1D09 Elucidation of the Co-evolutionary Dynamism of Japan's System of Management of Technology

— Comparative Empirical Analysis of the Institutional Systems between Japan, the US and China

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1. Introduction

As we have entered into a knowledge economy, innovation and the ability to innovate distinguished themselves as an important production factor. This paper compares and analyzes the institutional systems of three economies: Japan, US, and China, focusing on the dynamic evolution of the systems of management of technology. Although starting with different baselines, all these countries have focused on increasing their national innovation capability as a mean to strengthen their economic growth. The US has kept as its technological leadership since the beginning of the century. Japan started to accumulate its technical capability since the Meiji period and risen to a technology giant after the second world war. China, since its market economic reform in the 1980s, has started to build its innovation capabilities to boost its fast economic growth.

Our hypothesis is that these three countries economic growth and more specifically technology progress is highly related to their institutional systems. The institutional systems for innovation have been dynamically evolved with their specific socio-economic environment and the development of the industrial technology. Existing works in institutional systems and specifically for these three countries mostly focus on the national innovation systems (Gu, 1999; Watanabe, 1999; Hirono, 2001; Liu and White, 2001; Colecchia and Schreyer, 2002; Watanabe, Asgari, and Nagamatsu, 2003).

This paper compares and analyzes the institutional systems of these three economies Japan, US, and China, focusing on the dynamic evolution of the system of management of technology.

This paper is organized as follows: it will first examine the contribution of technology progress to economic growth of the three countries. Then, it will examine the dynamic evolution of the institutional systems in these three countries.

2. Analytic framework: Contribution of technology progress to economic growth

Japan's contribution of technology progress to the economic growth had conspicuously increased up until the 1980s, while then dramatically decreased in the 1990s (**Figure 1**).

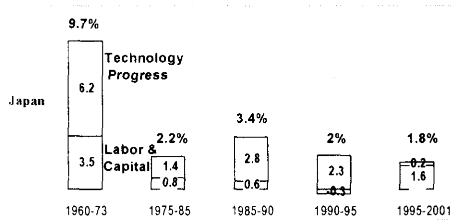

Figure 1. Contribution of Technological Progress to Economic Growth in Japan. (Source: 1960-1973: OECD Economic Studies (1988); 1975-2001: European Competitive Report (2001).)

The world leading economy, the US, has comparatively more stable TFP growth rate, i.e., technology progress has been continuously contributed to its economic growth, especially in the late 1990s, when the US led the world in the ICT sector (**Figure 2**).

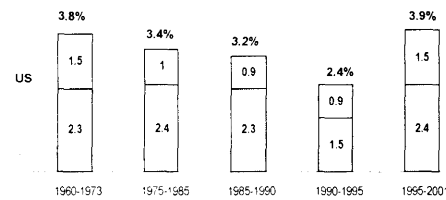

Figure 2. Contribution of Technology Progress to Economic Growth in US. (Source: 1960-1973: OECD Economic Studies (1988); 1975-2001: European Competitive Report (2001).)

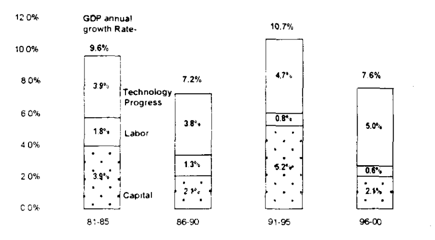

Figure 3. Contribution of Technology Progress to Economic Growth in China (1981-2000). (Source: Fan, 2004; Fan, Watanabe, and Taeb, 2004.)

For the emerging economy China, it is evident that technology progress has contributed significantly to China's economic growth, especially in the 1990s (**Figure 3**). From 1986 to 1990, technology progress became the leading production factor that contributed to the GDP growth and its role of technology progress is more distinguished in recent years.

3. Findings and Interpretation: Institutional Systems of Innovation

3.1 Japan

Japan's institutional system is characterized by homogeneousness. It tends to use individual language. It is supplier-oriented and highly stable. The enterprises focus on operational efficiency, growth (pursuit of market share), and attempt to leverage both cost and quality advantages. The decision-making process is consensus based and it is a partially integrated system. (Rong, 2004)

From 1973 to 1985, Japan's economy has shifted from a high-growth path to a so called "stable-growth" phase. The international environment in the 1970s (New Economic Policy by the Nixon government, world food crisis, energy crises, global adoption of the floating exchange rate system, etc) caused the inflationary in many countries, including Japan, which resulted the slow-down of the Japanese economy and the increase of the unemployment rate. However, the Japanese government successfully utilized technology policies to encourage the development of energy-saving and less energy-intensive technologies to make Japan's economy less energy-intensive. Nevertheless, despite the success in certain technology policies, overall, the government has failed to institute the structural reforms that put Japan in long-term stable growth basis. Hirono (2001) analyzed that the Japanese government failed in (1) deregulation and decontrol to increase the competitiveness of domestic industries; (2) trade liberalization; (3) decontrol foreign exchange; and (4) decentralization of public administration and tax.

These failures in structure reform were only the prelude of the policy failures in the bubble and the post bubble period (1985-1999). During the period, the international environment was characterized by accelerated globalization through further trade liberalization, a rapid enlargement of highly liquid global capital market, and the sky-rocketing price of shares and real-estate, all these are accompanied by the rapid advanced development of information and communication technologies (ICT). The huge appreciation of Japanese yen caused an outflow of manufacturing investment to oversea. The government continued its effort in supporting technologies development in manufacturing sectors. However, heavy regulation and protectionist mindset has prevented restructuring in non-manufacturing sectors. The failure of government policies in those areas has constrained Japan's productivity improvement at national level despite the marvelous progress in manufacturing technology. (Hirono, 2001)

Japan's experience reveals that institutional settings can facilitate or impede technology development. While appropriate institutional setting will stimulate innovation (in the 1960s and 1970s); inappropriate institutional setting will impede innovation (in the 1990s).

3.2 United States

Form 1950s to 1968 is called the golden age of defense-based American science and technology. There are two main elements of the US postwar technology policy: government support for research in basic science and active development of advanced technology by federal agencies in pursuit of their statutory missions. The assumptions underlie the bipartisan support for science are (1) pipeline model (scientific research and invention are returned by industrial innovation, which is sequentially followed by product development and production) and (2) spin-off (technology created in pursuit of government missions, such as defense, space, and nuclear energy, would flow to industry and make for prosperity). Both assumptions view that the process are automatic or free.

US high-tech competitiveness started to fell, especially in 1986, when high-tech trade balance first became negative. In responding to the concerns of the erosion of the US high-tech competitiveness, the US government coped with a series Acts in the 1980s, such as the Bayh-Dole Patent Act and Stevenson-Wydler Act in 1980, The National Cooperative Research Act in 1984, The Technology Transfer Act in 1986, and the Omnibus Trade and Competitiveness Act in 1988, to accelerate the spin-off of government technology to the commercial sector. For instance, the National Cooperative Research Act in 1984, which encourages firms collaborating in R&D, was a response to the Japanese research consortia.

But it was not until 1993 that the break with reliance on the spin-off model was clear. The new technology policy has a shifted balance from the military to civil R&D, and the civil R&D expenditure has a dramatic increase. To deal with the new environment for R&D, such as increasingly and decentralized nature of technology, cooperation focuses R&D resources on core strengths, seeking outsourcing, reaching out university for technology, and decentralizing of technology management responsibilities (from central R&D laboratory to business divisions). The US government positioned itself to cast a new institutional relationship between industry, government, and university.

US' institutional system is characterized by homogeneousness. It tends to use standardized language. It is market-oriented. It has transformed from a defense-based innovation system to a customer-oriented innovation system, facilitated by the deployment of the information technology. The enterprises focus on growth as well as profitability, and attempt to leverage both cost and quality advantages. The decision-making process is decentralized.

3.3 China

China's institutional system however, is characterized by heterogeneousness. Currently, it is in transition from using individual to standardized language and from central planning to market-oriented. The enterprises focus on strategy, profitability. They often choose between cost and quality advantages. The decision-making process is partially centralized and partially individualized. It focuses on full integration of innovation system and also coordination among actors (Rong, 2004).

A close look at the organization of China's national innovation system and its reform will provide some insights to comprehend China's institutional system. Corresponding to the improvement of the technological capability is the transitioning of China's national innovation system. China's innovation systems under central planning system and since the reform can be illustrated as Figure 3.5. The most conspicuous change of China's NIS from under central planning system to after the reform is the expansion of the primary actors and the much horizontal involvement of the primary actors of the institutional system. For instance, in addition to State-owned manufacturers (SOEs), other ownership-types of firms, such as multinational enterprises (MNEs), national technology enterprises (NTEs), also joined as primary actors falls into the classification of firms. Before the reform, primary actors involves only one or at most two fundamental activities of the NIS. Now they have expanded to more activities. In the command era, universities were only involved in only education, but it has expanded activities in almost every perspective of the national innovation system. Academy of Science institutes and industrial research institutes have had the similar expansion.

China's NIS reform has focused on its R&D system. After the culture revolution, rehabilitation and expansion of R&D system were put into practice (1978-1980). From 1981 to 1985, R&D planning practice was further elaborated. Since 1985, there is consensus about market reform decision for R&D system and thus three steps were taken to into action in the following decade. First, R&D institutes were advocated to merge into existing enterprises (1987). Further, from 1988, spin-off enterprises from the research institutes have been encouraged and the Torch Program were started to offer incentive for commercialization of the R&D result (establishing new technology enterprises). In the 1990s, the government started to focus on the base of the R&D system, transforming the established R&D institutes.

The merging R&D institutes into the existing enterprises turned out to be a failure because of the inability of the enterprises both in terms of supporting R&D institute financially. Further, the R&D institutes were backward in technology comparing to other means that are available for the enterprises to get their technology. On the other hand, spin-off new technology enterprises have turned out to be very successful, especially in the field of computer technology. The direct transformation of the R&D institutes is much comprehensive package of system reform. In addition to the spin-off new technology enterprises, R&D institutes were also encouraged to establish production center and consultancy center that directly involved in the economic activities.

3.4 ICT

The following indicators generally measure a country's ICT infrastructure: telephone mainline, mobile phone, Internet host or Internet users, and personal computers (per 1000 people). Japan and the US have very well-developed ICT infrastructures, which lead the world now days. China's ICT infrastructure has experienced explosion over the past decade.

We can compare the contribution of ICT to output growth of the last two decades of Japan and the US, Not surprisingly, the US economy has benefited most from the ICT deployment. At the second half of 1990s, ICT capital accounted for 50% of the overall contribution of capital services to output growth. Japan's ICT, in comparison, has a lower contribution (about 35% of the overall contribution of capital services) to output growth. However, during the past two decades, its ICT contribution has been increased, from around 16% (1980-1985) to 35% (1995-1999). **(Table 1)**

Table 1. Percentage Point Contribution of ICT to Output Growth (Business Sector)

Period	Growth of Output	Total Capital Service	Total ICT
Japan			
1980-1985	3.31	1.1	0.18
1985-1990	5.14	1.5	0.3
1990-1995	1.33	1.49	0.31
1995-1999	1.1	1.07	0.38
US			
1980-1985	3.35	1.25	0.44
1985-1990	3.31	1.1	0.43
1990-1995	2.64	0.97	0.43
1995-1999	4.43	1.69	0.86

Source: Colecchia and Schreyer, 2002.

4. Conclusion

As the experience of the Japan, US, and China have illustrated, the institutional system for innovation has been dynamically evolved with a country's specific socio-economic environment and the development of the industrial technologies. Emergence of innovation and advancement of institutional systems is a co-evolutionary dynamic process. On the one hand, innovation generation cycle that leads to emerging innovations to market highly dependent on institutional systems. On the other hand, institutional systems strongly shape emerging innovation; innovation may also change the underlying institutions. The co-evolutionary dynamism between emergence of innovation and advancement of institutional systems is decisive for an innovation driven economy. It may stagnate if institutional systems cannot adapt to evolving innovations. This can be illustrated by US's experience in the 1980s, Japan's experience in the 1990s, and China's experience before the market reform. US and China have recently quite successfully adapted their institutional systems to the evolving innovations, while Japan is currently standing at a crossroad. The reform of the institutional system will be crucial for Japan's technological capability in future.

Will China's current institutional system of innovation be able to sustain its current high growth or will it become inappropriate thus impede the innovation?

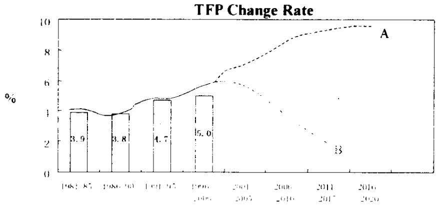

Figure 4. Two possible paths for China's TFP Change Rate .(Source: Rong, 2004)

Figure 4 indicates that there are two possible paths. Which path China may take mainly depends on how the institutional system can evolve and adapt itself to the changing social-economic context.

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