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The virtuous cycle between institutional elasticity, IT advancement and sustainable growth: can Japan survive in an information society?

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Abstract

Japan's success in achieving sustainable development during the "catch-up" years up to the end of the 1980s can be attributed to a high institutional elasticity that can be distinctly observed in a "virtuous cycle" between technological innovation and economic growth.

Japan's domestic institutions functioned efficiently during the era of an industrial society driven by manufacturing industry. However, a new paradigm characterized by a shift to an information society emerged in the 1990s and Japan's traditional institutions did not function as efficiently as they did in preceding decades.

Consequently, a virtuous cycle between institutional elasticity and economic development changed to a vicious cycle between non-elastic institutions and economic stagnation that resulted in Japan losing its international competitiveness that reacted to further economic stagnation. Thus, Japan has been facing a dual vicious cycle leading to solid institutional elasticity.

This paper analyzes the structural sources, which compelled Japan to lose its institutional elasticity.

Keywords: Institutional elasticity; Japan's institutions; Virtuous cycle; Vicious cycle; Industrial society; Information society

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1. Introduction

While the dramatic advancement of information technology (IT) in recent years has provided all nations of the world with huge potential benefits, and effective utilization of these benefits has become one of the most crucial aspects of competitive strategy for a nation, effective utilization of these potential benefits greatly depends on the state of the institutions relevant to the inducement and diffusion of IT [1]. As the OECD [2] shows, new technology itself represents only potential, and in order to exploit this potential, institutional change is necessary. In this context, the flexibility of the institutions, or institutional elasticity plays a key role [3]. In fact, Japan's success in achieving sustainable development during the "catch-up" years up to the end of the 1980s can be attributed to a high institutional elasticity [4].

Notwithstanding such a high institutional elasticity up to the end of the 1980s, Japan's institutional system has lost its elasticity under a new paradigm of the shift from an industrial society to an information society that emerged in the 1990s [3]. Remedy of this problem has become crucial as the effective utilization of IT depends on the elastic interaction between the institutions and the technology that leads to construction of a virtuous cycle between sufficient inducement and diffusion of IT and further elastic reaction to the advancement of IT.

In light of the significance of the interaction between innovation and external circumstances, a number of works have focused on the identification of this interaction mechanism.[1] Baranson [14] postulated a concept of interaction between internal technology and external technology. Internal technology means qualification of the R&D environment and consists of quality and quantity of resources for R&D. External technology consists of the "economic environment," "physical and natural environment" (such as energy, resources and geographical conditions), "social and cultural environment" (such as informatization, education, ethics of labor and entrepreneurs, customs and tradition, and preferences of consumers) and "policy system" [4,15]. These components are collectively designated as "institutions."

North [16] defined institutions as follows: "The humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g. rules, laws, constitutions), informal constraints (e.g. norms of behavior, conventions, self-imposed codes of conduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies". Thus, institutions play a significant role in inducing and diffusing technological innovation.

While a number of works have conducted broad-ranging theoretical and empirical analyses on the behavior of institutions (e.g. [16–20]), their focus is not necessarily the identification of the role of institutions as a core inducing factor of innovation and stimulator for broad diffusion. An exceptional pioneer work can be found in Ref. [21]. This work paid special attention to the role of institutions in inducing

[1] In addition to these works, to date, a number of studies have identified the impact of technological innovation and its diffusion process (e.g. [5–9]). Furthermore, analyses of the impacts of IT on socioeconomic development and firm strategy have become popular works for economists (e.g. [10–13]]).

innovation. Over two decades, since Binswanger's postulate was demonstrated, intensive work has been conducted on the identification of the behavior of institutions including Refs. [22,23]. Nelson and Sampat in their recent work developed the notion of institutions as standard [1].

In line with the dramatic advancement of IT, significant aspects of the interaction between technological innovation and institutions have been structurally changed leading to the increasing significance of institutional elasticity [24,25].

As postulated by previous studies [26,27], contrary to manufacturing technology, which was the leading technology in an industrial society, IT strongly possesses a self-propagating feature that closely interacts with individuals, organizations, and society during the course of its diffusion and behaves differently depending on the institutions involved. Its functionality is formed dynamically during the course of interaction with institutions. Furthermore, whether the potential benefits of IT can be exploited largely depends on the nature of these institutions [28].

Due to this unique feature of IT functionality development, which is contrary to manufacturing technology, under a new paradigm shift from an industrial society to an information society, Japan's virtuous cycle between institutional elasticity and economic development changed to a vicious cycle between non-elastic institutions and economic stagnation that resulted in Japan losing its international competitiveness, which reacted to further economic stagnation.

This paper first attempts to demonstrate Japan's shift to a non-elastic reaction to the IT advancement, and, second, demonstrates that a dual vicious cycle is the source of such solid institutional elasticity.

2. IT waves and the essential role of institutional elasticity

2.1. The IT advancement

IT waves are changing the structure of business and impacting the daily life of people. According to *Nua Internet Surveys*, there were approximately 544.2 million Internet users worldwide as of February 2002. *Internet Domain Survey* conducted by Internet Software Consortium reports that as of January 2001 there were about 109.6 million Internet hosts worldwide, that is a 51.3% increase from the previous year.

In order to make the best use of the benefits of IT and urgently establish international competitiveness, each government of the world is aggressively developing its own IT policy such as IT^2 (US), eEurope 2002 (The European Commission), UK online (UK), CYBER KOREA 21 (Korea), ICT21 Master Plan (Singapore), Multimedia Super Corridor (Malaysia), 2001 Digital 21 Strategy (Hong Kong), and e-Japan 2002 (Japan).

Rapidly surging IT waves over the world are inevitably forcing a traditional society to transform its socioeconomic structure. As Ref. [29] describes, IT waves are hastening the paradigm shift from an industrial society to an information society. IT enhances efficiency of the society as a whole and realizes dramatically cheaper

and faster transactions [30]. Release from the restriction of time and distance promotes border-less information exchange and also provides socially disadvantaged people with more opportunities to participate in social activities. With minimal first stage investment, IT gives opportunities to venture firms to compete with established firms equally.

Cairncross [31] analyzes the impact of the death of distance on our lives, which has been brought by the IT revolution accompanied by the paradigm shift from an industrial society to an information society. She examines the effects of IT revolution in such broad-ranging fields designated as "institutions" [16] encompassing (i) commerce and the shape of the company, (ii) the economy, (iii) society and culture, and (iv) government and the political process, and concludes that the death of distance is a revolution about opportunity and about increasing human contact.

US DOC [12] pointed out that "although IT is generally available in world markets, the US economy to date has achieved greater gains from IT than other countries at least partly because of favorable monetary and fiscal policies, a pro-competitive regime of regulation, and a financial system and business culture prepared to take risks".

Actually, the US is the leading Internet nation, with 166.1 million users and 59.8% penetration rate as of August 2001.[2] Looking at the Internet commerce market, the US Internet commerce final consumption goods market was worth $25.8 billion in 2000, while that of Japan was modest, about $6.0 billion [32]. In February 2002, the World Economic Forum [33] reported a major comparative assessment of the 75 countries' capacity to exploit the opportunities offered by IT, using the "Network Readiness Index" which provided a summary measure that ranks 75 countries on their relative ability to leverage their information and communication technology networks. In this assessment, Japan ranked modest 21st while the US ranked the highest.

This high penetration rate of IT in the US leading its success in the IT revolution and subsequent new economy in the 1990s to the beginning of this century can be attributed not only to the nation's excellence in technology level, but also to such institutional elasticity enabling a flexible labor market, stimulating activated competition in a market place, and inducing a risk taking business challenge as well as broad utilization of IT products. These all correspond to DOC's postulate that institutional elasticity plays a significant role in maximizing the benefits of IT and also inducing further advancement of IT.

2.2. IT characteristics in light of institutional elasticity

During the 1980s, developing excellent manufacturing technology was a key for firms to be successful in an industrial society. Manufacturing technology has been developed by the supply side to provide end-users with products and has been introduced to factories to replace part of the workforce for improving productivity. Like

[2] NielsenNetRatings.

other technologies, features of manufacturing technology are established or programmed at the beginning and once it leaves the supply side, it does not change its basic use substantially during its dissemination. In this case, individual firms are responsible for forming features of technology.

Contrary to manufacturing technology, suppliers of IT are more concerned about compatibility. This is because IT products are often utilized as a communication tool. If a subscriber to a certain mobile communications service career cannot make a call to a subscriber of another career, people lose an incentive to purchase cellular telephones, or try to subscribe to a career that boasts the dominant number of subscribers. On the other hand, any home appliances such as refrigerators or TV sets can be purchased without being constrained and effected by the compatibility issues. In this context, IT products are subject to network externalities. With computers and telephones, for example, the more people use compatible systems or the more people are on a network, the more valuable the system or the network becomes, thus attracting more potential users [23].

Focusing on these points, Watanabe et al. [28] demonstrated IT's self-propagating feature that closely interacts with individuals, organizations, and society during the course of its diffusion and behaves differently depending on the institutions it interacts with. The study suggested that the functionality is formed dynamically during the course of interaction with institutions and whether the potential benefits of IT can be exploited greatly depends on the nature of these institutions.

2.3. Japan's shift to a non-elastic reaction to the IT advancement

IT waves are also gaining their power in Japan. There were some estimated 55.93 million Internet users in Japan with a penetration rate of 44.0% as of the end of 2001, an increase of 18.8% year over year. The number is forecasted as expanding to 87.2 million in 2005.

However, Japan does not seem to fully utilize the potential benefits of IT. Comparative analyses on IT and productivity have revealed that Japan's IT contribution to productivity is far behind the average level of developed countries (e.g. [34–38]). Dewan and Kraemer [35] for example, demonstrate that Japan's productivity level (average GDP per worker over 1985–1993) was extremely lower than that explained by the level of IT capital stock per worker. This low productivity was conspicuous among developed countries.

Similar trends can be found in Fig. 1, which was reproduced from the OECD's report on the OECD Growth Project [39], illustrating the relationship between network expansion rate and GDP growth. In order to demonstrate how Japan lags behind in utilizing the benefits of IT compared to other OECD countries, a trend line was indicated based on regression analysis. Looking at the figure, not to mention Japan's low level of network development rate, Japan is far behind the OECD average, which resulted in not achieving the expected GDP growth rate with respect to the increase in network development. In other words, Japan does not enjoy the benefits of IT to achieve high growth in GDP.

As OECD [39] argues, "In the long term, growth depends on building and main-

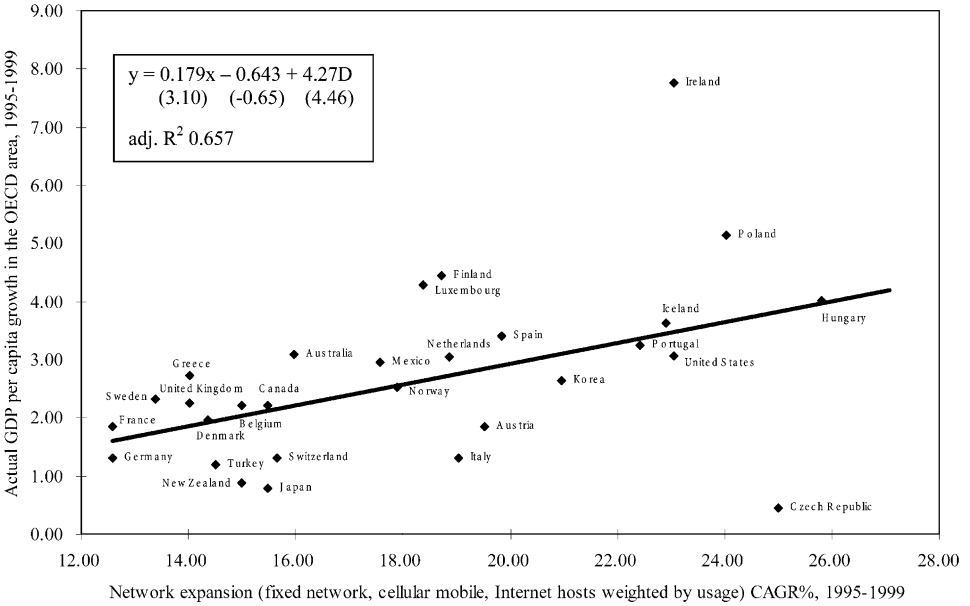

Fig. 1. Network expansion and GDP growth (1995–1999). Korea, Czech Republic, Hungary, Mexico and Poland were excluded from the analysis since these countries joined OECD relatively recently. D in regression indicates dummy variables: Ireland=1, other countries=0. Figures in parentheses indicate t-value. *Source:* Reproduced from OECD's report on the OECD Growth Project [39].

taining an environment (or institution), that is conducive to innovation and the application of new technologies", Japan's inferiority in utilizing the benefits of IT should be explained by institutions peculiar to Japan, more precisely, peculiar to Japan during the "catching-up" years in an industrial society. During the "catching-up" period up to the end of the 1980s, Japanese business management such as lifetime employment and seniority system well matched the nation's institutions and led the nation to a winner in an industrial society.

Telecommunications Council [29] reports that the Internet usage by Japanese managers are quite low, 15%, compared to those of other countries, for example, 60% of Canada's and the US's.[3] The low utilization rate of the Internet by Japanese managers can be explained by the nation's seniority system. In general, only seniors can occupy high positions in Japan. However, the Internet usage rate by seniors is quite low: only 15.9% of people in their 60s use the Internet, 36.8% in their 50s, while almost 70% of the Internet users are in their 20s or 30s [32]. Furthermore, hierarchical structure of Japanese firms hinders senior managers in communicating with younger employees who generally recognize the importance of IT. As senior

[3] The report refers to "Internet Usage by Managers", a survey conducted by Andersen Consulting in 1999.

managers are not aware of the benefits of IT, they have no incentive to utilize IT and accordingly, the effectiveness of IT would not be fully utilized.

Since institutional elasticity can be typically observed in behavior of labor, particularly its productivity against changes in fundamental factors such as wages,[4] trends in the institutional elasticity indicator can be observed by measuring wage elasticity to labor productivity [3]. An empirical analysis demonstrates that this elasticity in Japan's manufacturing industry decreased dramatically to 0.41 before the period of the bubble economy (1975–1986); 0.32 during the period of the bubble economy (1987–1990); and 0.18 after the bursting of the bubble economy (1991–1996) [3].

Among tangible and intangible factors leading the Japanese manufacturing industry to lose its institutional elasticity in terms of wage elasticity to labor productivity, a decrease in technology substitution for labor due to the imbalance of technology incorporated in labor and capital can be considered one of the major sources [24,40].

The imbalance of technology in labor and capital can be attributed to the imbalance of the lead time in technology, particularly IT incorporation in labor and capital. Contrary to a smooth incorporation of IT into capital, due to institutional constraints such as traditional norms, custom, educational and training systems, and aging trends, IT's incorporation into labor is rather complicated and not necessarily as easy as incorporation into capital. An empirical analysis demonstrates that:

(i) The lead time for technology incorporation (embodiment) in labor and capital has been in harmony up until the end of the 1980s.
(ii) However, lead time for labor has changed to longer lead time than that of capital from 1991 (the year corresponding to the starting year when institutional elasticity dramatically decreased) resulting in a dramatic increase in the imbalance of technology incorporation in labor and capital.

These results demonstrate our hypothesis that the imbalance of the lead time in technology, particularly IT incorporation in labor and capital led to the dramatic increase in the imbalance of technology incorporation in labor and capital resulting in the decrease in technology substitution for labor and losing institutional elasticity. In addition, the sources of such imbalance can be attributed to institutional constraints such as traditional norms, custom, educational and training systems, and aging trends, inducing further solid institutional elasticity.

IMD's (International Management Development Institute) "World Competitiveness Ranking Report" (April 2001) revealed that Japan's ranking has further dropped to 26th (24th in 2000). The Report also revealed that this is due primarily to the deterioration in such institutional elasticity as venture spirit, accountability of shareholders, and transparency of government policy. These factors are closely linked

[4] The "Productivity standard principle" introduced in 1969 made a significant contribution to Japan's success in attaining sustainable growth without inflation by limiting wage increase to the level of productivity increase. This success can be attributed to Japan's elastic relationship between wage increase and productivity increase.

to factors that hinder the effective utilization of the benefits of the advancement of IT and support our hypothesis as well as the above analyses.

Fig. 2 was reproduced from Ref. [39] to exemplify Japan's deterioration in its institutional elasticity by analyzing the relationship between the access costs and a diffusion of the Internet. A trend line was indicated based on regression analysis, which reveals that countries with lower access costs typically have more Internet hosts. As the figure clearly exhibits, Japan does not achieve the expected Internet penetration rate in spite of its moderate Internet access cost. By contrast, the US performs fairly well. This gap should be attributed to the contrastive institutional elasticity of the two countries.

All analyses in this section reveal that Japan has lost its institutional elasticity in a process of the shift from an industrial society to an information society.

3. Sources of the structural change in institutional elasticity

Based on the empirical evidence verified in the previous section, this section analyzes and compares the sources of the structural changes in institutional elasticity in Japan and the US.

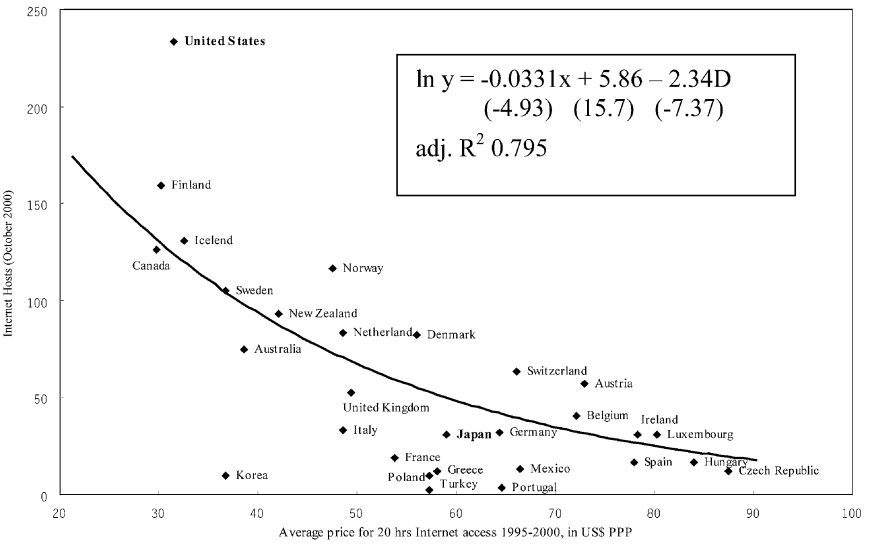

Fig. 2. Access costs and uptake of the Internet. Korea, Czech Republic, Hungary, Mexico and Poland were excluded from the analysis since these countries joined OECD relatively recently. D in regression indicates dummy variables: Turkey, Greece, Portugal=1, other countries=0. Figures in parentheses indicate t-value. *Source:* Reproduced from OECD's report on the OECD Growth Project [39].

3.1. Flexible institutional systems of Japan in the 1980s

Historically, Japan has been elastically introducing, adopting, assimilating, and developing new technology into Japanese economic, social, and cultural systems without spoiling its indigenous culture. Especially, during the *Edo* period (1603–1867), "Sankin Kotai system" which was the "Shogunate's system" of periodic obligatory attendance at Edo (now Tokyo) for Daimyo (federal lords) activated information exchange among regions. An unexpected call by the Kuro Fune (America's "black ships") in 1853 triggered a flood of western civilization and culture, to which the Japanese reacted elastically and adopted them with objective appreciation for their excellence. Following the Edo period which ended with the Meiji Restoration in 1868, the Meiji Government (1868–1912) focused its policy on wealth and military strength of the nation, strengthened industrial production, and intensively promoted western learning while cultivating Japanese spirit by establishing educational systems and regarding moral ethics as significant. These historical efforts greatly contributed to realize technological developments in Japan before, during and after World War II. Furthermore, remarkable improvement in the high technology in the 1980s was considered as the crystallization of such historical efforts.

At the same time, Japanese managerial activities and systems can be regarded as reflecting Japanese institutional characteristics, which have been cultivated historically. The centuries of isolation from foreign influences ("*sakoku*") during the Edo has meant that the Japanese population is culturally and ethnically more homogeneous than in most other countries [41]. This fairly homogeneous population, together with a highly dense population with high educational level in Japan, has contributed to develop unique features of the Japanese organizational and behavioral norms such as group orientation and feeling comfortable to "be the same" as others (neighbors) are. McMillan [42] concisely characterizes the Japanese as consensual, highly stable, homogeneous, disciplined, and long-term oriented. Under these *homogeneous conditions*, the basis of Japan's elastic institutional systems were founded, as Japanese people were not forced to make an effort to communicate with different nationalities, which led them to rely on implicit understanding and a failure to develop an open communication interface.

During the "catching-up" period towards the end of the 1980s, when manufacturing technology was considered as a core technology of an industrial society, Japanese business management systems such as lifetime employment, the seniority system, lean production (e.g. TQC, JIT and Kaizen), the main bank system, and *keiretsu* well matched the nation's institutions and successfully established the feeling of "family ties" strengthening the highly efficient closed network among related entities [43].

For example, in the lifetime employment system and the seniority system, Japanese firms invested in training their employees for improving their skills specific to each firm bringing stability to the labor market. The *Keiretsu system*, or long-term oriented relationships among Japanese firms was developed under the limited conditions such as shortage of resources, which the nation faced after World War II. By establishing highly closed business networks among related firms, business achieved the efficient

coordination of production and distribution of goods based on technical and institutional stocks specific to related entities.

Under this system, Japanese manufacturers intensively developed products with their own in-house technology, since customers were most interested in the quality of products, not so much in the compatibility among products of different manufacturers. In order to assure quality, firms preferred in-house procurement of manufacturing parts, or relied on their *keiretsu* companies that reflected Japanese long-term orientation. In other words, Japanese firms used an "*individual language*" that consequently excluded entities outside the family. This mutually dependent system worked effectively to distribute risks among related firms by flexibly distributing losses and profits independent of each deal.

These traditional business systems of Japan together with the main bank system, which enabled mainly financing banks to obtain inside information on related firms for monitoring their financial conditions, developed highly closed networks that were established individually. Within the network, each system functioned complementarily and dependently, achieving high productivity and competitiveness during the catching-up period to the end of the 1980s where excellent line-workers and a stable supply of products were available. Actually, within these closed networks, implicit transaction rules among related entities and specific communication "language" were developed that excluded new comers outside these tight-nit "families".

3.2. The Japanese institutional systems in the 1990s

By contrast, IT enables global information exchange, thus inducing global procurement of goods and mobility of human resources. Although the Japanese institutional systems performed effectively up to the end of the 1980s, external changes in the 1990s such as, shift to an information society stimulated by the advancement of IT together with the aging trend, and subsequent low, zero or negative economic growth revealed the ineffective aspects of this system [3,24].

The increasing aging trend is now exposing the inefficiency of lifetime employment based on seniority system. With the expansion of unfulfilled credit, the main banks have lost their ability to rescue their related firms. Notably, IT enables global information exchange, thus inducing the global procurement of goods and the mobility of human resources with fairly low cost. Furthermore, with the phenomena of network externalities, value to a consumer of IT related products increased as the number of compatible users increased. This means that traditionally closed networks of Japanese firms with high barriers to entry cannot work effectively any more. The closed networks with a "peculiar language" hinder entities with high potential participating in the value networks and limit the creation of more value [44]. As Katz [45] argues, once Japan's economy matured, a set of institutions during the catching-up period that enabled the state, the banks, and the manufacturing industry to coordinate each other had outlived their usefulness.

When a new paradigm emerged with the dramatic advancement of IT in the 1990s, Japan can no longer depend on well-tried, low-risk paths and other benefits available to a country undergoing "catching-up" [41]. Actually, the fact that such industries

as automobiles and home electronics in Japan have survived quite well into the 1990s cannot be overlooked. One of the significant reasons for these successes can be attributed to their production style: they required a high level of horizontal coordination in which Japanese corporations have been strong while US workers have been weak [46]. However, as Gao [46] mentions in his work, these industries in the end provided only 12% of Japanese employment, and although Japanese corporations were able to effectively share information in closed networks, when the IT revolution brought about open systems, they are confronting a significant challenge. In other words, Japanese indigenous characteristics such as homogeneity and preferring high stability do not allow react firms to flexibly in enhancing the disseminative, interactive, and co-evolutional features of IT [28].

As Callon [47] criticized, industrial policy such as the Fifth Generation Computer Project by MITI in the 1980s did not work well to foster computer and software industries that are rather the foundation of IT. Researchers preferred private-sector-led research cooperation to government-led, forced joint research with given targets. Actually, the given targets might ignore the IT's self-propagating feature, resulting in hindering the development of the industries.

Consequently, Japan's institutional systems, which performed effectively in the 1980s, shifted to a non-elastic and solid reaction to the dramatic advancement of IT [3], and is not efficient any more in an information society, and even hinders exploiting the potential benefits of IT.

3.3. The structural change in the US industry driving the IT revolution

On the other hand, as MacRae [48] argued, the melting pot of the US makes the nation a great generator of new ideas, cultivates frontier spirit, and enhances flexibility, thus inducing positive effects incorporating the unique features of IT. These indigenous qualities in the US efficiently accelerated the structural change of the US industry in the 1990s [49].

In the late 1980s, US firms came to intensively invest in business sectors where they have competitive advantages, focusing on core competence management, in order to improve their profitability, or return on investment, for which shareholders are most concerned. Furthermore, they started to outsource part of their business, such as data processing and invested in the development of systems to pursue efficiency. These movements induced the expansion of the outsourcing market and the mobility of labor in the US.

The dramatic advancement of IT in the 1990s further stimulated the structural change in US industry. Firstly, with the advancement of network technology, business transaction cost among firms greatly decreased enabling firms to divide their business process into modules for efficient outsourcing. In this context, there emerged firms focusing on their core competence and competing against one another to make deals regardless of past relationships [12].

Furthermore, the rapid development of IT together with network externalities enabled IT related products and services to disseminate quickly and shortened product life cycles, resulting in the difficulty in forecasting future product trends. Facing

these surging IT waves, where speedy R&D and timely introduction of products and services into the market plays a key role for successfully establishing a competitive position in the world, flexible business alliance with other firms became an efficient business strategy. Realizing this trend, US firms actively disclosed their business information to find appropriate business partners that would lead to enhancing their value chain as a whole.

Finally, increased electronic connectivity leveled out the asymmetry of information on products between suppliers and customers. Customers could more easily obtain the information on market products through the Internet. Accordingly, suppliers are now required to address the needs of customers in order to be successful in an intensely competitive market.

Legislated firms did this, because not doing so was illegal. This is an example of the government's role in this process. In order to respond to these changes in the external environment, US firms have flexibly transformed their strategic management by disclosing their business information to share their resources with potential partners and inducing the formation of networks that are open to any firm and are value-added for participants including customers.

These mechanisms correspond to the unique features of IT formed during the course of interaction with institutional systems to which institutional elasticity plays a significant role. Thus, we can conclude that the US's IT initiated new economy can be attributed to a virtuous cycle between institutional elasticity and advance of IT innovation and diffusion [49]. This elasticity reacted to further enhance flexible labor market, stimulating activated competition in a market place, and inducing risk taking business challenges as well as broad utilization of IT products.

These structural changes in the US firms, which led the nation to be successful in an information society, are supported by their efforts to standardize their communication interface, or to establish a "*common language*". Actually, efforts to establish the "*common language*" seemed to be rather natural for the US firms considering the melting pot of the nation: the heterogeneous environment of the US stimulated the nation to establish "*standard languages*", so that people or organizations can communicate implicitly, and to form open networks with standardized interfaces resulting in the easy acceptance of new comers and changes.

On the other hand, many of these qualities were ineffective in the 1980s where steady and incremental advance, or horizontal coordination was most critical. In the 1990s, under the IT revolution, American corporations overcame their traditional weakness in horizontal coordination and increased their productivity through their indigenous qualities as illustrated above.

4. Vicious cycle between stagnant growth under a new paradigm and lost institutional elasticity

On the basis of the above comparative analysis on the effectiveness of institutional systems in Japan and the US, Fig. 3 suggests how Japanese institutional systems and those of the US performed as the paradigm shift occurred from an industrial

	1980s	*1990s*
Paradigm	**Industrial society**	**Information society**
Core technology	Manufacturing technology	IT
Key features	**Given, Provided by suppliers**	**To be formed during the course of interaction with institutions**
Actors responsible for features formation	Individual firms/organizations	Institutions as a whole
System structure	Optimization	Standardization

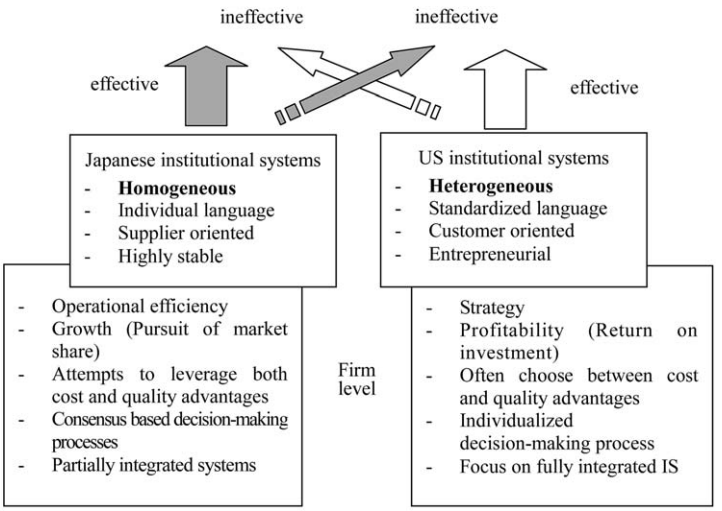

Fig. 3. Comparison of effectiveness between Japanese institutional systems and the US institutional systems under the paradigm shift.

society to an information society. As analyzed above, though the Japanese institutional system was effective in the paradigm of an industrial society, it cannot be effectively applied to the new paradigm of an information society. Conversely, the US system, which was ineffective in the paradigm of the 1980s, was very effective in the paradigm of the 1990s.

OECD [39] reported an uneven growth trend of GDP per capita in OECD countries over the past decade compared with the 1980s. It described this trend in the 1990s as being higher than in the 1980s in countries such as Australia, Canada, and the US, while growth declined markedly in areas such as Japan, Switzerland and Korea. Although there are a number of factors to explain these divergences,[5] one reason is undoubtedly Japan's inflexibility in broadly adopting IT.

[5] See Refs. [11,19,30,34–38].

Fig. 4 summarizes a scheme leading Japan to lose its institutional elasticity by comparing the US system which indicates that, contrary to the dual virtuous cycle up to the end of the 1980s, Japan has been suffering from a dual vicious cycle.

During the period of an industrial society initiated by manufacturing industry, Japan's domestic institutions based on young vitality functioned efficiently towards the "catching-up" target leading to high economic growth.

In the 1990s, Japan's economy clearly contrasted with the preceding decades. Facing a new paradigm characterized by a shift to an information society initiated by service oriented industry, globalization, diversification of the nation's interest, aging trend, and subsequent low, zero or negative economic growth, Japan's traditional institutions did not function efficiently as they did in preceding decades.

Consequently, a virtuous cycle between institutional elasticity and economic development changed to a vicious cycle between non-elastic institutions and econ-

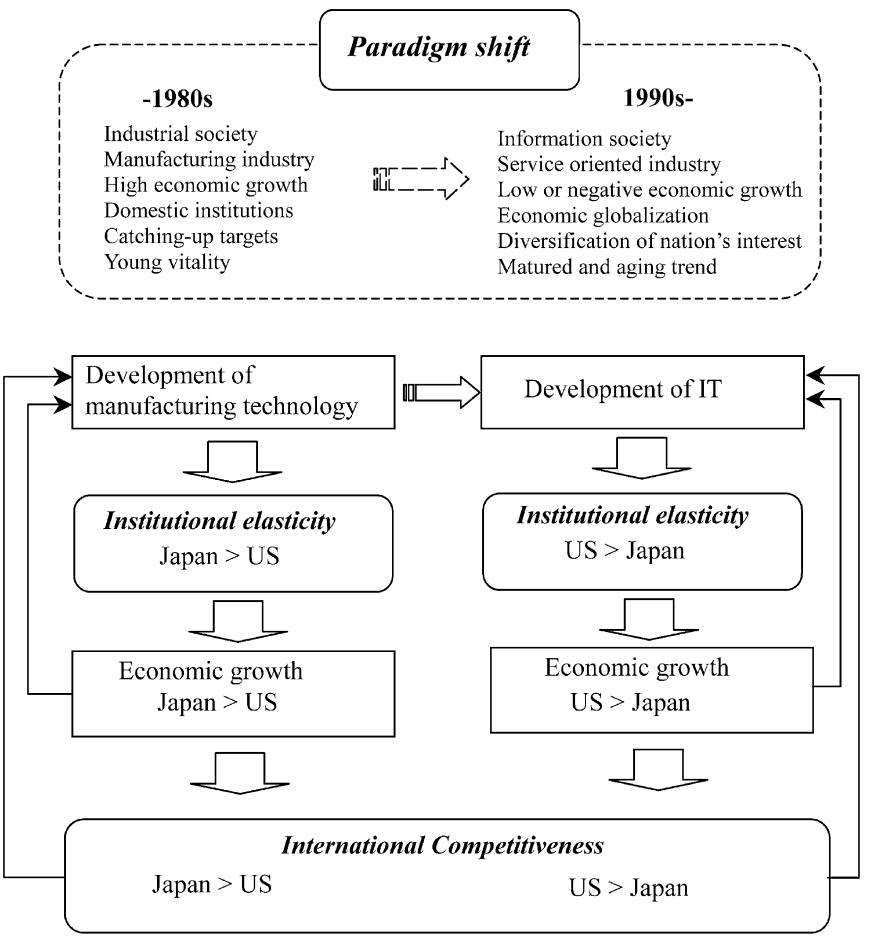

Fig. 4. Scheme leading Japan to lose its institutional elasticity.

omic stagnation. Previous analyses in Fig. 1 with respect to the contribution of network expansion to GDP growth, and the imbalance of technology incorporation in labor and capital, exemplify this vicious cycle. These vicious cycles resulted in Japan losing international competitiveness and further contributed to economic stagnation. Thus, Japan has been facing a dual vicious cycle leading to a solid institutional elasticity.

5. Implications and conclusion

As analyzed so far, institutional elasticity plays a significant role in inducing and diffusing IT. If a nation's indigenous institution can react elastic to the advancement of IT, diffusion process of IT is accelerated, then that nation should be able to fully enjoy the potential benefits of IT, resulting in enhancing its international competitiveness.

Although a quick remedy for the lost institutional elasticity cannot be easily prescribed since institutional systems are usually built up on the basis of historical accumulation, Japan's exceptional success in such specific business models as "i-mode" service, that allows users to access to the Internet from their cellular phones, implies potential elasticity of Japan's institution.

Since February 1999, when NTT DoCoMo[6] launched its i-mode service, subscriptions to this kind of mobile Internet access service had been dramatically expanding, 31.4 million subscribers in 2001 to 50.3 subscribers in 2002.

This exceptional diffusion can be explained by the learning experiences. When the i-mode service was started, (i) cellular phones were already diffused, (ii) users had already experienced "short message service" that enables message exchange, (iii) users already recognized how useful the Internet can be. This elastic reaction based on learning experiences could be an important complement in a global system leading to restructuring a virtuous cycle between institutional elasticity, IT advancement and sustainable growth in a global context.

While these interpretations are general, a more focused, in-depth analysis of differing firm strategies is required to shed light on critical success factors in this dynamic IT driven environment. More specifically, firm-level analysis could reveal why some Japanese firms remained flexible and competitive and flourished even amidst the economic stagnation. This would also correspond to why some US firms were unable to remain competitive even with the structural advantages elucidated in this work.

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