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"Innovation 25" Plan in Japan

Introduction

The Japanese economy experienced the so-called "Lost Decade" in 1990s and thereafter, when the asset price bubble burst and the economy continued to stagnate and remained in a slump. Moreover, there was price deflation. During the "Lost Decade", production technology or total macroeconomic factor productivity decreased and has remained relatively lower than that of the US and European countries, and lower than in the period before the bubble burst. The prolonged economic slump forced Japanese companies to rush to restructure, and may have discouraged them from investing in R&D and IT, reducing total factor productivity in Japan.

The Japanese economy is facing a severe long-run problem related with a declining and ageing population, which needs to increase labour productivity so that a smaller working population must support the whole population. Accordingly, the Japanese economy must increase labour productivity, through improved production technology or total factor productivity where mar-

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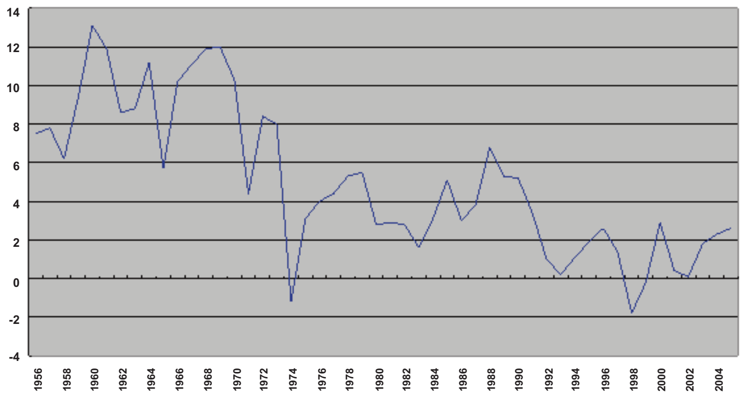
ginal products of capital are no longer higher. In this context, Prime Minister Shinzo Abe has adopted a long-term strategy for the creation of innovation to promote growth until 2025. The "Innovation 25" is directed by the "Innovation 25" Strategy Council under the tutelage of Minister of State for Innovation Sanae Takaichi, which is debating the "Innovation 25" from October 2006 to June 2007.

This paper focuses on total factor productivity to explain the low economic growth of the "Lost Decade" in 1990s and thereafter. It identifies the factors that have caused lower growth of total factor productivity, specifically investments in IT and R&D, and discusses the innovation activities of Japanese companies focused on research of the factors promoting innovation. The paper then looks at the Innovation 25 Plan, explaining the long-term strategy to promote innovation until 2025, its merits and problems, as presented in an Interim Report by the Innovation 25 Strategy Council at the end of February 2007. The Interim Report points out that the Japanese government should promote innovation in three areas: Science and Technology, and Social and Human Resources.

Current Situation of Japanese Economic Growth

Long term statistics on growth rates of real GDP (Figure 1) show that the growth rates of real GDP have been diminishing over time. The Japanese economy underwent three stages, from higher growth rates in the 1960s, through medium growth rates in the 1970s and 1980s, to lower growth rates in the 1990s and thereafter. The 1990s and thereafter have been labelled the "Lost Decade" because of the declining asset prices and ensuing prolonged economic stagnation.

Figure 1: Growth Rate of Real GDP (at constant prices)



Source: National Accounts, Cabinet Office

Hayashi and Prescott (2002) assume the following aggregate production function to clarify the effects of production technology or total factor productivity (TFP) on the lower growth rate during the "Lost Decade".

$$(1) \qquad Y = AK^{\theta} (h \cdot E)^{1-\theta}$$

where, Y: aggregate output, A: total factor productivity, K: aggregate capital, E: aggregate employment, h: hours per employee. They divided equation (1) by the working-age population N to obtain the following equation:

$$(2) \qquad y = A^{1/(1-\theta)}\, h \cdot e \cdot x^{\theta/(1-\theta)}$$

where $y \equiv Y/N$, $e \equiv E/N$, $x \equiv K/Y$.

They disaggregated output per adult y into four factors: the TFP factor $A^{1/(1-\theta)}$, the workweek factor ^{h}, the employment rate factor ^{e}, and the capital intensity factor $x^{\theta/(1-\theta)}$. They assumed that the capital share parameter $^{\theta}$ was 0.362 to make calibration. Table 1 shows contributions of each of the four factors to the growth rate of output per adult. It is clear that the growth rate of TFP factors fluctuated during the period from 1960 to 2000, while the growth rates of the other three factors were relatively stable over the whole period. Moreover, the growth rates of output per adult are more strongly correlated with those of TFP factors. The growth rate of TFP factors was 0.3 per cent in the “Lost Decade” from 1991 to 2000 when the Japanese economy experienced no more than 0.5 per cent of growth in output per adult.

Table 1: Accounting for Japanese Growth per Person (Age 20-69)

Period	Growth Rate	Factors			
		TPF Factor	Capital intensity	Workweek length	Employment rate
1960-1973	7.2 %	6.5 %	2.3 %	- 0.8 %	- 0.7 %
1973-1983	2.2 %	0.8 %	2.1 %	- 0.4 %	- 0.3 %
1983-1991	3.6 %	3.7 %	0.2 %	- 0.5 %	0.1 %
1991-2000	0.5 %	0.3 %	1.4 %	- 0.9 %	- 0.4 %

Source: Hayashi and Prescott (2002)

Jorgenson and Motohashi (2005) analyzed the effects on Information Technology (IT) on TFP in Japan by comparing it with that of the United States. They assume that aggregate output consists of non-IT investment goods, computer investment, software investment, investment in communications equipment, consumption of non-IT goods and services, and consumption of IT capital services by governments and households, and that aggregate input consists of non-IT capital services, computer services, software services, communications equipment services, and labour services to represent the following production possibility frontier:

$$(3) \qquad Y(I_n, I_c, I_s, I_t, C_n, C_c) = A \bullet X(K_n, K_c, K_s, K_t, L)$$

where Y: aggregate output, I_n: non-IT investment goods, I_c: computer investment, I_s: software investment, I_t: investment in communications equipment, C_n: consumption of non-IT goods and services, C_c: consumption of IT capital services by governments and households, X: aggregate input, K_n non-IT capital services, K_c: computer services, K_s: software services, K_t: communications equipment services, L: labour services, A: total factor productivity.

Table 2 shows the sources of economic growth in Japan and the United States. According to Jorgenson and Motohashi, the difference in growth rates between Gross Domestic Income (GDI) and

GDP is equal to the growth rate of TFP, while the growth rate of GDI is disaggregated into the contribution of IT capital, non-IT capital, and labour services. They found that decreases in the growth rate of GDP can be attributed to those of TFP as well as labour from 1980s to 1990s-early 2000s. The decreases in Japanese TFP were smaller than those in the United States, especially during the IT bubble period between 1995 and 2003.

Jorgenson and Motohashi disaggregated TFP growth into information technology and non-information technology growth. The contributions of both information technology and non-information technology growth to TFP growth are shown in Table 3. The growth rate of information technology was stable from 1975 to 2003 in Japan. In contrast, growth rate of non-information technology decreased from 1.35 per cent in 1975-90 to 0.48 per cent in 1990-95, and then to 0.10 per cent in 1995-2003. The decrease in growth rate of non-information technology reflects the decrease in TFP growth rate. By contrast, the US experienced increases in both information technology and non-information technology. Moreover, the growth rates of information technology were almost the same in Japan and the United States, while the growth rate of information technology was smaller than that of non-information technology.

In summary, the decreases in Japanese economic growth were caused by the decreases in TFP during the "Lost Decade." Decreases in TFP have reflected non-information technology rather than information technology.

Table 2: Sources of GDP

(JAPAN)

	1975-90	1980-90	1990-95	1995-03
Gross Domestic Product	4.03	3.97	1.64	0.28
Contribution of Information Technology	0.43	0.55	0.22	0.47
Computers	0.22	0.29	0.11	0.19
Software	0.13	1.18	0.08	0.22
Communications Equipment	0.08	0.09	0.03	0.06
Contribution of Non-Information Technology	3.61	3.42	1.41	0.81
Gross Domestic Income	2.46	2.71	0.84	0.83
Contribution of Information Technology Capital Services	0.36	0.44	.029	0.54
Computers	0.18	0.21	0.13	0.22
Software	0.12	0.16	0.12	0.20
Communications Equipment	0.07	0.07	0.04	0.11
Contribution of Non-Information Technology Capital Services	1.01	1.08	0.77	0.62
Contribution of Labor Services	1.09	1.19	-0.22	-0.32
Total Factor Productivity	1.57	1.25	0.80	0.45

Notes: Average annual percentage rates of growth. The contributions of an output is the rate of growth multiplied by the value share.

(US)

	1948-73	1980-90	1990-95	1995-03
		Outputs		
Gross Domestic Product	4.00	2.99	2.43	3.56
Contribution of Information Technology	0.11	0.35	0.37	0.59
Computers	0.03	0.18	0.15	0.32
Software	0.02	0.08	0.15	0.17
Communications Equipment	0.07	0.09	0.08	0.09
Contribution of Non-Information Technology	3.88	2.64	2.06	2.97
		Inputs		
Gross Domestic Income	3.07	2.68	2.13	2.56
Contribution of Information Technology Capital Services	0.16	0.38	0.49	0.88
Computers	0.04	0.20	0.22	0.49
Software	0.02	0.07	0.16	0.22
Communications Equipment	0.09	0.11	0.10	0.17
Contribution of Non-Information Technology Capital Services	1.80	1.11	0.71	1.01
Contribution of Labor Services	1.11	1.18	0.93	0.67
Total Factor Productivity	0.93	0.31	0.31	0.99

Source: Jorgenson and Motohashi (2005).

Table 3: Decomposition of TFP Growth

(JAPAN)

	1975-90	1990-95	1995-03
Total Factor Productivity Growth	1.57	0.80	0.45
	Contribution to TFP Growth:		
Information Technology	0.23	0.32	0.36
Computers	0.13	0.18	0.23
Software	0.05	0.10	0.04
Communications Equipment	0.05	0.04	0.09
Non-Information Technology	1.35	0.48	0.10

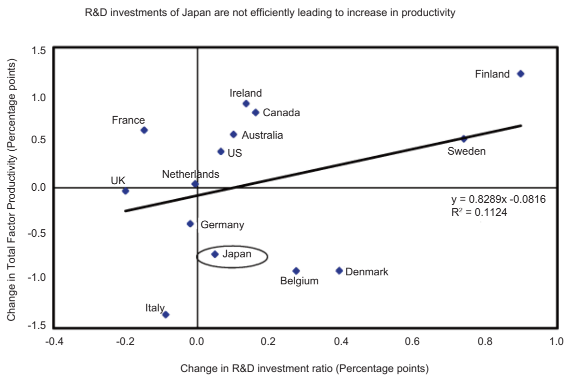
(US)

	1948-73	1973-89	1989-95	1995-03
Total Factor Productivity Growth	**0.93**	**0.31**	**0.31**	**0.99**
Information Technology	**0.05**	**0.20**	**0.23**	**0.46**
Computers	**0.02**	**0.13**	**0.13**	**0.31**
Software	**0.00**	**0.03**	**0.06**	**0.06**
Communications Equipment	**0.03**	**0.05**	**0.04**	**0.08**
Non-Information Technology	**0.88**	**0.11**	**0.08**	**0.53**

Source: Jorgenson and Motohashi (2005)

It is important that innovations spawned by R&D activities should lead to improvements in productivity (TFP). Figure 1 shows the relationship between TFP and a ratio of R&D investment to GDP for industrialized countries in terms of changes from the average of "1990 to 1995" to the average of "1996 to 2001." It shows there is a moderately positive relationship between TFP and R&D investment in the industrialized countries. However, increases in the ratio of R&D investment to GDP in Japan since the 1990s have been accompanied by a decline in the growth of TFP. R&D investment has not contributed to TFP growth in recent years. Although changes in TFP cannot be attributed solely to innovation, this trend indicates the possibility that improvements in productivity commensurate with the amount of R&D investment have not been achieved.

Figure 2: The Relationship between the R&D Investment Ratio and TFP

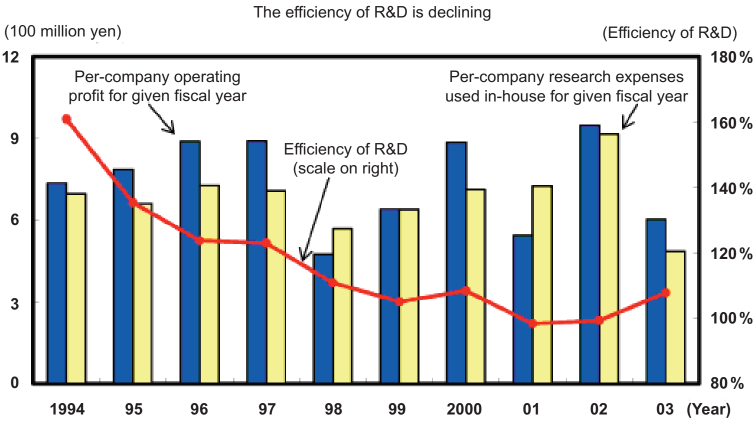


Source: OECD Factbook 2005 and Main Science and Technology Indicators 2004, OECD.
Notes: 1. The R&D investment ratio is the ratio of R&D investment to GDP.
2. Changes shown here are between the average of "1990 to 1995" and the average of "1996 to 2001."

Source: Cabinet Office of Government of Japan (2005)

The Cabinet Office (2005) pointed out that the above probably indicates a less efficient R&D investment in Japan including by the private sector. An index that measures the efficiency of R&D investment (calculated by dividing cumulative operating profit over five years by cumulative R&D costs over five years) shows an immediate, albeit modest, increase upon the recovery of corporate profits as a result of economic recovery, but the long-term trend is downward as shown in Figure 2. From these statistical patterns, it can be concluded that the efficiency of R&D by Japanese companies is declining in comparison with the past.

Figure 3: Movements of Efficiency of R&D in Japanese Manufacturing



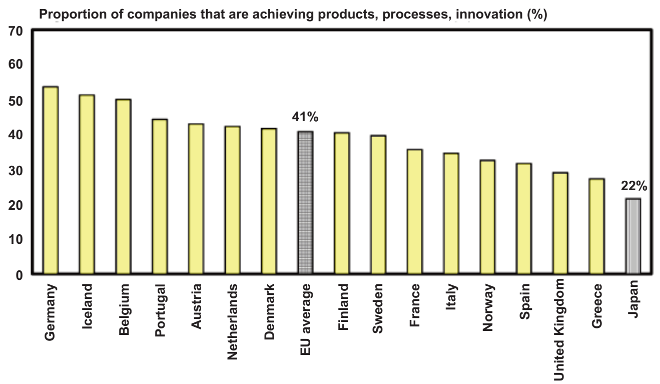
Notes: 1. Survey of Scientific and Technological Research, Ministry of Internal Affairs and Communication.
2. Efficiency of R&D in a given fiscal year is calculated as (per-company cumulative research profit over the past five years counted from the given fiscal year) / (per-company cumulative research expenses (on an expenditure basis) used in-house over the past five year counted from the given fiscal year).

Source: Cabinet Office of the Government of Japan (2005)

The Innovative Activities of Japanese Companies

The Cabinet Office of Government of Japan (2005) used the National Innovation Survey of the Science and Technology Policy Bureau, Ministry of Education, Culture, Sports Science and Technology to outline the innovation activities of Japanese companies today. According to the survey, more than 20 per cent of the companies examined with more than ten employees had achieved either product innovation (i.e., the introduction to the market of a product that is either new in some way or substantially improved), or process innovation (i.e., the introduction of a process, including a method of providing a service or distributing a product, that is either new in some way or substantially improved) in the three-year period from 1999 to 2001. This is considered by the Cabinet Office (2005) to be the percentage of companies that have achieved innovation. The Survey made reference to a similar survey conducted in the European Union (EU), which showed that 40 per cent of companies in EU member countries had achieved innovation. On the basis of these two surveys, therefore, it would appear that innovative activities by Japanese companies are not particularly extensive. Figure 2 compares innovation activities by Japanese companies and companies in EU member countries.[1]

Figure 4: International Comparison of Companies' Innovation Activities



Notes: 1. *National Innovation Survey 2003,* National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology; Innovation in Europe, Eurostat.
2. The survey period was 1999-2001 for Japan and 1998-2000 for the European countries.
3. The "EU average" is the average of 12 countries that were EU Member States at the time of the survey.

Source: Cabinet Office of the Government of Japan (2005)

[1]It should be noted that the National Innovation Survey and the EU's "Third Joint Innovation Survey" differed in their methodologies in that the former performed sampling with replacement to the population represented by the number of companies, while the latter performed sampling with replacement to the population represented by the number of employees, and bias may have existed in the responding companies. Consequently, the proportion of companies in Japan that have achieved innovation may have been excessively small. The results of the "Third Joint Innovation Survey" were announced in "Innovation in Europe-Results for the EU, Iceland and Norway" from Eurostat.

According to the National Innovation Survey referred to above, the reasons why companies did not engage in some type of innovative activities or follow through with such activities include staff shortages, inadequate information about technology and markets, and organizational rigidity. This suggests that success in innovation will be affected by disparities in the managerial and organizational initiative of companies, including human resources development.

In 2004, the Cabinet Office conducted a National Innovation Survey (December 2004). The survey results show there are problems with improving competitiveness, highlighting the relationship between managerial and organizational initiative and success in innovation, and the relationship with the profitability and productivity of companies.

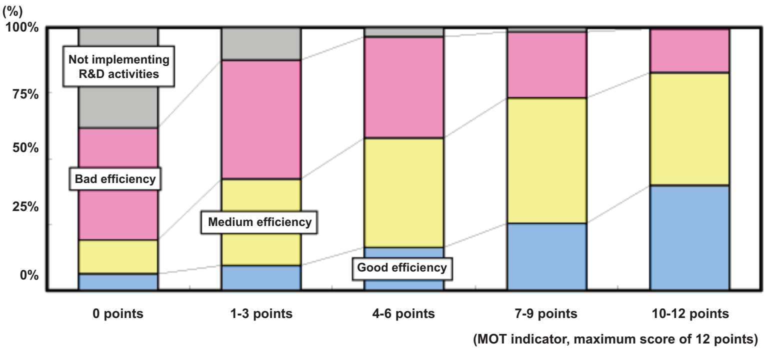
In the survey, companies were asked whether they had taken action in 12 areas, including developing a strategic vision for R&D, forming linkages between R&D strategy, management strategy and marketing, instituting a strategy for securing and developing personnel, and managing the progress of research and development. More than 50 per cent replied that they had taken action to clarify the system of responsibility concerning R&D strategy and to manage research and development. However, relatively few had adopted measures to prevent the loss of personnel, or to secure and develop personnel, or to flatten their organizational structure (Table 4). By totalling these results and assigning points to a "management of technology (MOT index)" with a maximum rating of 12, it was confirmed that, generally, the higher the MOT index, the higher the R&D efficiency, as shown in Figure 3.

Table 4: Management of Technology Indicators

Content of the management of technology indicator	Average (0-1)
Clarifying decision-making and the system of responsability concerning R&D strategy and appointing an R&D director (clear involvement of top executives in R&D)	0.527
Managing the process of research and development	0.510
Implementing continuous R&D	0.471
Developing a strategic vision (roadmap) for R&D	0.449
Forming linkages among market surveys and the sales department and R&D activities	0.400
Establishing a knowledge (technology) sharing platform / environment (System building and establishment of a corporate culture, etc.)	0.372
Forming clear linkages between R&D strategy and management strategy	0.365
After implementation of R&D, conducting evaluation and providing feedback to the management strategy and R&D strategy	0.359
Flaening the organizational structure and implementing cross-sectorial projects	0.342
Forming strategic parterships with other companies for knowledge acquisition	0.307
Enhancing systems and building a strategy for securing and developing R&D personnel	0.282
Developing mechanisms and systems to prevent the loss of personnel	0.149

Source: Cabinet Office of the Government of Japan (2005)
Notes: 1. *Questionnaire Survey of the Technological Creativity of Companies* (2005), Cabinet Office.
2. The sample size of the survey was 1,618 companies.
3. The average is the proportion of responding companies that replied "we are taking action" in each area.

Figure 5: MOT Indicator and R&D Efficiency



Notes: 1. *Questionnaire Survey of the Technological Creativity of Companies* (2005), Cabinet Office.
2. In response to the question “To what extent are your R&D activities getting results?,” companies that replied “nearly always” or “often” were rating as having “good efficiency,” companies that replied “around half of the times” were rated as having “medium efficiency” and companies that replied “not often” or “never” were rated as having “bad efficiency.”
3. The sample size of the survey was 1,618 companies.
4. MOT indicator shows which of 12 areas of managerial and organizational efforts that are considered to be related to the achievement of innovation are being implemented by companies. It assigns companies a score between 0 and 12.

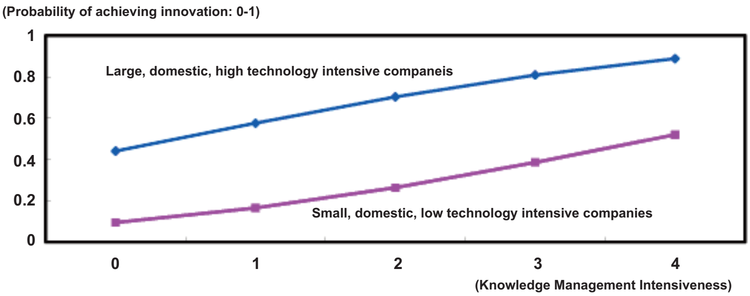
Source: Cabinet Office of the Government of Japan (2005)

The Cabinet Office (2005) also pointed out that knowledge management is a particularly important element in strategic managerial initiatives that serve as the infrastructure for stimulating the innovative activities of companies. In the EU Third Joint Innovation Survey (CIS3) performed in France, the concept of knowledge management was defined in terms of four management techniques: (i) the establishment of written policies concerning knowledge management; (ii) the creation of values and a corporate culture designed to promote knowledge sharing; (iii) the creation of incentives for retaining employees and directors; (iv) the establishment of partnerships and strategic alliances with other companies for knowledge acquisition.

In a study to determine which kinds of companies practiced knowledge management, it was found that companies that are larger or in high technology intensive manufacturing industries were more likely to practice knowledge management employing any of the abovementioned techniques. However, even among large companies and high technology intensive industries, the percentage that implemented an incentive policy to retain employees was less than 30 per cent, which is low compared with the use of other techniques of knowledge management. The lack of incentives is reflected in companies' slow progress in establishing systems for handing the assignment of rights pertaining to inventions developed on the job (i.e. service inventions), as seen in the large number of lawsuits by employees against companies demanding substantial compensation.

To determine whether or not the practice of knowledge management leads to product innovation in manufacturing industries, an evaluation was conducted using a probit model. It was observed that if the company practices only one technique of knowledge management, the probability of achieving some type of innovation for that reason alone is a high 10 per cent compared with cases in which none of the four management techniques are practiced. This means that managerial and organizational initiative as typified by knowledge management probably has a large impact on the success of companies' innovative activities.

Figure 6: Knowledge Management and Innovation



Notes: 1. *Japanese National Innovation Survey,* National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology; *OECD Science, Technology and Industry Outlook (2004),* OECD.

2. Knowledge management intensiveness shows how many of the four management techniques defined in the Innovation Survey (establishment of written policies concerning knowledge management, formation of values and a corporate culture designed to promote knowledge sharing, creation of incentives for retaining employees and directors, formation of partnerships and strategic alliances with other companies for knowledge acquisition) are being implemented. It is assumed that each technique makes an equal contribution to innovation and if all four are being implemented the intensiveness is four.

3. The function is estimated with a probit model that caries out a regression on the function of a cumulative standard normal distribution. Whether or not product innovation had been realized was set as the dependent variable and knowledge management intensiveness was set as the independent variable. Different characteristics were controlled using dummy variables for industry type, company size, and foreign capital companies. Concerning industry classifications, the four industry types in *OECD Science, Technology and Industry Outlook (2004),* OECD (high technology intensive, medium-high technology intensive, medium low technology intensive, low technology intensive) were used and dummy values assigned to them. For company size, the three sizes in the Japanese National Innovation Survey (large, medium, small) were assigned dummy values. Foreign capital companies refers to companies with their headquarters overseas.

4. The basis for the dummy variable for this graph is small, domestic, low technology intensive companies.

Source: Cabinet Office of the Government of Japan (2005)

The Japanese Innovation 25 Plan

It is generally recognized that the declining and ageing population in Japan means that it is necessary to increase labour productivity by improving production technology or total factor productivity, and that improvements in the production technology or total factor productivity should be brought about by innovation. In his policy speech to the first Session of the Diet on September 29, 2006, the Prime Minister pointed out that as Japan has become a society with a declining and ageing population, it is essential to increase productivity and strengthen growth potential so that Japanese people may continue to have hopes for the future, and to maintain a social security system which provides the basis for more secure lives. He then referred to the Innovation 25 Plan as a personal political commitment to revitalize the Japanese economy through innovation and openness. The Innovation 25 Plan provides long-term strategic guidelines for innovation up to the year 2025. The Prime Minister also stated the following: "Aiming at the creation of innovation that contributes to growth, I will compile and put into effect a long-term strategic guideline, "Innovation 25," which will offer a range of prospects until 2025 in medicine, engineering, information technology, and a variety of other fields. By making full use of a world-leading high-speed Internet infrastructure, my goal is to improve substantially productivity by, for example, doubling the number of teleworkers who work from home."[1]

The Prime Minister referred to the Innovation 25 Plan again in his policy speech at the beginning of the 166th Session of the Diet on January 26, 2007. In his words: "It is now time to elevate the Japanese economy to a new stage for economic growth over the medium and long term, and to that end, we have formulated the "Direction and Strategy for the Japanese Economy," which lays out the reform goals that we will pursue during the next five years. Under my leadership, we will strongly advance a new growth strategy under this policy so that the people can truly sense for themselves that we are achieving real growth. This will be realized through innovation which brings about cutting-edge technologies, products and services, and an open approach which

[1] See: www.kantei.go.jp/foreign/abespeech/2006/09/29speech_e.html

brings the vitality of Asia and the world into our country.[1] Prime Minister Abe promised that he would draw up the Innovation 25 Plan by May 2007 and would implement concrete policies, such as strategic assistance to develop medicines with dramatic effects on cancer and Alzheimer's disease, and make efforts to unify the various patent systems of different countries around the world.

Thus, the "Innovation 25" Plan is a long-term strategy initiative of the Japanese government for the creation of innovation to promote economic growth until 2025. Sanae Takaichi, the Minister of State for Innovation, was appointed to promote the Innovation 25 Plan, and the Innovation 25 Special Mission was set up within the Cabinet Office, and Dr. Kiyoshi Kurokawa, special advisor to the Cabinet on science, technology and innovation issues was nominated Council Chairperson of the Innovation 25 Strategy Council under Minister Takaichi, Minister of State for Innovation. Further, the Innovation 25 Strategy Council, composed of intellectuals from industry and academia, was established. Initially, the goal was to present in an easily understandable format an idea of how the lives of people in 2025 will be improved by innovation, and what kind of innovation is to be targeted. The Cabinet Office gathered ideas from many individuals until February 2007.

The "Innovation 25" Plan is a long-term strategy initiative of the Japanese government for the creation of innovation to promote economic growth until 2025.

During the discussion of the Innovation 25 within the Strategy Council, Council Chairperson Kiyoshi Kurokawa referred to innovation policies in other countries, among them the EU New Lisbon Strategy of 2005, the Creating Innovative Europe (Aho) Report, and the Seventh Framework Programme of 2006. Also he mentioned that he had exchanged views with Mr. Aho on November 13, 2006. Kurokawa pointed out that the EU was trying to revive its society and economy through science and technology with the Lisbon Strategy, notably by increasing the ratio of R&D Investments in terms of EU Gross Regional Production to 3 per cent by 2010. He stressed that the Japanese economy cannot delay the promotion of innovation policy and fall behind other

[1] See: www.kantei.go.jp/foreign/abespeech/2007/01/26speech_e.html

countries, especially the EU. Following discussions, the Cabinet Office drew up a plan, consisting of a roadmap for feasible strategic policies, which was discussed by the Council for Science and Technology Policy and other government bodies. The results of these discussions were brought together to form the Innovation 25 Plan, which was finalized by June 2007.

Kurokawa noted that the following three points were very important when thinking about a society based on innovation: the creation of new wealth for citizens; economic growth in Asia and, the creation of a society where high-spirited, highly creative people are willing to take risks to play an active role in society.

The Innovation 25 Strategy Council produced an Interim Report at the end of February, which is similar to a report prepared by the Science Council of Japan on January 25, 2007. The report describes how to promote innovation in a context of globalization and within an ageing society with declining birth rate. It includes contributions of scientists from various areas, including the humanities, the social sciences, natural science and technology. The report suggests conditions, environments, and systems to promote innovation until 2025, to ensure the security of citizens, to make full use of highly developed information and communication systems, to promote the participation of all regions, to tackle global environmental and energy problems, and to adequately deal with water and food problems. The conditions, environment, and systems that help to promote innovation include systems to foster talented people who produce innovations, environments and R&D system that also produce innovation, and a social system design that promotes innovation. According to the Interim Report, there are three major areas of innovation: Science and Technology, Society, and Human Resources.

Science and Technology

The Interim Report states that heterogeneous discovery and invention should lead to innovation although research that might produce the buds of innovation is the most uncertain of all research activities. Thus, highly creative research involving high risks must be supported, and basic research should be extensively promoted. At the same time, it is necessary to establish bases for innovative research that are attractive for domestic and foreign researchers so that innovation producing R&D is generated. The Report also notes that fusion of knowledge in different fields plays an important role in innovation. The report focuses on life science, information technology, engineering, ecology and energy, and service science.

It is important to create an environment and R&D system that bring about innovation. This calls for the establishment of universities with global standards, such as the Centre of Excellence (COE) in Japan. Universities must have the highest level of capacity so as to be global centres in terms of education and research. Universities should invite excellent scholars and students from the rest of world. Universities should collaborate actively with companies not only in Japan but also abroad. Further, regional universities should be established as Centres of Excellence (COE) in key research fields by inviting national and foreign scholars. Regional universities should establish close links with regional industries so as to activate regional innovation.

The government must increase official support to promote research. This includes developing new fields by establishing cooperation among different fields. It should give support for junior and women scholars, and it is equally important to provide systems for improving mobility of talented persons. The government should revise employment norms, seniority based pay scales, retirement schemes, and the pension system to increase the mobility of talented persons between education and research institutions and firms.

It is important to make environmental readjustments to foster venture business. The government thus needs to increase supportive services for experts in the fields of finance, accounting, judicial affairs, and tax affairs to foster venture business.

The Report points out that collaboration between industry and university is important for innovation. Thus, it is necessary to establish rules on deregulation and conflict of interests. The government should conduct a tax reform to promote donations by companies to universities. Moreover, it should strengthen academic associations, which could work to promote innovation.

Finally, the intellectual property system needs to be strengthened. Intellectual property at education and research institutions must be protected, which means familiarity with intellectual property systems in Japan, the United States, and the European Union. At the same time, it is necessary to support talented persons working in the field of intellectual property and who are engaged in cutting edge research. The government should strengthen regulation of imitations and piracy. It is important to secure freedom of academic research but also to establish an intellectual property system that provides incentives to innovate in industry.

Society

The government should establish a social system that generates innovation effectively. The Report proposes that the various meanings of value in society, social interrelationships, and historical changes be understood, so as to undertake reform that promotes social development. It notes that social system design should be such that it ensures intra-generational and inter-generational balance, and establishes an intellectual infrastructure for sustainable social and economic development. The government should investigate how society establishes symbiotic social relations in which people with different nationalities and life styles can share knowledge.

It should be possible to allow the subjective design of a social system that combines value and technology to promote ongoing improvements. The support of ongoing education, investment and loan systems, tax systems and others is essential to develop the varied potential of individuals and to promote those researching business models and cultural activities that develop as social economic activities. It is necessary to promote individual voluntarism and solidarity. It must be possible to have a social organization and social networks that allow for individual fulfilment and satisfies public needs.

The government should promote a "social technology" to allow for a proper understanding of scientific technology. It is necessary to develop comprehensive and self-examining research in order to promote scientific technology adequately. Further, the potential and risks of scientific technology must be understood so as to limit risks. Communication instruments between ordinary people and experts should be developed to identify strengths and deal with social problems. Scientists should consciously promote autonomous organizations of scientists and researchers to form a community that is open internationally, that spread scientific knowledge, and promote the social responsibility of scientists. Scientists should make review and report developments in scientific technology regularly to society. The report proposes to promote research on innovation policy as part of policy science, as is the case in the United States and the European Union. The government should prepare a system that allows the proposal and implementation of a comprehensive and consistent innovation policy.

The Interim Report points out that the creation of "service innovation" is necessary to provide new services in a context in which people are increasingly concerned with a mentally rich life rather than a product rich life. Productivity in Japan is lower than in the US although the service industry represents around 70 per cent of Japanese GDP. It is necessary to increase productivity to achieve sustainable economic growth. The government should promote service science research as well as the active use of IT, the promotion of new enterprises through deregulation, and the promotion of new industries.

Human Resources

The Interim Report notes that human resource is at the heart of innovation. It recommends strengthening a framework to foster human resource development to that innovations are not windfalls but part of a chain reaction. A system that promotes talented and innovating individuals is vital for an active innovation society. The goal is to promote talents in various quadrants, and individuals who engage in active exchanges with different cultures to promote improvements through friendly competition. This means establishing graduate schools that gather talented people from around the world, with top foreign experts invited to Japanese universities under internationally competitive standards. Graduate students must be allowed to move to different schools at different universities to engage in their research under the tutelage of the best possible professors. Promising young researchers cannot be trapped in a closed competitive environment early in their lives. Individuals must be encouraged to go out into the world to experience the diversity of values and goals. Needless to say, it is of utmost importance that those in higher education – undergraduates, graduates, postgraduates, university personnel and researchers – who are engaged in human resources development and who promote scientific knowledge and policy must support such openness. It is necessary to build a career forming structure in which scientists, researchers, and educators are encouraged to mingle with their peers and refine their research by submitting it to open critical appraisal. In a "vertical" society like Japan's, to introduce and improve a system of integration in the early stages of education and socialization is the most basic policy measure, which can contribute to the cultivation of human resources (Science Council of Japan, 2005).

Conclusion

This paper has outlined, on the basis of research by Hayashi and Prescott, and Jorgenson and Motohashi, the most important factor leading to the lower growth rate of Japanese economy. The growth rates of output per adult are more strongly correlated with those of TFP factors. During the "Lost Decade" (1991-2000) in particular, the lower growth rate of TFP factors had an impact on the lower growth rate of output per adult in Japan. Decreases in TFP reflected non-information technology rather than the information technology. R&D did not contribute to the growth of TFP. Improvements in productivity commensurate with the amount of R&D investments did not occur, which reflects the lower efficiency of R&D investments in Japan.

According to the National Innovation Survey, innovative activities by Japanese companies are significantly lower than those for EU countries.

According to the National Innovation Survey, innovative activities by Japanese companies are significantly lower than those for EU countries. The reasons for this include staff shortages, inadequate information about technology and markets, and organizational rigidity. The management of technology (including developing mechanism and systems to prevent the loss of personnel, enhancing systems, and building a strategy for securing and developing R&D personnel) is poor in Japanese companies. The poor management of technology has adverse effects on R&D efficiency. Managerial and organizational initiatives as typified by knowledge management may be reflected by the lower innovative activities of Japanese companies.

Prime Minister Abe has adopted the Innovation 25 Plan as a long-term strategy initiative to generate innovation to promote Japanese economic growth until 2025. The Innovation 25 Strategy Council produced an Interim Report, which stresses that it is important to promote the three Innovations of Science Technology, Society, and Human Resource in order to bring about continuing innovation in Japan. The Innovation of Science Technology would contribute to fomenting buds of science technology and final products and systems arising from it. The innovation of society can create the context for innovation. Human resources are the key to innovation. The Japanese government should promote all of the three areas of innovation to promote an innovative and knowledge-based society.