICT goods is fixed cost such as the

research and designing cost. Once a prototype is successfully completed, the rest of the production process is straight-forward; it is the one of mass production or copy-making. True, this applies to almost all products, ICT or not. But the relative magnitude of the fixed cost is high with ICT goods, as seen typically in software products. Consequently, it is common that the supply price of ICT goods and services is determined strategically by the supplier depending on market conditions. The way that the fixed cost is defrayed over products (i.e., the price to be attached to each ICT good) is not stable. In other words, the rate of profit of ICT goods may be quite high, low, or even negative. Thus, it is not so easy to determine the effects of ICT investment, of which the supply price as well as the usefulness is on shaky ground.

In the following we consider two examples of research objectives in the impacts of ICT, the determinants and the effects of T/T and the Productivity Paradox, to explain the standpoint of this project.

2.2.1. Telework/telecommuting(T/T)[5].

T/T, or in general ICT, is expected to play important and wide-ranged roles for the society as a whole. Contribution to sustainability is an important, perhaps the most important, role. We state that, in general, ICT may contribute to the society through three distinct routes: a) direct technological effects, (b) indirect contributions through changes in the behavior of individuals and organizations, and (c) promotion of the overall decision-making capability of a society.

First, direct effects arise from the increase in the efficiency of facility operations or human activities through the use of ICT goods and services. Examples are the saving of energy with air conditioners through controlling them by information devices, and the saving of energy for transportation by means of intelligent transport systems (ITS).

Indirect contributions come from changes in the style of living and work with the use of ICT. For example, T/T saves not only the daily commuting time of workers but also the energy consumed for commuting. Other examples are the development of remote-sensing devices to monitor the state of global environment, and the use of computerized bidding mechanism for trading the right to emit CO_2. These are but a few of the many examples of possible ways through which ICT contributes to sustainability and other objectives of the society.

There is one more way; ICT improves the overall decision-making capability of a society to implement relevant public policies. Collective decision making on public policies, however, are subject to political factors. In a democratic society, a collective choice which influences the majority of the people can be supported only with the approval by them. This means that, in order to accept the consequences of public policies useful, say, for the global community as a whole in the long-run but often go against the direct and short-run interests of individuals and communities, the majority needs to understand the consequences of selfish decisions to the world as a whole, and eventually to each of them. Knowledge society is a prerequisite for sustainability in this sense, and ICT can help one built as quickly

as possible and hopefully before it becomes too late.

We next consider the causal relations of T/T. The development of ICT helps people telework, thus relieving them of physical commuting and decreasing the atmospheric emission of CO_2. This is easy to understand at a glance, but the causal relations involved may be complicated, calling for careful attention when public policies are formulated for T/T. Below, we will mention some of the important causal relations around T/T[6].

Observe first that the promotion of T/T contributes to the reduction of atmospheric emission of CO_2, and the reduction of CO_2 contributes to sustainability.

Next, the penetration of T/T depends on ICT technology and services and also on policy instruments (such as government subsidies). In addition, we point out possible effects of policy instruments on ICT technology and services themselves.

It is noted that the decision on T/T is made by workers and corporate management for private benefits, not for global sustainability. Likewise, the development of ICT technology and services is a consequence of decisions made by ICT industries, seeking corporate objectives. The government (or the society as a whole) can influence T/T by means of various policy instruments, but it can do so only indirectly. Thus the government, in planning and implementing public policies for the promotion of T/T, needs to estimate the effects of its policies on the behavior of workers and management.

We further need to state, however, that ICT and T/T may contribute against sustainability, i.e. have a negative impact on the environment. There are several reasons for such effects. For instance, the actual reduction of transport due to T/T is less than expected due to a number of other transports taking place, such as personal transports during the day, transports at a later time to the offices, increase in customized delivery to the T/T personnel, and so on. When considering actual estimates of ICT and T/T on sustainability, it is therefore important to consider the net effects, not only the positive effects.

The complexity of causes and effects of T/T explained above indicates the vastness of the issue of ICT and sustainability. One can imagine hundreds of interconnected causal relations each of which looks like the one explained above. A research work such as this paper can report only a small portion of this issue.

2.2.2. The "Productivity Paradox"

The productivity paradox arises from findings in aggregate economic data which are apparently inconsistent with our daily experiences. On the one hand, ICT products and services are widely used by individuals and organizations, recognizing that ICT products and services are more than useful to their operations such as daily lives and office works. Yet on the other hand, aggregate economic time-series data together with standard economic tools for analysis (production functions or total factor productivity estimation) seem to indicate that ICT investment had little contribution to the (labor) productivity. In

---

[5] This subsection is a modification of a part of Mitomo & Oniki [1999].
[6] For a detailed explanation with diagrams, see Mitomo & Oniki [1999].

short, in spite of massive ICT investment in the 1960s through 1980s, the labor productivity during this period kept declining in U.S. and in other advanced countries.

A number of research scholars attempted to "explain" this paradox[7]. David (1989) pointed out the presence of "time factor"; it takes a long time for a new technology such as ICT to exhibit its full benefits to production because of the scale factor (the advantage of large-scale operation). Brynjolfsson & Hitt (1998b) showed that, if one uses micro-level data such as data of firms or establishments, the benefit of ICT investment seems to emerge, since those, say, firms investing large in ICT tend to produce greater profits, thus indicating the benefit of ICT, which is cancelled out and thus unobservable with aggregate data.

Brynjolfsson & Hitt (1998a) also argued that one of the reasons of the difficulty in observing the benefit of ICT investment arises from the fact that ICT investment is frequently made in order to improve managerial and organizational improvement of corporate operations, not to improve a single product or service. In addition, some, particularly those who are not "core economists", seem to agree that the paradox arises from the inability for statistical data to incorporate drastic advance in the quality of ICT goods are services and massive reductions in their price. For example, a PC produced in 2000 (PC_1) may be as twice powerful as a PC produced in 1999 (PC_0). If PC_0 and PC_1 are competitively sold in the same market, the price of PC_1 should be twice of the price of PC_0. In reality however, the competition in the PC market is so keen that, at the time PC_1 is offered, PC_0 is driven out of the market and its price is not observable. Statisticians would report the nominal price of PC_0 and PC_1 together with the quantity sold, ignoring the quality improvement with PC_1 over PC_0. Users of PC know the quality improvement very well, and they keep buying new PCs to be benefited from using higher-quality products. Thus, the aggregate demand for ICT goods and services keeps increasing, thanks to ever-improved quality and enhanced capability, but the aggregate economic data fail to capture this fact.

We think that all of the four explanations stated above are true; each of them expresses a portion of the dynamic process of the development and the use of ICT.

In this project, we plan to collect certain data for obtaining information as to the improvement in the quality of ICT goods and services. Needless to say, such information is not provided in the statistics collected with the conventional scheme, in which quality improvement is mostly neglected. Further, as stated previously in the beginning of this subsection, it is intrinsically difficult to obtain information on the usefulness of ICT goods and services, which should "define" the quality. In other words, the quality of ICT goods and services depends on how and by whom they are used.

In the questionnaire survey we conducted recently, we asked a few number of questions as to the "value" of ICT investment[8]. For example, we asked, "if the ICT investment made by your corporation during the past year had not been made, what percentage of the revenue would have been lost during the same period?" Theoretically, such is to collect information of the marginal product of the ICT

[7] See Brynjolfsson & Yang (1996) for a survey of articles.
[8] See Q9 & Q10 of Appendix.

investment, a means to evaluate its value. We plan to construct, if such information is successfully obtained through the survey, a quality-adjusted price indices of a bundle of ICT goods and services. By using such series, we plan to estimate the contribution of ICT investment to output at the industry level as well as at the aggregate level.

The rest of this subsection is devoted to explaining the approach we intend to use in this paper in order to deal with the productivity paradox. To do this, we will use a simplified example. We consider an airlines company (to be called Company A) facing severe competition via the introduction of frequent flyer programs by rival airlines. In the beginning, i.e., in base year 0, this company was operating with old-style computers and was offering no frequent flyer program. Because of the competition, however, Company A was forced to introduce a frequent flyer program in the following year, i.e., year 1. In order to do that, the company needed to invest heavily in computers. At that time, rapid advancement was being achieved in computer technology; consequently, the amount of money that this company invested in computers to implement the frequent flyer program was not so high as it was expected. Thanks to this investment and the newly introduced frequent flyer program, the company was able to maintain its revenue at the same level as in the base year.

Table 2.1. shows the state of Company A during the base year. The balance sheet shows that Company A was operating with aircraft in the value of 200 (million dollars) and computer 0 in the value of 10 (equal to 1 thousand dollars times 10 thousand computers), so that its net worth was 210 (million dollars). During the year, the company achieved a revenue in the amount of 100 (which is equal to 10 thousand passengers multiplied by the average revenue per passenger equal to 10 thousand dollars), paid 40 as wages, 20 as the depreciation allowances for the aircraft, 20 for fuels, and 10 for the depreciation allowances for computer 0, so that the profits left were 10. It is assumed that the computers depreciate in one year because of rapid obsolescence.

During the next year, i.e. the year 1, Company A introduced a frequent flyer program. New computers, computer 1, were purchased; the number of the new computers purchased was 10, and its nominal price was 1. The competition drove down the average revenue per passenger to the level of 5, but at the same time, the number of passengers was increased to be 20, thanks to the frequent flyer program, so that the revenue in year 1 was unchanged from that in year 0. Thus, the balance sheet and the profit and loss statement of Company A looks as seen in Table 2.2.

It is noted that the numbers appearing in Tables 2.1. and 2.2. are exactly the same, in spite of the changes having taken place with Company A. This might describe the situation we were observing in the 1970s and 1980s; i.e., on the one hand, there was investment in computers (for this case the investment in computer 1 by Company A), and on the other hand, there was no change in the aggregate output (in this case the revenue of Company A). Of course, in the example case, if the amount of the aviation services were measured correctly, then the increase in the number of passengers from 10 in the base year to 20 in the following year might have been detected and recorded, although such is not always possible for various reasons. For example, a service may be an aggregate of heterogeneous entities and

there may be no simple way to express them in one-dimensional measure. Further, since the change brought about by investment in computers is qualitative, not quantitative, it is frequently difficult to detect and quantify it.

Table 2.1.-3B. Nominal Accounting vs. "Real" Accounting: An Example with Airlines Company (Impacts of ICT Investment via Frequent-flyers Program)

Table 2.1: Before (Base Year t=0)
Nominal and Real Accounting:

B/S

Aircrafts:	200	Net Worth:	210
Computer0:	10 (=1x10)		

P/L

Wages:	40	Revenue:	100(=10x10)
Aircrafts:	20		
Fuel:	20		
Computer0:	10 (=1x10)		
Profits:	10		

Table 2.2: After (Year t=1)
Nominal Accounting:

B/S

Aircrafts:	200	Net Worth	210
Computer1:	10 (=1x10)		

P/L

Wages:	40	Revenue:	100(=5x20)
Aircrafts:	20		
Fuel:	20		
Computer1:	10 (=1x10)		
Profits:	10		

Table 2.3A: After (Year t=1)
Real Accounting in price of t=0
Case Real Revenue can be estimated

B/S

Aircrafts:	200	Net Worth:	250
Computer1:	50 (=5x10)		

P/L

Wages:	40	Revenue:	200(=10x20)
Aircrafts:	20		
Fuel:	20		
Computer1:	50 (=5x10)		
Profits (attributed):	70		

Table 2.3B: After (Year t=1)
Real Accounting in price of t=0
Case Real Revenue cannot be estimated

B/S

Aircrafts:	200	Net Worth:	250
Computer1:	50 (=5x10)		

P/L

Wages:	40	Revenue (attributed):	140
Aircrafts:	20		
Fuel:	20		
Computer1:	50 (=5x10)		
Profits:	10		

Notes: MP of Computer0 = 1, MC of Computer0 = 1, MP of Computer1 = 5 and MC of Computer1 = 1

In the example case discussed above, Company A experienced two changes between year 0 and year 1. The one is the improvement in the quality of the computers invested in year 1; the other is the reduction in the average revenue per passenger and the increase in the number of passengers. We will incorporate these changes in a revised balance sheet and a profit and loss statement. These revised tables may be called real, as opposed to nominal, accounting tables. First, we need to obtain some additional piece of information to quantify the increase in the quality of the computers; without some such information, no quantitative analysis of the impacts of a quality change in computers would be possible. In our research, as explained previously, we, in a survey, attempted to collect answers to a question such as "If the ICT investment made by your corporation during the past year had not been made, what percentage of the revenue would have been lost during the same period?" Suppose that the answer for the present example case was a decrease of revenue by 50. This means that the marginal product of computer 1 was 5 (50/10), whereas the marginal cost was 1. Second, assuming that the quality of the aviation service provided by Company A was the same as in the base year, we put the average *real* price per passenger in

year 1 to be the same as that in year 0, i.e., 10, increasing its revenue in the year-0 price to be 200. As seen in table 2.3A, this produces the (attributed) profits in the year-0 price to be equal to 70. This revision makes the *real* net worth of Company A to be 250, and the labor productivity in year 1 is doubled in the real terms in comparison with year 0.

By comparing Table 2.1. and Table 2.3A, we can recognize the consequence of the investment in computers in year 1, which is the increase in the (real) revenue by 100. A standard statistical method to measure the growth of the company (in the aggregate level, the growth of GDP) may be applied to the two tables.

Finally, we can consider the case in which we cannot obtain the real increase in the revenue, as in Table 2.3A. A way to handle this is explained in Table 2.3B. In this case, we put the attributed revenue in the real terms to be 140, balancing the *real* account. We may use Tables 2.1. and 2.3B for analyzing the effects in the investment in computer 1 without having data to express the increase in revenue achieved by the investment.

3. Managerial and environmental impacts of ICT: a survey

3.1. Outline

In this project, we assume that every firm would react to the exogenous challenge, which is either an opportunity or a threat to the firm, primarily through a strategic investment decision (Fig. 3.1.). These investments are expected to produce either or both of the following two types of innovation: an innovation in product ("product innovation"), which enables the introduction of new products or quality-improvement of the existing products; and an innovation in process ("process innovation"), which improves the firm's management efficiency and allows the firm to produce greater output with less input. When these innovations attain their expected targets, a firm can streamline its entire operation, generate better bottom-line figures, and realize some external effects, such as reducing environmental impacts. If a given firm attains these advantageous results, it can increase its market. If a single player can obtain this effect, competition will surely drive other firms to follow the suit. Then, what was once a change of a single non-market-dominant company will become the macro-economic trend of the whole nation, which would in turn create/produce another wave of exogenous challenges to corporate management ("feedback effect").

Assuming the above management patterns, the impact of ICT can be varied according to the following factors:

- ✓ The initial exogenous factors,
- ✓ The characteristics of firms (such as size, location, and when they went into business), whether the firm is involved in the ICT business or not
- ✓ How those exogenous factors are perceived and evaluated by the management
- ✓ How the management reacts to those exogenous challenges
- ✓ How they allocate their financial resources between product innovation and process innovation

- ✓ How smoothly those innovations attain the respective objectives
- ✓ How competitive the market is
- ✓ How the competitors react

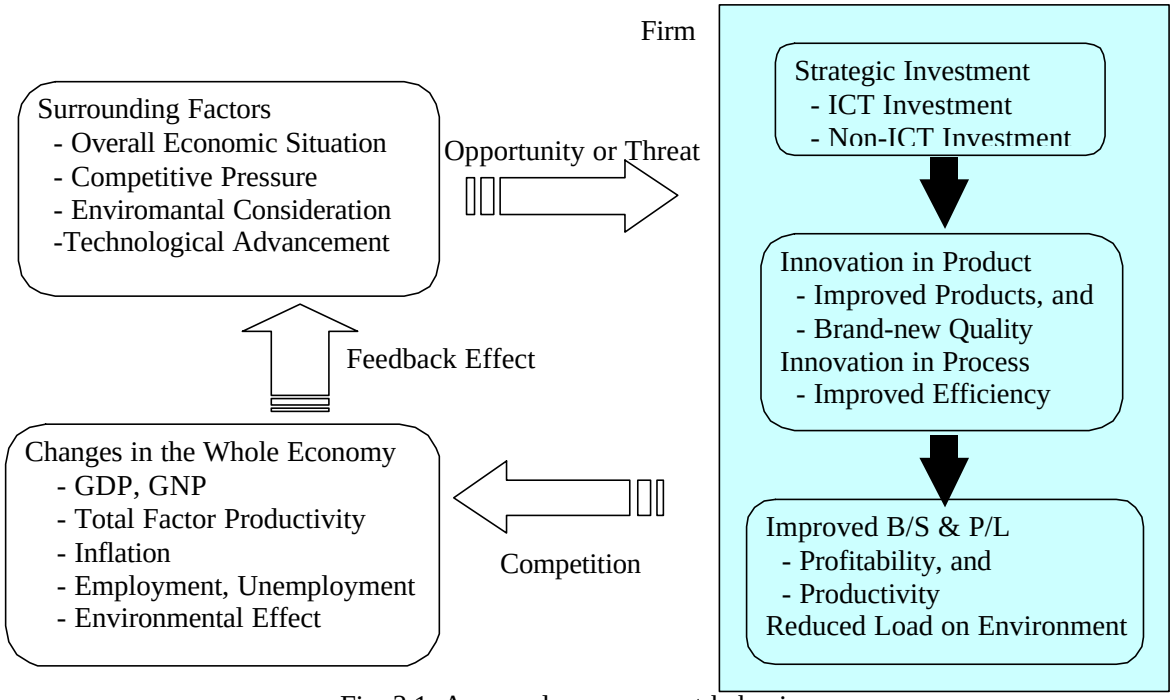


Fig. 3.1. Assumed management behavior

For example, the impacts of product or process innovation in the different time frameworks are expected to have different patterns as illustrated in Fig. 3.2.

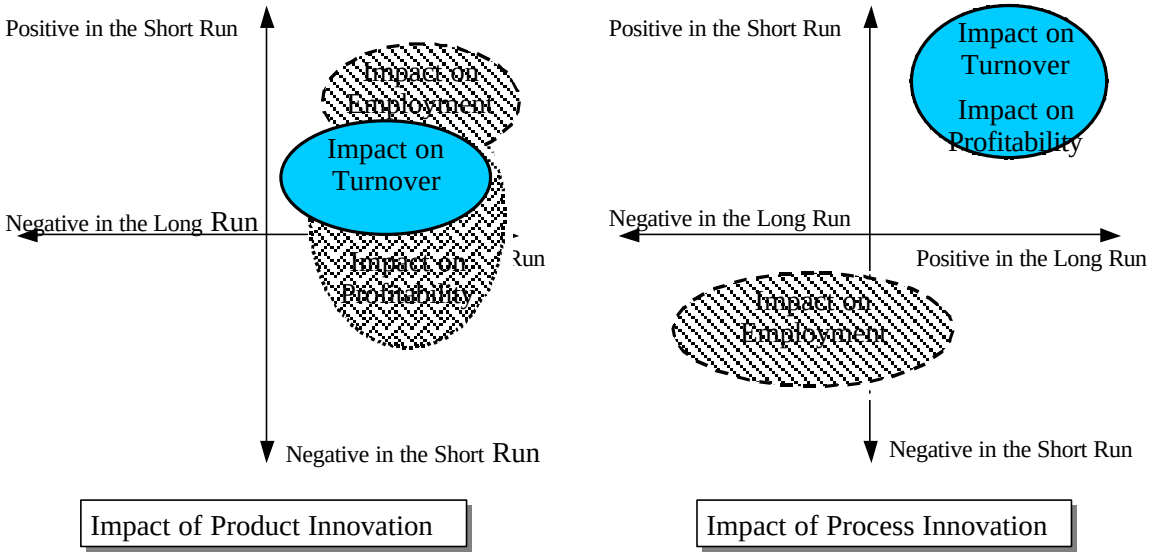


Fig. 3.2. Possible Impact of Innovations

Although Fig. 3.2. itself needs to be proofed and further investigated, it is possible that if some countries or sectors have uniqueness in allocating financial resources between these two types of innovations, they might experience certain uniqueness in ICT impacts on this economic sector or the nation's economy as a whole. Considering that job security is usually the single most important management as well as union concern in Japan, if Japanese ICT investment is heavy on the process innovation side, for fear of deteriorating job security, Japanese firms cannot so positively exploit the opportunity which ICT realizes as their US counterparts. If this is the case, it would offer some possible explanation of why Japan has not yet been enjoying the so-called "New Economy." Also, as Barras (1986) pointed out, sectoral difference concerning the sequence of product innovation and process innovation (i.e. a standard product cycle vs. a "reverse" product cycle) will make a remarkable difference on ICT's macroeconomic impact.

It is important to mention that, like other investments, ICT investments also need time to become fully effective in attaining their pre-determined goals. For example, Brynjolfsson & Hitt (1997) mentions that while short-term benefits were about what would be expected if they had "normal" returns, the long-term benefits were substantially larger: from 2 to 8 times as much as short-time benefits. In addition, as Brynjolfsson & Hitt (1998a, 1998b) again finds out, in order to cultivate the greatest benefits of ICT investment, it must be coupled with other complementary investments; new strategies, new business processes and new organizations (such as flatter and less hierarchical organizations). Therefore some difference in corporate history, its culture or trade practices may yield a big difference in the competitive advantage which is driven by ICT.

As mentioned in the previous section, the purpose of this year's research is to collect data concerning the status-quo of the corporate introductions of ICT and try to find out relationships between their ICT introduction and related factors, such as corporate strategy or overall economic situation.

Some empirical results have already been obtained in this field of study, which can be classified into the following two groups: a) case-studies on several forefront firms which frequently appear on trade-magazines or news articles, and b) a nationwide or sectoral analysis which is based on aggregated statistical figures. However, it is not appropriate to derive any general conclusion from the former study, and the latter study can not say anything about how the difference of corporate strategy on ICT will results in the difference in corporate performance. In addition, as Mizoguchi (1996) pointed out that the existing statistics on ICT may lead us to the wrong conclusion. Therefore, in order to overcome these deficiencies of previous researches, we are going to use individual company data collected randomly from the whole nation. The data set for the entire study will be created by combining two main data sources: the financial statements of all publicly-traded firms in Japan, excluding firms in agriculture, forestry and fishery sectors and a sector of firms which only be categorized as "Other"; also, a questionnaire survey which covers the same companies. The questionnaire, which is attached as an appendix, was mailed to 3,321 firms in the middle of January 2000 with 2 weeks' deadline for mail recovery.

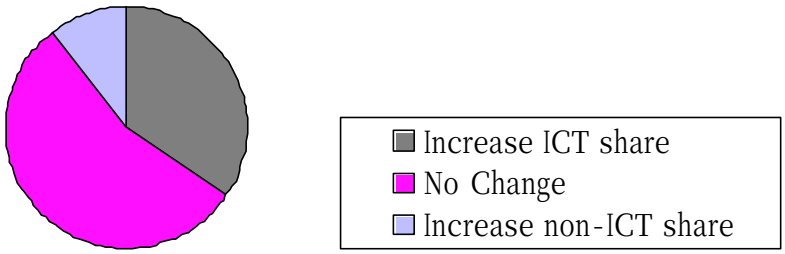
3.2. Preliminary results

Due to the time-constraints, here we can present a summary data of only 70 respondents, half of which are come from a manufacturing sector, and almost all of them are come from a non-ICT industry. The following are some of the very first analyses of our sample data and their possible implications.

I. **Utilization of networks (Q2)**: The results indicate that 72.7% of personal computers currently using in the sample firms are now connected to some kind of networks. Its share is less in manufacturing and construction sectors (68.8%) than in the remaining firms (78.4%). When focusing on PCs which are introduced in 1998, all of these figures are increased by 12 to 14 points.

II. **Attitude toward ICT investment (Q4)**: 34.3% of them plan to increase the share of ICT-related; only 10.4% plan to increase non-ICT share (Fig.3.3.). This figure is well consistent with several statistical figures, such as MPT (1999), which also shows a steady and continuous growth trend of ICT investment. The data also shows that, compared to the other firms, construction or manufacturing companies tend to be less positive in ICT investment.

Fig. 3.3. Balance of future investment



III. **Purpose of ICT investment (Q5)**: Most companies see the position of ICT cost as the means to facilitate process innovation rather than product innovation (Fig.3.4.). In addition, Fig.3.5. may show some pattern of section-wise variation of ICT investment. If this pattern reflects some uniqueness of Japanese industrial culture or management style, this figure may give us some explanation why Japanese ICT investment has not yet make so much positive impact as the US counterparts have done.

Fig. 3.4. Purpose of ICT investment

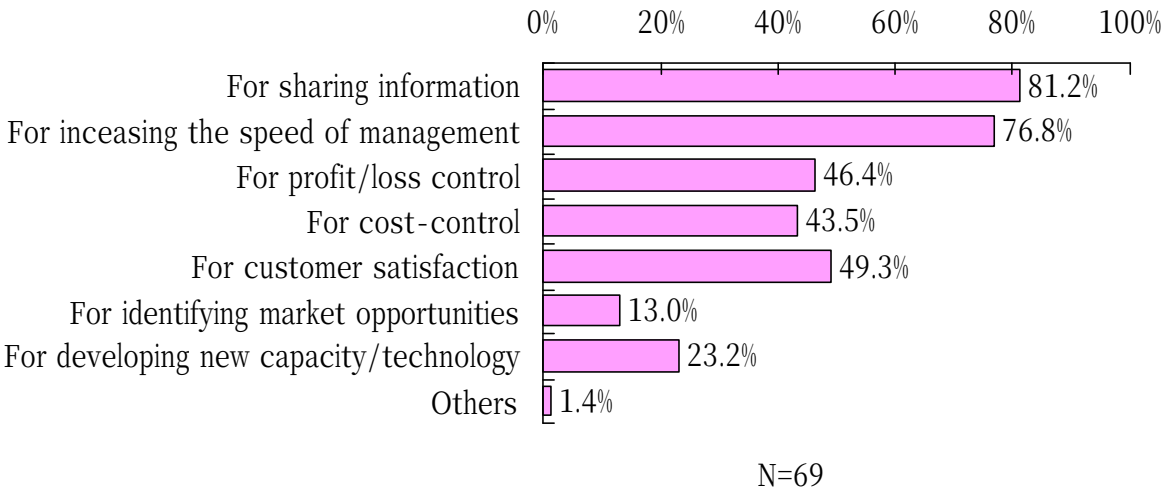
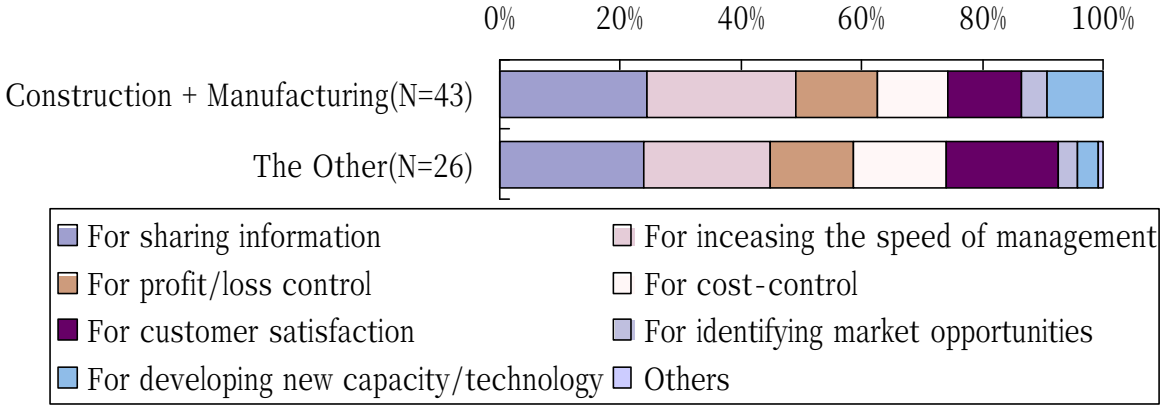


Fig. 3.5. Purpose of ICT investment



IV. **Realized impact of ICT investment (Q8,Q9 and Q10)**: ICT investment could cut the operating cost especially in the administration, clerical, and sales department; on the other hand, its impact is not so apparent in R&D, manufacturing, and logistics department (Fig.3.6.). Also, Fig.3.7. shows that ICT impact on cost reduction or sales increase is not obvious, not recognized, or unmeasurable in the first year of investment, which is consistent with Brynjolfsson & Hitt (1997).

Fig. 3.6. Sections which can reduce cost by ICT

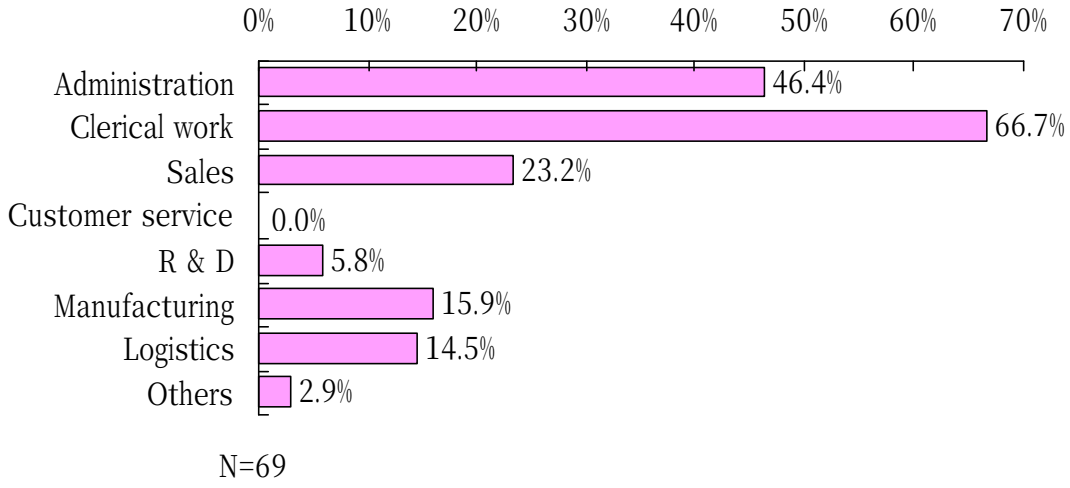
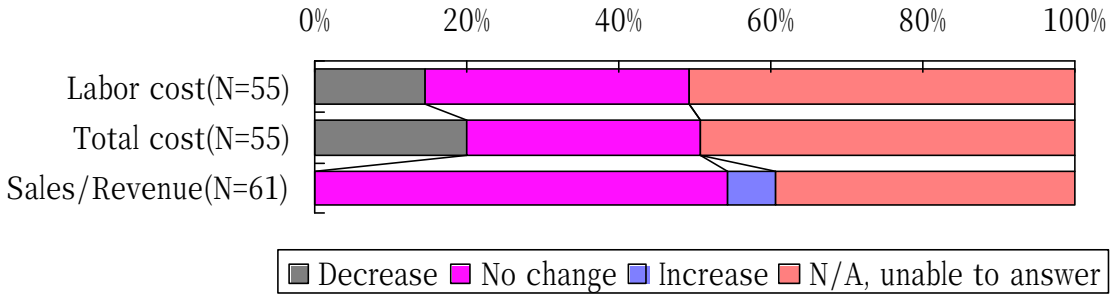
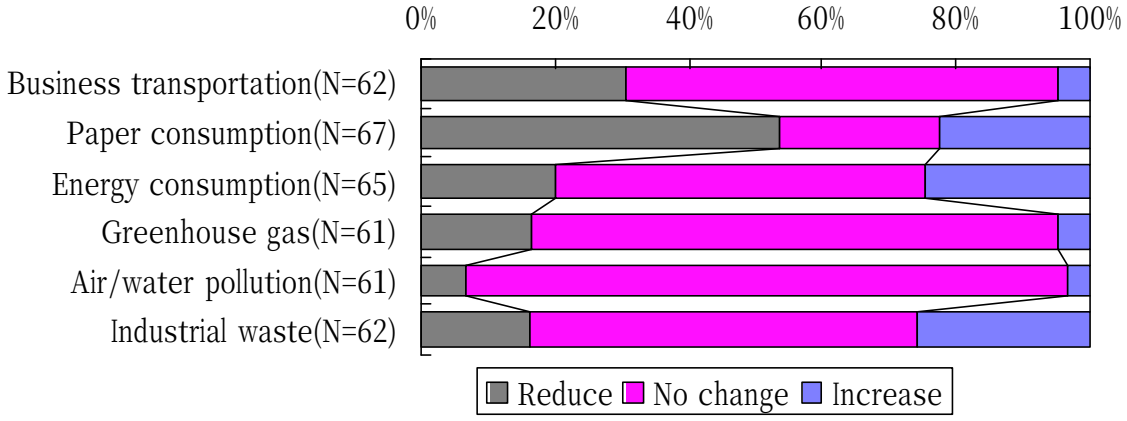


Fig. 3.7. Impact of 1998's ICT investment on 1998's operation



V. **Environmental impact of ICT investment (Q11)**: Since the 3rd Conference of the Parties to United Nations Framework Convention on Climate Change (COP3) in 1997, environmental issues have come to be considered as an important business challenges. However, less than 6% of the sample has taken environmental issues into consideration when making ICT investment; although, as shown in Fig.3.8., many companies realize its impact on environments, especially in reducing paper disposals.

Fig. 3.8. Environmental impact of ICT investment



4. Conclusion

We will conclude this preliminary analysis by the following few findings and implications:

- ✓ Results obtained from our questionnaire confirm the positive attitude among Japanese firms toward the introduction of ICT and networking technology. In the Japanese business arena, PCs are being increasingly connected to network facilities rather than used as stand-alone, and more firms are continuing to invest heavier in ICT rather than in non-ICT assets.
- ✓ If process innovation is proved to affect negatively on employment at least in the short-term, stress on process innovation among manufacturing and construction firms may hinder the realization of ICT potential in Japan, where job security is one of the most important management concerns. This may provide some clues to explain why the Japanese "New Economy" has not yet recognized in a macroeconomic scale.
- ✓ The recognition gap between the pre-investment and the post-investment concerning ICT's environmental effect may imply the existence of externalities of ICT investment. As the positive externalities result in socially-insufficient level of ICT investment and the negative externality yields excessive investment, some policy intervention, such as subsidy to the adoption of

environmentally-friendly ICT technology, may be required to efficiently attain the sustainable society.

It must be stressed again that the foregoing sections and the above remarks represent one of the very first analyses of the role of ICT investment in the Japanese economy using individual sample data, addressing such issues as the impact of ICT investment on corporate operation, as well as its contribution to environmental issues. Further analysis will present a significant amount of data to provide policy makers with a picture of the current state and likely future direction of ICT application. The preliminary findings and broad policy implications constitute an initial analytical basis for understanding the dynamics of the so-called "New Economy", how it may evolve and how it may transform our economies and societies. As with any analytical report which examines a phenomenon as young and complex as ICT, our findings generate as many questions as they answer. These questions form the basis of our future research agenda, which may includes a thorough literature survey, further data-mining, interviews with corporate managers, theoretical-model buildings, and empirical verifications.

References

Barras, R., 1986. Towards a Theory of Innovation in Services, *Research Policy*, No.15, pp. 161-173.

Brynjolfsson, E. and Hitt, L., 1997. Computing Productivity: Are Computers Pulling Their Weight? *Working Paper*, September.

_____ 1998a. Beyond the Productivity Paradox: Computers are the catalyst for bigger changes, *Communications of the ACM*, August.

_____ 1998b. Information Technology and Organizational Design Firm Level Evidence, MIT, *Stanford and Wharton Working Paper*, January.

Brynjolfsson, E. and Yang, S., 1996. Information Technology and Productivity: *A Review of Literature, Advances in Computers*, vol. 43, pp. 179-214.

David, P.A., 1989. Computer and Dynamo: The Modern Productivity Paradox in a Not-Too-Distant Mirror, *Working Paper 172*. Center for Economic Policy Research, Stanford University.

Economic Planning Agency [EPA], 1997. *A Study of New Economy: Has the productivity really improved?* (written in Japanese), URL: http://www.epa.go.jp/j-j/doc/1997fc-eco-j-j.html.

Ministry of Posts and Telecommunications [MPT], 1999. *1999 White Paper - Communications in Japan* .

Mitomo, H. and Jitsuzumi, T., 1999. Impact of Telecommuting on Mass Transit Congestion: The Tokyo Case, *Telecommunications Policy*, 23, pp. 741-751.

Mitomo, H. and Oniki, H., 1999. Information Technology for Sustainable Societies - Public Policy Perspectives in Japan: The Case of Telework, *The IPTS Report*, 32, March, pp. 24-31.

Mizoguchi, T., 1996. *Development of the Information Sector and Hidden Changes in Total Information Output.* In Mizoguchi, T., Kuriyama, T., and Terasaki, Y. (eds.), *The Facts Behind the Corporate Introduction of Information Technology Revealed by Economic Statistics*, (written in Japanese), Fujitsu Books, Tokyo: Fujitsu Institute of Management, pp. 111-129.

Mizoguchi, T., Kuriyama, T., and Terasaki, Y. (eds.), *The Facts Behind the Corporate Introduction of Information Technology Revealed by Economic Statistics*, (written in Japanese), Fujitsu Books, Tokyo: Fujitsu Institute of Management.

The Satellite Office Association of Japan [SOAJ], 1997. *Report on the estimated Japanese teleworking population, 1996,* URL: http://www.egg.or.jp/soajhome/twp96.htm.

Appendix: Questionnaire

Q1. Please describe the nature of business of your company.

Q2. Please provide (1) the total number of personal computers(hereinafter PCs) owned/used by your company. Please provide (2) the number of PCs introduced in FY 1998 in the right column.

Q3. Please provide the rate of increase(decrease) in your costs and investment on (A) ICT and (B) other facilities (non-ICT related facilities) in (1) FY 1999 and in (2) FY 2000 (outlook) from FY 1998.

Q4. In your company, how would you see the balance between costs on ICT and costs on other facilities (non-ICT) to change from now on?

Q5. How do you see the position of costs on ICT in the management of your company?

Q6. We would like to ask you the present state of the introduction of ICT of your company.

Q7. We would like to ask about the costs spent on ICT in the last three years at your company. Please provide figures for the total cost spent on ICT and its breakdown in the following table. Please also provide figures for the cost spent on newly purchased hardware/software (including upgrades/renewal and not including continued uses from the previous year) in FY 1998.

Q8. To which section of your company has ICT contributed in reducing costs the most?

Q9. With regard to your ICT related investment/expenditure in FY 1998, what impact did you envision the investment to have on the total costs (manpower costs and expenses) of your company? Please answer whether the investment was thought to bring an increase/decrease (compared to if this investment has not been made) in overall. Please base your answer on the assumption that all impacts of the investment appear by end FY 1998. Your answer may be based on your subjective views.

Q10. With regard to your ICT related investment/expenditure in FY 1998, how much increase in company sales/revenue was this investment intended to achieve? Please base your answer on the assumption that all impacts of the investment appear by end FY 1998. Your answer may be based on your subjective views.

Q11. How would your company's ICT related investment affect your company's activities' impact on

the environment?

Q12. Have you made any ICT related investment, which was specifically targeted, to improving the environment within the last three years?

Q13. Has the importance of transferring the jobs which were managed by your permanent staff to non-permanent staff, or subcontracting them externally (outsourcing) become important in the last three years?

Q14. Please describe the introduction of the some organizational systems/movements within the last three years at your company.

Q15. Please indicate the monthly average working hour (regular working hour plus overtime) of your permanent employee for the last three years.

Q16. Please describe the excess/shortage in manpower of your company.

Q17. Please show the number of permanent staff of the last three years.

Q18. Has your company's customer base expanded over the last three years?

Q19. Has it become easier to provide products/ services that are suited to each customer over the last three years?

Q20. Has customer satisfaction improved over the last three years?

Q21. Has the lead-time between product/service development and sales been reduced over the last three years?

Q22. Has decision making amongst top and middle management become quicker over the last three years?

Q23. Has networking, information exchange and collaboration with other companies become easier over the last three years?

Q24. Has the introduction of ICT contributed to the improvement of efficiency of your company?