AN OVERVIEW OF UNIVERSITY-INDUSTRY COLLABORATIONS IN ASIAN COUNTRIES

Toward Effective University-Industry Partnerships

June 2005

Risaburo Nezu
Fujitsu Research Institute

TABLE OF CONTENTS

1. Introduction

1. This paper is produced as a result of the project organized by the World Intellectual Property Organization (WIPO) to examine and evaluate recent progress made in seven Asian countries towards more effective and mutually reinforcing relations between universities and industries in the field of scientific and engineering undertakings and to propose a set of guidelines to make these relationships even more effective from a broad national economy perspective. In particular, it highlights the mechanisms adopted by these Asian countries for technology transfers and the regimes for protecting intellectual property rights. While economic and historical situations are different across Asian countries and no simple solution can be found that is universally applicable throughout the region, it is the hope of the participants in this project that this document will provide some useful lessons and analysis, and will thus be helpful to policy makers who are concerned with evaluating the effectiveness of university-industry relations in their respective countries and identifying ways to improve them.

2. This overview chapter draws largely from the inputs of the national experts on technology transfer between university and industry who participated in this project as well as the discussion at the Roundtable on 26 and 27 April 2005 in Tokyo. The list of the national experts who participated in this project is given at the end of this chapter. The inputs from these experts are reproduced in the subsequent chapters. At the Roundtable, it was found that in all of the Asian countries, transfer of technology involves not only universities, but also government-funded laboratories. For the purpose of this synthesis chapter, however, discussion is confined to transfer of technology from universities, since universities do have special challenges and institutional problems that are not of direct relevance to national laboratories.

2. Historical and Cultural Settings for University- Industry (U-I) collaborations

3. The relationships among universities, industries and national research laboratories are very much subject to the historical and cultural background of the individual country. In every country, universities operate under a different set of rules, practices and constraints. While there are some exceptions, most of the

Asian countries had been isolated from the global trade until three decades ago in the manufacturing and service sectors, either because their economies were not sufficiently developed or because they refused to participate in global economic activities under the command and control regime. With the fall of the Berlin Wall in 1989 and the consequent demise of the planned economy, many Asian nations chose to participate in the global competition and reap more benefit from the efficient use of their knowledge. But at the present, the levels of economic developments among the Asian countries that participated in this project are significantly different. Japanese per capita income exceeds $35000, while those of four countries are less than one tenth of that (Table 1). The resource devoted on R&D, both financial and human, shows even wider difference. China is undoubtedly the largest nation in the world, while Singapore is one of the smallest. In addition to historical and cultural differences, these differences in the economic realities in which individual countries are placed, present divergent contexts for university-industry relations. However, over the last twenty years, Asian governments began to pay increasing attention to the effectiveness of their national innovation systems, in particular the relationships between universities and industry.

4. In spite of its overwhelming success in its process of industrialization throughout the post-war period, by late 90s, Japan was obliged to fundamentally transform its university- industry relationship. In Japan, many good universities have been traditionally state-owned and were thus shielded from the pressures of business communities. As a result, they have shown little interest in working with business communities. Particularly after 1945, they harbored strong anti-business sentiment, believing that large business had been responsible for driving Japan into the painful Pacific War. It was next to impossible for such state-owned universities to offer services to businesses in order to help them to resolve technical problems. Universities believed that they must be allowed to pursue truth, free from the interests of external agencies such as government and business. This belief in sheer independence, coupled with the strong left-wing anti-capitalist political atmosphere that prevailed among young students of the early post-war period, made collaboration between universities and industry something to be looked down upon if not totally rejected.

5. It was only as late as the 1990s that Japanese people became serious about

establishing mutually supportive relations between the two communities. The cause that directly led to this change was the obvious loss of competitiveness by Japanese firms to the United States in such key sectors as information technology and biotechnology. Korea and then China, countries that were industrializing at accelerating speeds, were posing new threats to Japanese industry. The response to these new challenges was to upgrade industrial structures and raise the competitiveness of Japanese industry. Companies began to show increasing interest in utilizing the knowledge of universities rather than doing all of their research on their own. Call for open innovation was intensifying under the pressure of global competition and thus, utilizing the most advanced knowledge developed by universities in a speedy fashion became a matter of highest priority for Japan. On the part of universities, there are increasing indications that Japanese universities are falling behind the foreign universities in the levels of academic research, because they have not interacted with the industry which employs equally competent scientists. At the same time, there is still strong cautiousness, often legitimate, that universities should not give way to the pressure of external pressure to contribute to commercial gains at the expense of its academic and educational missions. Many Japanese universities are considering and reviewing to find out the right balance.

6. China emerged through a completely different historical background. Its University-Industry partnerships began as early as the 1950s. From the start of the Communist regime, universities were called upon to make full contributions toward the increase of production in China, as the Chinese economy was deemed to be in a state of "shortage." One good example of such contributions by the academic community under the planned economy was the project "Two Bombs and one Satellite." Clearly, the academic community was strongly urged to play important roles in the defense and military fields rather than in the civilian field. Transfer of knowledge from universities was conducted without explicit rules in respect of the intellectual property. It was only after the major policy change during the '80s that China became serious about the productivity of the economy and thus began to mobilize academic and scientific resources to achieve economic ends. The Decision on the Reform of Scientific and Technological Systems of the Central Committee of the Chinese Communist Party of 1985 marked this turning point in Chinese science and technology policy. This decision allowed universities to take their own decisions as to organizing R&D programs and transferring

technologies according to the situation of the market. In addition, the Decision made it possible to provide incentives through "more pay for more work". The role of the government moved from direct intervention and control into universities to laying out set of rules by way of laws and regulations under which universities could decide on their courses.

7. Korea presents another developmental model. To narrow the gap quickly with Japan and other industrialized countries, Korea began to recognize the importance of closer working relations between universities and businesses. The industrial sectors of strategic importance to Korea changed quickly from labor-intensive products to more high tech machinery and information sectors, as Korea itself is being caught up by other Asian countries. In the recent past, a number of legislations were introduced and amended to make way for a broader range of collaboration between the two. Four laws were of particular importance to facilitating U-I partnership: the Science-Technology Basic Law, the Technology Transfer Promotion Law, Patent Law and the Law for Industrial Education Promotion and Collaboration Boost. The World Bank and the OECD view the Korean innovation system as being based upon catch-up model and suggested to reorient its direction toward long-term basic research and open up its innovation system to foreign participations. Strengthening U-I relationship will be the right step to achieve this end.

8. Singapore provides an interesting example, which is different from any other Asian country. Small and densely populated, it has been open to international competition from the beginning of its independence after World War II. By the 1990s, the country had already reached a high level of industrial development and an industrial strategy utilizing cheap labor was no longer feasible. The need to move to an innovation driven economy was felt earlier than in its neighboring countries. Due to the small size of the country, it was in large measures the work of two universities that drove U-I collaborations; namely, the national University of Singapore (NUS) and Nanyang Technological University (NTU). Being open to the foreign direct investment (FDI), Singapore has attracted a high number of multi national companies (MNCs) from the developed countries. The interaction with such MNCs, along with its English language speaking culture, gave Singapore a unique advantage to learn from foreign countries how to develop an efficient scheme for U-I collaboration.

9. Philippine is still at an early stage of industrial development. A large proportion of industrial activities is in agricultural sector, which mainly serves its domestic market. Collaboration between university and industry is new and not wide-spread yet. A very small proportion of universities have strong R&D units that enable U-I collaboration. An in-depth study commissioned by a government agency acknowledges that several problem areas surfaced in respect of research activities in Filipino universities, including administrative process, lack of full time researchers and other resource shortage. What is noteworthy is Philippine is that many of the firms operating in that country are subsidiaries of foreign firms. They lack confidence with the local laboratories and wish to consult with their parent companies that fail to have first-hand knowledge about the research at Filipino universities. However, during the past decade, the industry tried to consult the local research institutions and universities to resolve their technical problems. This was made necessary by the economic difficulty the country was experiencing.

10. After independence in 1947, Indian science and technology policy was integrated in a fabric of planned economy. A series of five-year plan set out the basic national strategies for economic growth and industrial development. Over the last ten years however, India moved gradually from planned and closed economy to a more open and deregulated one, with a new challenges being set forth for universities and industries. Presently, India is in the process of implementing its 10th five-year plan. Specifically, in the area of science and technology (S&T), the country is being steered by the S&T policy 2003 and its implementation plan. In general, it is in the recent years that the Indian industry started collaborative programs with the universities. Although Indian success in competing in the global market has been modest in the manufacturing sectors, its success in the software is remarkable. The market share for India in the global software development business is now around XXX %. All powerful global IT companies have outsourced part of the operation and have established R&D centers in India. Indian IT engineers are working in many industrialized countries and contributing to the advancement of the information technology. A few world-famous universities like Indian Institute of Technology have made this success possible. But in general, Indian industries are not coming forward to sponsor projects in universities. Most of the collaborations are in the form of consultancy, which normally do not involve

large-scale projects. On the other hand, according to the survey questionnaire conducted by Professor Ganguli, Indian universities are not fully aware of the importance of intellectual property rights (IPRs) and lack in resources to manage them. Both sides need to reach out if U-I collaborations are to flourish.

11. Thailand is another Asian county that stands at an early stage of development. But economic progress in the last decade has been remarkable, with a brief interruption at the time of the Asian Financial crisis of 997. Owing to a high level of foreign investment in the manufacturing sector, in particular, automobile and electronics machinery, Thailand is already a global hub for production of parts and components in these industries. But, Thailand's indigenous private sector is not very active in pursuing their research. Only very large firms have their laboratories. The U-I collaborations in this country has limited history and experience. There is no overarching framework underpinning such collaborations. Its regime for managing the intellectual property right is rather new. The first law for protecting intellectual property, which covered only industrial patents, was enacted as late as 1979. This was followed by another law of 1991 and an amendment of 2000 which covered trademarks. Protection of copyrights came much later in 1994. However, the Thai government is fully aware of the potential benefit of U-I collaboration, as is evidenced by its national Social and Economic Plan No 9, which stresses the importance of transformation of national structure of production, trade and service sectors. The Ministry of Finance allows registered firms, including public and private firms, universities and research institutions, to deduct up to 200 % of R&D expenditures from taxable incomes.

12. In spite of these differences in historical backgrounds and stages of economic development, the recent wave of globalization in the national economies of East Asia has given rise to a common concern across the region. That is, how to ensure rigorous economic growth in the increasingly competitive global market by taking full advantage of the opportunity provided for by the advent of a knowledge-based economy. The arrival of Information Technology has offered an unprecedented opportunity for young developing countries to narrow the gaps with developed countries over a short space of time. Korea, Taiwan, Singapore, China and India are among those that have successfully seized such opportunities and have risen up to the forefront of global competition. The classical model of economic development, as illustrated by the so-called geese-flying model, is no longer valid.

In the time of knowledge economy, countries are able to make a leapfrog jump to the most advanced stage of development. China, for example, is today the largest user of third generation mobile phones, even though ten years ago, most people did not even use landline telephones. Philippine is another country that today uses mobile telephone extensively for personal and industrial uses, but it does not have past record of IT equipment producer. Korea is the most advanced user of the broadband Internet, but it never produced mainframe computers. India is the biggest supplier of outsourcing IT service for the United States and other OECD countries, to an extent of causing serious debate in the US, but there is no trace of that country having had effect of equal magnitude in the industrial sectors.

13. The primary reason for such a jump in the process of economic development is that we are now living in a time of global business activity and knowledge economy. Capital, which was once the major constraint to growth, is now mobile on a global scale. Natural resources can be shipped to anywhere they can be used in the most efficient way. What really matters is the knowledge that enables a company to differentiate and generate competitive advantage. The advent of digital technology and biotechnology in the '90s has amply demonstrated the way in which the nature of competition today differs from the earlier paradigm. A high number of new information technologies originated from academic circles and venture businesses rather than from the laboratories of large firms. An increased call for the value of money and reduced time to the market added to the pressures on firms to use the output of R&D that takes place outside laboratories of companies. All of these forces came together to create growing incentives for firms to work with universities for research and development.

14. From the perspective of the universities, there is a growing interest to join forces with the private sector. Universities are being called upon to make tangible contributions to society. In many economies, governments are coming under the strain of allocating limited resources over divergent requirements such as providing for the aging population, combating environmental degradation, and maintaining education and social welfare. The university is no longer a sacrosanct investment, free from the critical evaluation of cost effectiveness. To work with industry is now a very attractive option for universities, as the laboratories of the private sector are often better funded and better equipped with research instruments. The level and quality of their research is as high as those of

universities. In addition, students tend to wish to attend universities that have close working relations, since such universities offer chances of finding good jobs after graduation.

15. But being independent, universities are not always aware of how to best mobilize their academic knowledge. Traditionally, Japanese university scientists attached far greater importance to writing academic papers and having them published on famous scientific magazines like Science of the United States and the Nature of the United Kingdom than to acquiring patents. A low awareness in applying for IPR was also mentioned by the Philippine expert as a cultural and mindset problem, although today faculty members have more positive attitudes towards applying for patents.

16. In order to better understand the way industrial laboratories work, they need to interact with the private sector. The state-owned universities in Japan are a very good case in point. As of April 2004, their legal status has been changed to independent administrative agency. While they now have greater leeway over the management of their own affairs, including partnerships with the business community, they are held accountable for ensuring efficient operations and making proper contributions to society. One good way for the university to render service to society is to make their scientific and engineering knowledge available to businesses and to work with them to commercialize such knowledge. Often universities find that researchers and research facilities in the private sector are of high caliber and are helpful to their purposes. Thus interest in reaching out to the other is growing on both sides.

17. The experience of the United States has been examined carefully across the world. The US industry lost its leadership position largely to Japan during the '80s, but revived since the middle of the '90s. During the '80s, the US introduced many measures to facilitate the commercial use of scientific knowledge that was in the hands of the universities. The Bayh-Dole act of 1980 was the best-known legislation for that purpose. The Act permitted the universities to retain their new knowledge that resulted from publicly funded research activities and where possible to commercialize such knowledge through licensing to industry or to start-up companies. According to a study conducted by AUTUM, 260,000 jobs and $ 40 billion of economic activities were created in the US. There have been many

other measures of equal importance taken to facilitate U-I collaboration. There is some debate about to what extent, the pro-patent policy in the US facilitated the commercial use of inventions by universities. It is without question that university inventions gave rise to many ventures and added to the technological advantages of the US firms in the information technology sector.

18. Unlike mechanical engineering and information technology, in biotechnology, scientific discovery is directly used for producing drugs and diagnostic substance. Most of the patents are filed by academic institutions and small ventures rather than by large pharmaceutical firms. The distance between university laboratory and the market is very short. Accordingly, there is higher chance of success for spin-outs. The emergence of this new US model and its overwhelming success story in the biotech sector urged other nations to reinvigorate the relations between universities and industry. The report from the US Council on Competitiveness (1998) states, "The nation that fosters an infrastructure of linkages among and between firms, universities and government gains competitive advantage through quicker information diffusion and product deployment." As a result of such developments taking place in many countries in Asia and the rest of the world, it is generally correct to conclude that relations between science and business communities has gained importance throughout the '90s to become one of today's top priority issues for policy-makers worldwide.

３. Deepening University-Industry (U-I) relationships

19. To examine the deepening relations between industry and the academic community in a quantitative way and to make an international comparison is by no means an easy task. The most reliable indicator is the so-called science link, namely the number of academic papers cited in the patent applications filed to the US Patent and Trademark Office. This science link indicator shows a clear upward trend in all industrialized countries, and at the same time significant gaps among these countries as well. In the US for example, the number of academic papers cited per patent application was less than 0.5 in 1985, but went up to a level of three in 1998. On the other hand, the same figures for Japan were 0.2 and 0.6 respectively, showing a substantial gap between Japan and the US in the strength of U-I linkages (Table 2). US industries draw much more heavily from academic research when they file patent applications. Other industrialized

countries come between Japan and the US. Korea represents a unique and remarkable case in the sense that in spite of a high level of R&D spending relative to GDP (2.5%), its science linkage is the lowest among the Organization for Economic Collaboration and Development (OECD) member countries. This confirms that Korea has the potential for taking huge benefits through strengthened U-I collaboration.

20. By discipline, biotechnology shows remarkably high degree of science linkage, followed by organic chemistry. (Table 3) In other word, a patent application in biotechnology field draws from more than twenty scientific papers. The high level of science linkage in the US is explained by higher degree of presence of the US in this sector. This indicates that a commercial success in this sector cannot be achieved without having strong scientific research in the university or public laboratory. This is exactly why non-US nations find it difficult to narrow the gap with the US. By contrast, computing is the area with the lowest level of scientific linkage. Computer industry is a sector where engineering skill, as opposed to scientific knowledge, is the key input to produce patentable knowledge. This may be the reason why many Asian countries could catch up with the American and the Japanese leaders.

21. In respect of China, universities are entirely free to engage in profit seeking business. Such university-run enterprise can be either scientific/engineering business or non-scientific business such as shops. The number of scientific type university -run enterprise is around 2000, employing 238,000 workers, of whom 78,000 are scientific staff. The sales income from university-run scientific enterprises increased from RMB 18.5 to 45.2 trillion. Technology transfer and licensing from universities are also on the rise. The number of patent transfers, for example, went up from 298 in 1999 to 532 in 2002. During the same period, technical transfers also increased from about 4000 to 5600. In addition to these forms of technology transfers, contractual research, consultancy and enterprise incubation are widely seen as a means for university researchers to work with the private business. During the three year period between 2000 and 2002, 326 research establishments were created in cooperation with Chinese or foreign enterprises. What is remarkable about the funding of scientific researches conducted by Chinese universities is the high proportion of funding from the enterprise. It is 40 %. This points to a very high level of readiness on the part of

Chinese business in pursuing U-I collaborations.

22. The World Bank's Report of 2001 on " China and the Knowledge Economy " confirms that Beijing University and Tsingbua University created more than sixty spin-offs each in high tech areas. Some are already listed on the Chinese stock market and generating profits and royalties. This is very much due to strong incentives such as allowing researchers to keep at least 50 % of the earnings from commercializing technologies. There are differing views on this distinctive feature of the Chinese innovation system. Some argue that this is essential for pushing knowledge economy in china. Others argue that universities are not set up for a profit and they must first fulfill their roles as generator of knowledge for the common good. Chinese Ministry of Education recently began to look into the current state of affair of U-I collaboration to ensure the right balance.

23. University Spin-Off or University spawned ventures are one widely recognized form of commercializing the result of researches conducted by universities. This is particularly common in such fields as information technology and life science. Such spin-offs include: (i) firms founded by public sector researchers, including staff, professors and post- doctorate students, ii) start-ups with licensed public sector technologies, and iii) firms in which a pubic institution has an equity investment

24. Spin-offs are an entrepreneurial and risk-taking method of exploiting knowledge developed by public laboratories for commercial benefit. The effectiveness of this method is particularly noticeable in such sectors as biotechnology where a new discovery is directly usable without having to go through the many stages from basic research to commercial application. In Japan, the number of university-spawned ventures has been looked at as a key indicator for measuring the overall effectiveness of U-I collaborations. The Minister for Economy Trade and Industry (METI) proposed that one thousand such ventures be created by the end of March 2005. When it was announced three years ago, it was seen to be too ambitious to be realistic. But it turned out that a total of 1099 university spin-offs ere created during this period, overshooting the publicly announced goal. The biggest contributor to this achievement was the Tokyo University which gave birth to 64 spin-offs, followed by Waseda and Osaka University. Most of the universities on the list were big and prestigious ones. The policy focus is now

moving from giving birth to as many start ups as possible to bringing them to the stage of public offering (IPOs). It is the intention of the Japanese government to shift the policy emphasis from quantitative expansion to qualitative improvements of such ventures. This will be a management issue, as well as technology issue. After all, the number of spin-offs from national university laboratories is small compared to the total number of technology led start-ups in the entire economy. The mere number of spin-offs from universities is, at best, a rough measurement of the effectiveness of U-I collaborations.

25. There is another evidence of growing interest of Japanese universities in protecting their inventions by filing patents. The Japanese universities filed 1,335 patents in 2002, a substantial increase from 76 in 1996. But there are some negative indicators which reveal weakness of Japan. Japanese companies spend more than two times as much money to collaborate with foreign universities as with the universities at home. In high tech fields such as IT and biotech, the gap widens to ten times. Why does this happen? Because in the views of the Japanese business, Japanese universities are much less responsive to the need of business, slow to act and less experienced in managing IPRs. While current progress is encouraging, Japanese U-I relation has still a number of problems to overcome.

26. In Korea, in the year 2003, 133 cases of technology transfers were reported from 19 Korean private universities. This represents a significant increase, up from 102 in 2002 and 58 in 2001. Parallel to this, the income for these universities from these technology transfers more than trebled, from 473 million Won in 2001 to 1913 million Won. Patent application by national universities seem to have increased drastically, too, after the set up of Industry University Cooperation Foundation (IUCF), which is responsible for the management of IPRs at each university. Seoul National University and Kyungpook National University produced 260 and 36 patents respectively in one single year of 2004. Prior to set up of IUCF, Korean universities were inactive in protecting their inventions. Up until May 2001, only 44 patents had been filed by the Korean national universities.

27. In Singapore, universities have been a major collaborator with industry, tapping into the Research and Development Assistance Scheme (RDAS), which was introduced in 1981. This was a grant scheme aiming at stimulating R&D in the

form of U-I collaboration. But a full-fledged technology transfer operation began in 1992, when NUS and the Industry and Technology Relations Office (INTRO) were formed to handle the entire range of research collaboration, IP management and technology transfer. Up to the present, INTRO facilitated the filing of more than 700 patents, 166 of which have been granted. 84 licensing agreements have been concluded to generate revenue of $1.44 million and equity in lieu of royalties of $4.85 million. In 2002, 136 research collaboration agreements were signed with a total project value of $42.5 million or 15% of the NUS annual research budget.

28. In contrast to Singapore, universities in Philippine has made marginal contribution to the advancement of technology prowess and competitive edge for its industry. But there are several specific examples of U-I collaborations reported in the national expert's paper. They indicate that contents of the agreements between universities and industry are very different depending on individual cases. Some are with local companies and some others are with foreign companies. This is particularly true for the balance of rights and obligations over IPRs between the parties, in particular, exclusive or non-exclusive nature of the licensing right. This may be a reflection of the fact that no Philippine university has strong IPR unit except the University of Philippine, thus all agreements on U-I collaborations must be negotiated from a scratch without a model or precedent. The other reason for weak U-I relation is that the business partners of the collaborations are often foreign firms and they send the problems concerning IPRs to the lawyers of their parent company. This may risk complicating the U-I relation and making the collaboration more difficult.

29. Indian academic institutions became aware of the importance of protecting and disseminating its knowledge through patents rather recently and the trend seems to be continuing. In 1995 only 35 applications were filed, but, it rose to 96 in 2001 and 79 in 2002 Out of the more than 300 Indian universities, the number of academic institutions that filed patents applications were in the range of 22 and 29 during the last four years, and this was still too small compared with the high number of educational institutions in India that are engaged in R&D activities. In contrast to this modest progress, the performance of Council of Scientific and Industrial Research (CSIR) has been path-breaking. The number of patens filed and granted doubled or tripled after 2001 compared with the previous years. This is a result of aggressive and systematic IPR policy as well as the benefit of

network of 39 laboratories. This points to the importance of attitudes and policies taken by individual research organizations in advancing the protection of inventions.

30. Thailand's expenditure on R&D is not very high even compared to its GDP, which is growing at remarkable pace. In 2003, only 0.18 % of GDP was spent. This low level of resource allocation for R&D is reflected in a small number of patents granted to universities. Between 1995 until 2004 a total of 139 patents have been granted to them, with two universities Kasetsart University and King Mongkut's University accounting for more than 60 %. Patents granted to all universities showed some increase in late 90s, but during the last four years, it went down from 35 in 2001 to mere 1 in 2004. The patent granted to U-I collaboration has been very rare. Only six cases have been on the record since 1995. The majority of patents have been applied and granted by foreign companies and their subsidiaries in Thailand.

31. R&D resource in Philippine is also week both in terms of expenditure and number of researchers, but concrete examples of U-I collaborations are now beginning to be seen as statutory framework for protection of IPR was being adopted by major universities. Since 1991, University of Philippine has six patents registered and ten more pending with the patent office. University of Santo Tomas entered into the first licensing agreement with a company. The other universities are also moving toward entering into arrangement with either Filipino or foreign multinational companies.

32. As have been observed in the preceding sections, U-I collaborations are progressing in all Asian countries, albeit at different speeds and with different momentum. But universities and companies are running into new issues and challenges that had not been anticipated until they had embarked upon this process of collaborations. Such issue will be examined in the following sections

4. National Policy framework

33. In the Asian countries that participated in this project, deepening and expanding U-I relationships during the last decades have been very much due to the purposeful and deliberate public policy efforts in such areas as defining the legal

status of universities and their professors, relaxing or removing regulations that hindered faculty members to work with the industry, handling intellectual property rights and creating funding schemes, and ensuring adequate financial resources for research and development activities at universities. There is now a broad agreement in Asian countries, both developed and developing, that universities and public laboratories should make greater contributions to overall economic growth and competitiveness. While the universities, industries and the publicly funded research institutions should be allowed to develop working relations between them under their own initiative, governments also have the responsibility for establishing laws and practices that would give proper incentives toward collaborative research activities. At the same time, care must be taken not to lose sight of the importance of long-term scientific goals and educational responsibility. Universities should not cave in to the pressure to generate quick commercial outcome.

34. In all of the Asian countries that participated in this project, some form of policy framework underpinned by laws and government regulations has been put in place over the last two decades. This policy framework should serves three different purposes, first to state publicly the intention of the government in respect of the directions universities and industry should follow, second, to lay down legal rules for the conduct of universities and industry, particularly in relation to the management of intellectual property rights, and third, to secure financial resources and incentives to facilitate collaborations. Not all countries set forth policy framework in all of the three areas. In certain countries, legal status of universities needed to be redefined by new laws, so that they could operate as independent and responsible entities. In others, it was so obvious that there was no new legislation. In some countries, governments are taking pro-active positions to boost U-I collaborations, while in other countries they play more subdued roles, allowing universities and industries to determine their course of actions. Legal frameworks are very different among the Asian countries that participated in this project. In some countries, laws are written to spell out technical details. In some other countries, laws provide only basic settings, leaving all technicalities to ministries' directives and circulars and notices. In addition to legal framework, some countries draw up basic plans and goals for U-I collaborations with a view to setting forth future directions and accelerating the trend. Such basic plans are meant to be reviewed and if necessary modified regularly to take into account the

progress to date.

35. Asian countries give different legal status to universities in different countries. In Japan and Korea, state-owned universities were treated as part of the government and were not allowed to operate as an independent entity. Looking across the world, this legal arrangement is rare, but because they had no legal status, such universities did not have the capacity to write a contract or possess patents. This is particularly important because unlike the United States where top-level universities such as Harvard, Stanford and MIT are private, good universities in Asian countries are often funded by governments. Such state-funded universities normally do not have a legal status, which would allow them to claim ownership over the results of their research activities, employ researchers, write contracts with private companies and take on legal obligations if necessary. Rather, they were deemed part of the government itself and were obliged to follow a meticulous process to obtain a permission to work with the private sector. Professors were treated as government employees and accordingly, they were not allowed to work outside the university. In order to pave the way for more operational and efficient U-I relations, specific actions were taken in these two countries.

36. In Korea, for example, several different laws are collectively forming a basis for U-I partnerships and technology transfers. Among them are science and technology basic laws and patent laws, but the legislation of direct relevance is the technology transfer promotion law. Prior to this law, national and public universities had been prohibited from possessing a legal status as a legal person and therefore claiming patent right. The rationale behind this rule was that the results of publicly funded research should belong to the public domain, not to the organization that developed it. This had been a major obstacle and discouragement for universities with respect to conducting research in areas of commercial interest. Article 16 of the technology transfer promotion law reversed this statute in order to enable publicly funded universities to work with businesses and use their technologies and knowledge for commercial purposes. Under the new arrangement, researchers in national universities were allowed not only to work with the private sector, but also take some slice of the revenue in the event such project generates revenues. As of 2001, a significant gap was observed between the publicly funded universities and private universities in the

proportions of research funds coming from enterprises. In the case of the former, 14.7% was from enterprises, while in the latter case, it was 32.3%. Whether this low level of exposure of the national universities to corporate funding is a sound situation or not is debatable. Maybe, it is because national universities do not need to rely on the enterprise funding that their proportions are so low. But without doubt, national universities are less experienced in doing joint research with the private sector and part of the reason for this is the restrictive nature of the legal status of professors. Whether the new regime provided for by the Law for Industry Education Promotion and Industry University cooperation Boost of 2003, coupled with the monetary incentives, will bring about dramatic changes in the attitudes of the national universities is yet to be seen. But the initial indication is that this change in the legal framework seems to affect their patenting activities considerably.

37. This development is very similar to that of Japan. Several laws were introduced to facilitate technology transfers. The law Promoting Technology Transfers from Academia of 1996 was the first of such attempts, which was followed by a second law, Industrial Revitalizing Law of 1999, which provided for a legal basis similar to that of Bayh-Dole Act of the USA. However, the most important law took effect as of April 2004, to alter the legal status of national universities to an independent administrative entity. The purpose of this policy goes well beyond facilitating U-I collaborations. It aims to render the Japanese national universities more responsive to the changing needs of the society, by offering more freedom of conducts but at the same time taking them more accountable for creating value for the Japanese society. But one area where visible change is expected is U-I collaborations. This new arrangement gives universities an independent legal status, thus enabling them to possess ownership of the technologies and inventions that they develop. Researchers and faculty members in the national universities are no longer bound by the regulations applicable to the government employees. This change, coupled with other reforms that the Japanese national universities have gone through recently, changed very much the attitude and mindsets of the university researchers in respect of collaborations with the private sector. For example, the rapid increase in spin-offs from university laboratories is largely due to the relaxation of the old regulations prohibiting faculty members of state-owned universities' working outside the campus.

38. In this respect, Korea and Japan are minority in Asia. In Philippine, state-owned universities are autonomous and allowed to act as a corporation, although they are supported by the government. China has a very different situation. The Law of Corporation of the People's Republic of China (1994) stipulates that the legal person of an enterprise, institution or citizen is authorized to establish a corporation according to the law. Because universities are institutional legal persons under this law, it is possible for the university to make investments and establish a corporation with its own capital. In addition, the law stipulates that technology, patented or not, can be regarded as capital. This set of stipulations paves the way for universities to act independently to commercialize their technologies through enterprise incubation, or holding equity stakes in private companies. In the year of 2000, there were 5451 university-run companies. While most of them were not research based, their science-type companies accounted for 2.3 % of the total sales of the high tech sector in the rapidly growing Chinese economy. This is a very high number compared with other Asian countries. Such business activities conducted by universities concentrate heavily on the top five provinces.

39. In the late 1990s, China took a series of more specific actions to push ahead with U-I collaboration. The Central Committee of the Communist Party decided in 1999 that bilateral and multilateral mechanisms for collaboration should be created in the form of mutual part-time jobs and training. Quite a high number of stipulations were adopted by both the central and provincial governments in the years 1997, '98, and '99 in order to boost technical innovation and U-I partnership. Among them, there are two laws setting out supplementary details in regard to the right and obligations as well as contracts for those concerned with the parties involved in technology development, transfer and its commercialization. The measures put forth in Several Opinions on Bringing into Full Play the Scientific and Technological Innovation Role of the University of the Ministry of Education (2002) are directly oriented to U-I partnership. This government decision states: 'To promote universities to form technology transfer organization; to encourage universities to conduct diffusing application of technologies developed in various forms such the application of patent licensing, technology transfer, technical share admission. Under this decision, Chinese universities are allowed to work out their relevant stipulations on encouraging inventions and transfer in order to bring into

play inventions of faculty and students. Faculty member and students are encouraged to and backed up to engage in venture business while doing part-time jobs.

40. Setting out the legal framework for university is one important aspect to promote U-I collaborations. What is of equal importance is that Asian governments have moved to express their political will to bring about more active exploitation of knowledge developed by universities. In Japan, Korea and India, such political will has been incorporated into "basic plans" of some kind, which lay down long-term priorities and funding policies. While the processes used to draw this plan are not identical, it is important to note that U-I relations have been given renewed emphasis in all of the countries.

41. In Japan, formal U-I collaboration dates back to 1983, when joint research projects with the private sector were first approved, but it was more recent that U-I collaboration was given full recognition as a major policy direction in the Japanese science and technology policy. The Basic Plan for Science and Technology, adopted by the Cabinet in 1996, made a specific reference to it and stressed the importance of promoting collaboration between universities and business. During the few years that followed, several important decisions were made at the intergovernmental level, including the Japanese version of the Bayh-Dole act of 1999 and the Basic Law for IPRs of 2002. In Japan, for example, pursuant to the Basic Law for Science and Technology, the Science and Technology Council draws up every five years the "Basic Plan for Science and Technology." The latest one, published in 2001, recommended that the Japanese government spend 24 trillion yen over the next five-year period on public research and development. It also stressed the importance of strategic allocation of resources in basic fields to the organizations that could conduct world-class research.

42. The Government of Philippine is also beginning to play active roles in advancing U-I collaborations. Their National Science and Technology Plan (NSTP) of 2002 stresses the importance of linkage among university, industry and government. Unlike that of Japan, the Plan in Philippine has much longer time horizon reaching out to the year of 2020. This Plan has been formulated by close consultation among government, industry academic and interested non-governmental organizations. It sets out the S&T vision and defines the goals

to be achieved over the short, medium and long-term period. These goals should be achieved by collaborative S&T programs undertaken on a cost sharing basis, sharing of information and best practices. The Plan also attach importance to transfer of technology for commercialization (TECHNICOM). Details of this plan have been released in a series of government memorandum and administrative orders between 2002 and 2004. In response to these actions by the government, universities are moving towards having practical types of collaboration, such as training and consulting, that are suitable to the situation of the country. The Philippine Council for Industry and Energy Research Development of the Department of Science and Technology is helping universities to establish workable academy-industry linkage. This is meant to broaden and deepen U-I collaboration, but so far, only a few universities acted to set up a unit to carry out such a linkage.

43. In Philippine, in addition to the Department of Science and technology, Intellectual property office (IPO) administers " Information Brokering and Matching Program" whose mission is to promote, establish and enhance business linkages between prospective user of technology, the SMEs and owners of technologies, such as research institutions, inventors and patent holders. This service includes packaging of technology, access to database files of suppliers and users, matching and linking potential users to owners of technologies, assistance in finding sources of technologies, and assistance in negotiating terms and conditions.

44. The purpose of such basic plans is not merely making a political statement. Far more important is that it sets out the long tern goals and priorities. Goals set out in the basic plan will be a useful basis against which progress should be evaluated. The setting of priorities is of course not an easy exercise, as it affects the allocation of limited resources to R&D. Naturally, scientists and engineers advocate the fields in which they are in. The same holds true for government ministries, such as the Ministry of Education, Science and Technology and the Ministry of Economy, Trade and Industry. They compete for greater proportion of the resource. While situations are not identical among the countries, many national experts who participated in the Roundtable in Tokyo expressed their views that there are so many Ministries and agencies running their own programs that university researchers and industries are often confused. Basic plan should

provide overall guidance as to how the resource should be distributed and thus to minimize the potential conflicts.

45. In determining priorities and allocation of resources, Asian governments adopt a combination of top-down and bottom up approaches, with both of them having advantage and weakness. In many instances, they start discussions at mid management officials level to be cleared gradually by senior officials. This is inevitable since senior politicians normally do not have sufficient understandings about the potentials and meanings of advanced technologies. This bottom-up approach, namely leaving the resource allocation largely to government and research managers would be a better approach to preserve long term consistency, but may fail to ensure adequate resources for emerging technologies. Top-down approaches would be more suitable at the time when there is an urgent need for shifting priority, although this approach risks stable research environment and long term commitment of researchers. According to the OECD's study, compared with the United States, European countries and Japan are far slower in shifting research funds from mature fields, such as material science, nuclear physics and mechanical engineering to biotechnology and health. A recently published report of METI also confirms that, in response to the rapidly advancing life science, the number of students in the United States of America in the biotechnology field increased 70 % from 1991 to 2000, the number of students in Japan remained unchanged .When there is a need to expand resources for some emerging area at the expense of the area of declining importance would call for high level leadership.

46. Top-down decision-making would enable governments to rapidly move resources to new areas, thus to meet new demand for research. In 2004, in response to the sudden rise of fear of SARs, the deadly bird flu, some Asian governments decided to strengthen their research on infectious disease and public health. Thirty years ago, in order to deal with the oil crises, the Japanese government decided to give the top priority to the development of energy technologies. In retrospect, such timely response strengthened the industrial competitiveness of Japan and laid down the foundation of the prosperous era in 1980s and after. In order to ensure relevance and responsiveness of the national innovation system to ever changing need of nations, there is a need for political leaders to oversee the effectiveness of the entire system, including U-I collaborations. Drawing up a basic plan offers a

good opportunity for many stakeholders to do this.

47. Korea develops a basic plan regularly. Pursuant to the Science Technology Basic Law, the Minister of Science and Technology is required to make an execution plan every year. Chief of Central Administrative Organization and Chief of Local Bodies should make and implement the yearly plan in accordance with the Basic Law. The government has placed the National Science Technology Committee, and the Local Science Technology Advancement Council under these two chiefs. The law states that the Korean government should set up mid- and long-term policy goals and directions for science and technology development in order to achieve the objectives of this law efficiently, and that the spreading of technology transfers and the promotion of research utilization, should be included in the basic plan. As is clear from this, technology transfer and industrial utilization is a part of the objectives set out by the Basic Law. The Basic Law also requires the government to collect indexes and statistics regularly, predict trends and evaluate the effectiveness of the government policies. This is important because reliable statistics is the basis for objective assessment of a policy's effectiveness.

48. In India, science and technology policy is being carried out under the overall direction set out in Science Policy 2003 and its implementation plan. Responsibility of the administration of science and technology (S&T) policy is spread over many government Ministries and their Departments, each one of which has jurisdiction over particular fields, such as environment, agriculture, health, information technology, water, etcs. Department of S&T in the Ministry of S&T is the central body to deal with the promotion of S&T. But, apart from this department, Department of Scientific & Industrial Research (DSIR) was created in 1985, with a mandate of carrying out activities relating to indigenous technology promotion, development and transfer. DSIR is also responsible for coordination of the activities of the Council of Scientific and Industrial Research (CSIR) and two public enterprises, namely National Research Development Corporation (NRDC) and Central Electronics Limited (CEL). The NRDC provides consultancy service to academics, and industry to protect their IPRs and transfer of technologies. This function of NRDC is central to supporting and facilitating effective industry-academia interactions that result in commercialization of technologies.

49. Thailand is at a mid point of its 9th National and Social Development Plan that runs through the period between 2002 and 2006. R&D policy is under severe strain of resources. Its Ministry of Commerce is in charge of the IP affairs through its Department of Intellectual Property (DIP). While patent application procedure used to take a lot of time (two to five years), Thai universities and research institutions have now access to a much quicker procedure, hopefully less than 70 days, as an Memorandum of Understanding was concluded between universities and DIP on 25 February 2005 to expedite the process.

50. In conclusion, all Asian countries that participated in this project have put in place a national policy framework to advance U-I collaboration. It consists of two different strands. On one hand, Asian governments have introduced necessary laws, ministry directives and notices and in certain countries, laws by local governments. They are meant to set out stable rules for the government and university conducts. Such legal measures were taken for the most part in the second half of the 90s, reflecting the growing need for U-I collaborations. The second strand is of revolving nature, which normally takes the form of basic plan, with certain goals and targets to be achieved within given timeframe. Unlike legal frameworks, they are set to be reviewed and revised periodically. In many instances, such basic plan is a part of a broader strategies for economic development. Rather than an independent plan for U-I collaboration. In either case, the plan ought to express political commitment of the government of the time and the directions for university and industry to follow. Priority for funding different areas of scientific research is usually set in the plan.

51. In implementing laws and plans, different ministries are involved. Often, the Ministry in charge of S&T tends to have different perspectives and priorities from the ministry in charge of education, or the ministry in charge of commerce and industry. In many instances, Ministries and departments compete with each other for greater authority and influence. But because they all agree on the overall objectives of U-I collaboration, they often run similar programs that duplicate each other. So many various types of organizations were established related to U-I collaborations and technology transfers that they cannot be supported efficiently. In certain countries, there is a need for streamlining and reducing complexities. U-I collaborations are still in the process of making in Asian nations. The multiple avenues for government support programs run the risk of creating confusion on

the part of universities and firms that intend to use such schemes of support. Such fragmentation of the entire system risks resulting in inefficiencies and greater management costs. Strong leadership needs to be taken at a high policy level to address this question. A process of trial and error will have to continue before effective mechanism develops. In the meantime, Asian countries can learn from the experience of other countries as to how this complex job of coordination has been carried out in other countries and see if there is a best practice to deal with this question.

5. Framework for Managing Intellectual Property Rights

52. Universities across the world are confronted by a very delicate question of how to strike a right balance between publishing their inventions and patenting them. In earlier years, Asian university researchers placed higher priority on publishing, but drive for U-I collaboration has put pressure on them to shift such priority toward protecting their intellectual property rights (IPRs) through patenting. Although commercial gains are not always the goal for universities, patenting is advisable for the purpose of maintaining control over how their inventions will be utilized. At least, they can prevent from someone else from taking over the inventions and claim patents for themselves. Thus, the management of (IPRs) is the central issue in the advancement of U-I partnerships. Being members of the World Trade Organization (WTO), and more specifically, its Trade Related Intellectual Property Rights (TRIPs), all of the Asian countries that participated in this project have well defined systems to protect the economic value of innovations. But compared with the developed countries in America and Europe, such systems were introduced rather late and they have been implemented only insufficiently and practical experience is still limited. Particularly, in pursuing U-I collaboration, it is of crucial importance that individual universities have clear policy for managing IPRs. This is not always a case in Asian universities.

53. In China, both before and after their induction into the WTO, several important laws were put into effect regarding the protection of IPRs. The Chinese expert who participated in the project concludes, " With efforts of twenty years, China has basically built up the law system and law enforcement system of IPRs that are relatively complete in the world." While it is still very much a subject of debate whether such laws are satisfactorily implemented, there is no doubt that a lot of

progress has been made in laying down the framework for vibrant U-I partnerships.

54. The Law of Promotion of Transformation of Scientific and Technological Achievements of the People's Republic of China of 1996 stipulates in its Article 12: "Institutional organizations like R&D organizations, university, etc., are in a position to participate in the tender invitations and submission activities regarding the transformation of scientific and technological achievements implemented by related government agencies or enterprises." While general principles are stated in a set of laws, the details for managing IPRs in the context of U-I collaborations are left for universities to work out. Today, many universities have publicly stated IP rules, including the ownership of inventions, disclosure requirements and procedures. Individual university researchers are asked to report necessary information to universities by filling out check forms for IP protection. In addition, background information about the creative points and the details of the contract with the industry is requested. Based on this information, University IP Management Offices cast judgment on its patentability.

55. India also made additional amendments to comply with the TRIPs Agreement of WTO. In the last few years, the IPR legislations have been amended or new legislations have been passed to bring India in full compliance with TRIPs. But it should be noted that unlike Korea or Japan, India does not have any specific law like Bayh-Dole act of the United States to dictate the ownership of the inventions arising out of publicly funded R&D. Different Ministries and departments have different policies. For example, department of S&T issued general guidelines regarding the ownership of IPR that resulted from the funding by DST. This guideline leaves the ownership allocation to the contract between inventors and the enterprise. On the other hand, invention from projects funded by the Department of Ocean Development can be owned entirely by the institutions. Guidelines from other Government Departments are yet to be formulated, as their IPR Policy is still in the process of making. Generally speaking, the concept of IPR policy in Indian academic institutions is still in their embryonic stage with a small number of institutions announcing their policies. Most of them deal with the matter on case by case basis.

56. U-I relationship has evolved in a very informal way in Thailand. In many

instances relation started when an engineer in a private business runs into technical problem and seeks help from the university he/she graduated from. In other occasion, owners or company executive are friends of university faculty members. They invite university researches to do part-time jobs as corporate advisors and consultants. Conversely, it often happens that company engineers have part-time job of teaching at universities. In Thailand, this type of personal relation is the first step for developing U-I collaborations. The collaboration takes on a wide variety of forms, but consultancy is the most widely observed modality. The Thai government is supportive of these collaborations. It guides and encourages the industrial and business sectors to work together with universities to gain more intellectual property and utilize them. But, there is no publicly stated rule as to how they share the outcome of such IPs and royalties or disclosure of information and reporting requirement. It is largely up to the bilateral deals among the parties involved. Funding passes through faculty members, not university business office, so universities may not be able to keep track of what is happening. There is no formal approval or reporting mechanism. Very few universities in Thailand have their own activities in licensing and technology transfer to the business sector. It is left to individual faculty members. In short, in Thailand, U-I collaboration has been very much "connection based". In the event when some legal document is needed to spell out the agreement between university researcher and the industry, such an agreement takes a form of memorandum of understanding (MOU). There is some movement underway at the present moment, toward laying down more formal base for U-I collaborations. Several factors are under examinations. They include structure of the proposed project, location, management of the project, the types of IP to be expected out of the collaboration, ownership and potential users of the outcome, possibility of spin-off or other forms of technology transfers and licensing. A very concrete example of publicized IP regulation was released recently from Mahidol University. Its IP policies and regulations are winning broader acceptance from other universities as a model.

57. In Korea, under the Technology Transfer Promotion Law of 2001, organizations can be created within the university to take charge of technology transfers. They are responsible for managing and licensing the patent rights of universities. This U-I collaboration group deals with the whole process from drawing up a research contract to supporting the start-up of the business. But one piece of legislation

cannot ensure a satisfactory solution. The Korean expert who participated in this project sees the present situation as less than satisfactory. He points out that, "Our universities do not, for the most part, have technology transfer experts unlike America, and moreover, some universities make people work on miscellaneous various research projects concurrently." As a matter of fact, they are more like managing government R&D business than dealing with technology transfer. Financial condition of organizations in charge of technology transfer is becoming an acute issue, since it is not easy for universities to operate them profitably. Licensing income of universities is a very small amount compared to their entire budgets. In most cases, they are one to two percents." He also argues "In the end, it is a matter of IPRs. Even though they [professors] applied for patents in the name of the school, they don't pay separate royalties to the university in most cases. Some universities have regulations to make professors who founded business to donate to universities according to the business results; cases are very rare to be known." This is a very candid remark about how difficult it is to implement the rules. It points to the need for looking into the actual implementation of general rules, in addition to examining the rules themselves.

58. As result of a set of laws that were introduced late 1990s, Japanese universities are now capable of owing IPRs of the inventions made at their universities. Some of them have established internal patent regulations to deal with them. Faculty members are obliged to report inventions to the university. University evaluates its patentability and commercial values. They decide whether or not to file application. If such invention is patented, universities pay reward to the faculty member according to the rules of the university, who made the invention. If the university licenses the patent to a private company and receive royalty, the university should reimburse part of the royalty revenue to the faculty member. How much should be paid is again pursuant to the internal rules of individual universities.

59. As collaborative relations between universities and industries deepen, the distinction separating their different activities becomes less identifiable. Korean universities at present times are expected to carry out their public duties of different nature that often conflicts with each other, such as education, basic research and working with commercial interest. In order to enhance the accountability of universities, there is a need for adequate information and

transparency with respect to U-I collaborations. This is all the more true since it involves the financial resources collected from taxpayers. In the Korean patent law or in any other laws, there is no specific provision about reporting. Accordingly, there are insufficient reporting requirements on the management of IPRs. There is no reporting requirement on invention under the sphere of business influence. There is no punishment in case of negligence of reporting requirements. In the case of the Seoul National University, total of 1666 patent applications were registered by its faculty members between 1982 and 2000, but only 11 of them were reported to the University. Other universities show much higher rate of reporting.

60. Across the Asian countries, information regarding technology transfer is incomplete and inadequate for the purpose of monitoring and evaluation. There is no established procedure and rules as to what should be reported, in which ways, at what timings and to whom. On the other hand, if inventions are reported to the universities and transferred to the possession of the universities, then universities must decide on whether or not they apply patents, maintain them and decide on the royalties if they can be licensed. In respect of exclusivity of licensing, Asian universities in general have the preference for non-exclusive licensing, reflecting their conviction that their inventions made in universities should be accessible to anyone wishing to use the invention. This may run into conflict with the private companies that wish to utilize that invention exclusively. This is even more so in the case of risky start-ups or spin-offs. It is desirable for universities to publicly stated licensing policies in this regard.

61. In spite of the limited experience of Asian countries and the deficiencies of the systems in governing U-I relations, there is a clear tendency in all of the countries toward transferring, fully or partially, the ownership of publicly funded research results conducted by universities and public research laboratories to the private sector. But countries differ when it comes to the allocation of ownership among the various entities and individuals that directly or indirectly contributed to the generation of the idea. Views are different on how ownership should be distributed between those who conducted the research and those who funded it, or among the research institutions, the individual researchers and the government – both local and central – that offered funding for the research. The US model, established by the Bayh-Dole Act of 1980, allows the performer of the publicly funded research,

namely universities, to file patents on the results of such research and to grant licenses to third parties. While this model spreads through to many industrialized countries, a few countries like Finland and Italy grant ownership to the inventors. Globally, this issue of how to allocate ownership is a subject of on-going debate and Asian countries should keep an eye on how this debate develops, and should stand ready to review their country policies in accordance with the global trend.

62. Even within a single country, different schemes may be adopted. In Singapore, the National University of Singapore (NUS) divides net profits (royalties after administrative costs) as follows: 50% to inventor(s), 30% to the department and 20% to the university. On the other hand at the Nangyang Technical University, royalties are split with 75% going to inventor and the balance going to the university for the first $500,000, with a decreasing proportion going to the inventor as the royalties increase. Mahidol University of Thailand has more or less the same allocation system with NUS. 50 % of the net income should go to the inventor, 30 % for the University, and last 20 % is evenly split between faculty and the department. In Korea, KAIST pays 70 % of execution fees to the inventor. The Seoul National University has a slightly different policy. In a case of a small project which generates less than 20 million Wons of income, 100% of the fee should go to the inventor. As the project gets bigger, this ratio goes down to 60 %. In India, as of today, the ownership of IP is unilaterally given to the funding agency, but know-how generated by collaborative efforts belongs to the industries sponsoring the projects. In Philippine, according to the Implementing Rules and Regulation of the Magna Carta for Scientists, Engineers, Researchers and other Science and Technology Personnel in Government (Public Act 8439), a researcher normally takes 40 % and government institution takes the balance. Universities follow this practice when they receive financial assistance from the government. In China, income generated from U-I collaboration is distributed with 50-80% going for the R&D tem, university taking 10-25 % and the Department taking 10-25 %.

63. The allocation of ownership should shed light on the issue of how royalty revenue should be allocated. But allocation of ownership and that of royalty do not always go hand in hand. Instead, sharing of royalty revenues is common across countries and institutions and increasingly seen as a way to provide incentives not only to individual researchers but also to the groups of people and the institutions that

contribute to the IPR in one way or another. In practice, this makes more sense, since putting all the responsibility for the management of IPRs, including disclosure and ownership protection, on one single researcher would discourage the researcher and reduce the likelihood of filing patents. On the other hand, it should not be forgotten that many Asian universities and their TTOs are under increasingly heavy financial burden to cover the cost of patent application and maintenance.

64. Internationally, in respect of allocation of ownership and incomes that result from commercializing inventions, there are several different views. One line of argument is, of course, that the royalties should go entirely to the owner of the IPR. The other thought is to split royalties evenly among inventor, laboratory or department, and the university. Between these two extremes, there are many different variations and they are often determined on a case-by-case basis, even when there is a broad yardstick. The situation in Asia explained above is a testimony to this. While flexibility and room for individual negotiation may be welcome, this lack of clarity and diversity in national and international guidelines for IPRs can be a barrier to the commercialization of such inventions as it increases the risks and transaction costs of negotiating terms of collaborations. This will become urgent if U-I collaboration is to develop across national borders. As a matter of principle, there is no strong argument against having different rules for different universities in a country, or different countries having different rules. But, there may be confusion if such disparate policies are adopted by hundreds of universities and research institutions. This is already happening. Japanese IT companies, for example, are concluding research contracts with Chinese Universities to develop advanced software. Conversely, Japanese universities, like Kyoto University are setting up TTOs in China and other Asian countries to form research alliances with the local companies. In light of growing international collaboration across Asia, a case can be made for more consistent rules in IPR management that can apply at least on an Asia-wide scale. Without such transparent rules, disputes tend to arise if they are left entirely to individual negotiations.

６． Administrative and Organizational Set-up for the Management of U-I Collaborations and Role of TTOs

65. Recently, many Asian universities moved towards establishing an office within or outside the universities to deal with complex task of managing IPRs and transfer of technologies developed in their laboratories. They were mostly emulated from the Technology Licensing/ Transfer Offices (Hereafter in this chapter, his will be referred to as TTO) of the US universities. In most of the Asian universities that conduct research, offices of this kind have been set up, although in some cases they are not called TTO. In certain countries where technology transfer from universities is rare, task related to such technology transfer is handled by a general administration office. It is increasingly realized by Asian universities that transfer of technology calls for high level of expertise and deep knowledge about technology and the way university functions as well as legal aspects including IPRs. The functions played by individual TTOs are not identical. In some cases, it only deals with management of IPRs. In others TTOs engage in marketing of their technologies and searching for sponsors for the project in the universities. Some TTOs are regarded as profit centers and expected to be self-supporting, while in others they are heavily subsidized by the universities or even by the government.

66. Japan has gone through a radical transformation in managing IPR at universities. In 1977, it was agreed as a matter of general principle that IPRs that resulted from national universities research should belong to the individual researchers. But, it was too burdensome for individual researchers to file patents or undergo other processes necessary to claim and use IPRs. An alternative approach was to create an independent organization within or outside the universities that would be able to hold ownership over the IPRs and would encourage their commercial utilizations. Legislative action was taken in 1998 under the leadership of the Japanese Ministry of International Trade and Industry (MITI, which was renamed as METI in 2001), to pass the Law to Facilitate the Transfer of Technology from Universities. As a result, TTOs have been created in universities one after another. As of the end of 2004, there are 39 TTOs that are under operation. While most private universities with legal entity of its own established TTOs within the university, the national universities which did not have such an independent legal status, created TTOs outside universities, so that they could operate as an independent body.

67. In 2003, the Ministry of Education and Science (MEXT) moved in to instruct universities to establish IP headquarters within the universities. While their

functions are not exactly the same with TTOs, there is considerable overlapping between them. While at the present, many universities are managing to avoid unnecessary duplication and sharing work, or helping each other, it may be likely that in due course, they will merge together into one single office dealing all matters on technology transfers. As of June 2004, there are 119 offices in Japanese universities, either TTOs or IP headquarters. About half of them are national universities. In addition, 174 universities, national, private and public, are considering setting up such offices.

68. In April 2004, Japanese government introduced a major revision on the status of national universities. This policy aimed at changing the management of universities in all aspect, by allowing for more independence and freedom for them, while holding them more responsible for efficient operation and making proper contributions to the society. This policy has direct consequence on the R&D activities of the national universities. While the national universities are much smaller in number (87) than private universities (542), they spend as much money on R&D as the private ones combined and their qualities of researches are often far better than the latter. Until March 2004, inventions made at the universities were reported to the invention committees set up in each university. The committee decided whether the invention should belong to the government or the individual inventors. Universities could not claim ownership, because they did not have a legal status. As a matter of principle, researches funded by special budget arrangement and researches made possible by using a large-scale facilities owned by the government, should be placed in the hand of the government and treated as a part of the national assets. The fact was, however, in most universities invention committees were seldom called, because the procedures were so cumbersome. In general, university researchers wanted to pass their invention to the enterprise that worked with them. In rare cases, inventions were transferred to the control of the government, which was obliged to follow competitive bidding process. Due to this restriction, very few inventions were actually licensed.

69. After April 2004, most national universities of Japan began to claim ownerships of inventions made in their laboratories. In other words, if a university decides that an invention deserves to be filed for patent, such a filing is now done by the university through its TTO (footnote 1) or IP headquarter. While expectation is high for TTOs and headquarters, it is unrealistic to expect that creation of TTOs

will make dramatic difference within a short space of time. The amount of royalties collected by the all Japanese TTOs is 0.55 billion yen, while in the US, a total of one billion dollars have been generated by TTOs, about 200 time as much as Japan. Being young, in some instances, TTOs and IP headquarters and universities are unable to communicate with industry in one voice. In the long run, they will face a difficult question of how to generate a stable flow of revenue to cover the cost of filing and maintaining patents. Currently they are subsidized by the government budget, but such subsidy is expected to terminate within a five years time, which is fiscal year 2006. After the five year period, prospect is not clear how to keep TTOs and headquarters financially afloat. In addition to the financial aspect, Japanese TTOs and headquarters are lacking in experienced staffs who are capable of handling complex issues relating to technology transfers. METI recently announced that it aims to train and educate about 100 technology transfer specialists by supporting high performing TTOs to conduct human resource development programs. In addition, a report of METI released in February 2005 suggests that an independent body should evaluate the performance of TTOs by way of ratings and identifying the best practice among them, so that other TTOs can learn from it.

70. According to the study done by OECD and the World Bank, Singapore has a top ranking in terms of IP protection and research collaboration between university and industry (Korea and the Knowledge based Economy 2000). This is due to the special situation of Singapore which has its long standing affiliation with the advance legal system of the United Kingdom, English Language that makes it easier for the country to learn from the other English speaking nations, and high level of FDIs by large multinational corporations with extensive experience of managing IPRs in many different parts of the world. Unlike many other countries, the Intellectual Property Office of Singapore (IPOS) operates under the Ministry of Law, a government body that provides the infrastructure, platform and environment for the creation, protection and utilization of IPR. But actual handling of technology transfer is left to the universities. The National University of Singapore (NUS), the most influential university in the country, established a TTO in 1992 which is called Industry and Technology Relations Office (INTRO). While technology transfer through licensing is the most direct approach, NUS employs a variety of approaches to publicize the availability of technologies that have at hand. They send technologies to companies for evaluations and place

them on its “technology offer database” on the Internet. Companies thus approached are given opportunities to evaluate the technologies. If they are interested in exploiting the technology, they can submit a business plan for negotiation with INTRO. Companies often seek exclusive licensing, but NUS grants such exclusive licensing only when companies are ready to support continuing research on campus. INTRO markets and conducts licensing negotiations.

71. In China, the first TTO emerged in 1999 at the East China University of Science and Technology and Xi’an Jiotong University. In September 2001, the Ministry of Economy and Trade and the Ministry of education recognized six TTOs at six different universities. They were set up not as a part of their own universities, but as national technology transfer centers. Subsequently, more TTOs were established by universities. At present 30 TTOs are in operation in China. In addition to TTOs, university science parks and incubators are playing roles of equal importance in transferring technologies from universities to industry. Currently, there are more than 70 university science parks recognized by the government, with 459 enterprises having been created in such science parks. University incubators have also given birth to many enterprises. 2778 enterprises have settled down in those facilities.

72. In Korea, until XXXX, situation regarding technology transfer from national universities looked somewhat disorganized, with a variety of Industry-University (For short, this is the usual phrase in Korea.) collaboration institutions coming into play, each one of which was backed up by some government ministries. As a result, overall efficiency was lost. Situation improved very much in XXXX, when the Law for Industry Education Promotion and Industry University Cooperation Boost was amended to pave the way to establishing “Industry University Cooperation Foundation (IUCF). IUCF has its own judicial personality and accordingly can acquire IPR. This is the TTO of Korea. One IUCF is set up in each university. The IUCF negotiates contract with the industry, maintain IPRs, and take actions to promote technology transfers. At the present, however, roles and functions that have been played by various entities have not been transferred to IUCF yet. Ministries still remain reluctant to abandon the earlier schemes over which they could keep their influence and jurisdictions. But without doubt, number of patents filed by some leading national universities showed dramatic

increase in 2004. Private universities have their Technology Transfer Centers, and they are more active in working with the private sector. Particularly, the Small Business Administration is helping transfer of technologies to Small and Medium Business(SMB.)

73. Like other countries, Korea has problems in staffing IUCF with competent experts. They are largely office workers without specific experience of handling legal contracts and financial arrangements. They are often sent from outside organizations under temporary contract. This makes it difficult to create and expand human resource needed by TTOs in the long run.

74. The need for clear policy adopted by universities to protect and manage IPRs seems to be greater in countries where legal regime for protecting IPR is weak. Often, problems arise from inadequate implementation of rules, rather t5han the absence of rules. Therefore, policies must be formulated together with the implementing rules and regulations on IPRs, as this is an asset that the universities and industry can derive benefits. Without any IPR policy, the researcher, scientist and technologist might be taken advantage by shrewd parties. This raises a fundamental issue for all Asian countries. While we should not be overly nationalistic, Asian countries have the reason to feel that their intellectual asset may be lost to foreign countries due to inadequate knowledge and lack of experience in the area of IPRs. One solution to this concern may be to have a strong and effective TLO staffed with legal and technical experts. In Philippine, it was only in 2004 that the first TLO was formally created at the University of Philippine. In light of the overall scarcity of experts in this area, it seems to make a lot of sense for experts and experts to be in Asia to meet and exchange their experience. In some Asian countries, private law firms are moving into this field to provide professional service for fees, but from public policy viewpoint, they are rather poor substitute for TLOs, since only resourceful large firms are able to pay for such service.

75. In Thailand, at the present moment, there is no specific suggestion to establish TTOs. Instead, U-I partnership office is proposed to carry out the authority and responsibility in producing and utilizing all IP assets. If this suggestion is put in practice, it will play the role of facilitating the transfer of technology from university to industry. In light of the present circumstance in Thailand, it will be

necessary that a standard procedure and practice will be set out, regardless of whether it will be called TTO or partnership office. This can be done in conjunction with the new legislation regarding U-I partnership. In most Thai universities, there are IP asset office of certain form with different names, but in some other cases, they are only a part of the main business office under one director. U-I collaboration is usually placed under the supervision of university business office. This is undoubtedly inadequate, since, as evidenced by the experience of other Asian countries, technology transfer needs professional skills. Schedule, procurement, financial matters and administrative work must be good enough. A good mechanism for quality control and management must be in place. Progress is reviewed at various stages to ensure commercial values of the project.

76. It should be noted that more recently, Mahidol university of Thailand developed and published its IP regulations, which spells out ownership of patents and copyrights, as well as disclosure requirements and procedures, rules for income distribution of patents and copyrights and other rights and obligations for parties involved. Although, not named as TTO, its Applied and Technological Service Center is in charge of IP management. In light of absence of such offices in other universities, it is perhaps the first TTO in Thailand and as such may set a model.

77. While TTO are being created in an increasing number of Asian universities, they have another common problem other than human resource. It is how to finance the cost of operation, staffing cost. According to a recent research done APRU (Association of Pacific Rim Universities), while 9 out of ten very prestigious universities in North America find their income of TTOs adequate to cover their cost, only 22 % of first-rate Asian universities can do so. The reason is obvious. Due to the young histories, the number of technology transfers has been too few to make the operation of TTOs self- sustaining. In the United States, it is believed that many TTOs are operating as profit centers, TTOs of less well-known universities are not making profits either. This should not lead to concluding that TTO does have limited chance of success. The external benefit of technology transfer should go well beyond income collected by TTOs. Obviously, the performance of TTO should not be judged purely by their profits. 90 % of the Japanese TTOs are not profitable without government support. In the fiscal year 2002, Japanese TTOs as a whole filed 1,335 patent applications domestically and 284 with foreign patent offices. The royalty revenue was 410 million yen. This

number is expected to rise over a long period of time.

78. In many Asian universities, functions of TTOs go well beyond merely patent management. Instead of waiting for university researchers and industry people to knock at their doors, they are often expected to be more proactive in marketing the technology, finding potential partners, and securing fund. This calls for multi-faced talents, which is of course very short in supply. To deal with this, some Japanese experts are considering a kind of " super TTO ", which reaches out beyond university boundaries and combine several TTOs in the region. There are already a few such examples. The alternative approach is to outsource some functions to outside law firms and patent offices. Conversely, recruiting new staff from outside on a fixed term with the assurance that they can go back to the original places when the term expires, is yet another option for a TTOs. In either case, it still remains that Asian countries are devoid of experienced talents in this field. In light of increasing litigations brought to courts and dispute resolution mechanisms, the work to be done by TTOs call for more and more advanced knowledge. Only a handful of university professors are qualified to do this. To secure them, TTOs must be financially ready to offer right incentive. Very few experts with such talent would be willing to work out of altruistic motivation for a sustained period.

79. A specific concern was raised by several national experts in respect of young undergraduates who are less than 21 years of age who produced patentable inventions. Being minors, they are unable to claim ownership for an invention. While university can act on his/her behalf, it is not very clear how their inventions can be protected. Universities should have certain mechanism in place to deal with such cases. . ,

80. When a TTO is in operation, at least its financial statement as well as key indicators that permit to evaluate effectiveness of U-I collaborations should be released. This should include information about types, numbers and theme of cooperation and outputs. On the other hand, it is in the interest of no one to create excessively burdensome and bureaucratic reporting requirements and procedures. The right balance can be found through exchange of experience across the countries and organizations

７. Funding Scheme

81. Asian governments place high priority on ensuring adequate levels of funding for the activities of universities and public research institutions. Such funding for research activities create a pool of knowledge and inventions which can be tapped for the purpose of U-I collaborations. In addition, there are new types of funding in recent years, such as support for incubation facilities and science parks and soft loans. In some countries tax incentives have been adopted to provide companies incentives to utilize technologies developed by universities. In general, Asian universities have been given increasing amount for their research programs in the scientific and engineering fields. Chinese universities have been particularly successful in receiving increasing amount, one billion yuan in 1999 to 2.2 billion in 2002. About half of the fund came from the government, and the other half is from enterprise and institutions. In addition to general funding, there are several different schemes. One of them was the Industry-University Research Institute Combined Development Engineering Project Plan that was implemented between 1992 and 2003. Any project that was brought about through an agreement between a university and an industry and that conformed to the industrial policy of the government could be listed on the Project Plan. Once listed, these projects were eligible for non-reimbursable support from the government. There was another category, category B project plan, which was approved by the Ministry of Science and Technology. The applicants were required to guarantee that the leadership of the project came from the business sector. Once approved, the project was also eligible for non-reimbursable support. This project had to be of a scale of no less than RMB 50 million and was allowed to receive up to 10 % of the matched fund. Such support could take the form of lump-sum grants, interest free loans, or stock equity participation by the government. In addition to the direct support for U-I collaboration, the Chinese governments, national and local, moved to set up Enterprise Technical Centers and State Engineering and Technical Center. Up to now there are more than 1300 Enterprise Technical Centers across the country, Quite a few of them are supported by universities. State Engineering and Technical Research Centers have been created by an explicit initiative by the Ministry of Science and Technology to improve production enterprises of China and contribute to the growth of the Chinese economy. In 2002, they collaborated with 1878 enterprises and 521 universities and colleges. University Science Parks and Incubators have proved to be effective vehicle for U-I collaboration.

82. In India, most of the R&D funding comes through government ministries. In the year 2001-2, universities account for 51 % of the total projects in number, but about 28 % in terms of funding. The national laboratories spend 38 % of the total funding. Perhaps, universities undertake more fundamental basic researches which are less expensive, while national labs conduct research of more developmental stages which tend to be more expensive. Like many other Asian countries, engineering and life science (biotech and medical) are two biggest fields for national research funding. In addition to general funding, some government departments, such as the Department of Scientific and Industrial Research administer specific programs for collaboration with the private business at various stages of developments. Among them, the University Grant Commission (UGC) provides seed funds on condition that the outcome is patented.

83. The Japanese government also stresses the strategic importance of life science, information technology, nano-technology, environment and material. Energy, which was high on the priority list three decades ago are not there any longer. In the fiscal year 2000, more than 90 % of the government funding went to universities and national laboratories, with the balance being distributed among private universities and companies. In spite of the increasing pressure to cut expenditure from the national budget, which relies on debt for more than 40 % of the revenue, the Japanese government has remained determined to secure an increasing amount for R&D. The government stresses the importance of distributing the fund through competitive process, where researchers both in public and private laboratories are invited to make research proposals. In the current Basic Plan for Science and Technology, along with U-I collaborations, use of university inventions to create small business and university spawned venture business is very much stressed. It is expected that such new directions will invigorate research communities and give new opportunities for young and innovative companies that are less connected to existing research institutions.

84. The Japanese business community is paying more attention to U-I collaborations. Traditionally, Japanese large companies made donations to individual university professors mainly for the purpose of keeping working relations and soliciting informal consultancy, but most importantly, to recruit good students under the supervision of university professors. Today, Japanese companies are moving to

establishing formal working relations based on contract in exchange for financial support. Japan has a special incentive to support university spawned ventures. The revival of the US industry in 1990s had been achieved largely by thousands of high-tech ventures and start-ups, but in Japan, entrepreneurial activities by venture and start-ups have been at the lowest level among the OECD countries. Japanese universities began to place a particular emphasis on creating new start-ups by utilizing the technologies developed by universities. As a concrete example of such a movement, University of Tokyo and Tohoku University initiated a risk-taking venture capital.

85. Korea and Japan are the countries where public funding accounts for a small percentage of total research funding among the OECD countries. They are 26.3 % and 26.6 % respectively. Generally, this figure is above 30 % or even 40 % for many of the industrialized economies. Korea has the reason to believe that is must strengthen it basic research, which now accounts for only 13. 7%. It will become more difficult for the country to continue to import technologies from abroad, since it has already reached a high level of technology. Government funding is evenly split between national/public universities and private universities, but private universities take more funding from the private sector, reflecting their greater willingness to work with the industry. The funding mechanism looks complex. There are numerous institutions that funnel research fund from the government to individual research laboratories. Apart from the Research Foundation which supports pure basic researches, and therefore has little to do with collaborations with the industry, Korean Science and Engineering Foundation (KOSEF) administers several different programs such as Basic Research Grants, Center for Excellence, Special Research Materials Bank and Fellowship, whose entire funding amounts to 297 billion won (nearly $ 250 million). The Foundation selects projects at universities with a view to supporting activities of university researchers who are engaged in international cooperation and U-I collaborations. In addition, Ministry of Commerce, Industry and Energy covers part of the project costs that are deemed necessary to improve the competitiveness of the Korean industry. The Ministry runs several programs including Industry Innovation Technology Development, Part& Material Technology Development projects, Regional Specialized Business Development Business, International Development Business, Clean Production Technology Development Business, and Small and Medium Business Administration. Part of the funding may need to be returned, if

the project turns out to be a success and monetary benefit is realized by the industry that participated in the collaborative projects.

86. The funds for R&D in the public universities in Philippine largely come from the government budget appropriated for them. While the 3.61 % of the national budget is allocated for researches by universities and colleges, universities depend on private sectors for additional funding. Due to the severe fiscal constraints faced by the government, the total expenditure on R&D in Philippine saw a marginal increase during the last few years, from 4 billion Pesos in 1996 to 4.5 Billion in 2002. In addition to the fund distributed by the Ministry of Education, Filipino universities have one more source of fund, the Department of Science and Technology (DOST). The Department extends grants to the research institutions with the projects that meet the goals and standards set forth in the National S&T Priorities Plan. The Department recently started a new program known as Technology Incubation for Commercialization. This is meant to be a technology transfer program that seeks to identify key technological breakthroughs with excellent commercial potentials. The university and the industry can jointly request financial support from DOST. Some vertical Departments run programs for funding research projects in their respective areas, such as agriculture, environment and natural resources, health, industry & energy and advanced science. Thus, universities can obtain research funds from different ministries, depending on the nature and field of the projects. While patenting of their research outcomes is encouraged, the cost of filing is usually covered by the general funding for the project. Those projects that are funded by the government agencies are subject evaluations in respect of their progress and achievements by congress and the budget office. They are mostly non-technical staff members, thus, these R&D project are often snot sufficiently appreciated.

87. In addition to general funding for research activities at universities, in Singapore, since early 80s, a myriad of government incentives aimed at forging collaboration with industry have evolved and have been replaced with new ones. Today, schemes covering entire spectrum of research, IP protection, support for commercialization start-ups business development, investment, tax incentives and venture developments are available. The history of government support for U-I collaboration dates back to as early as 1981, when Research and Development Assistance Scheme (RDAS) was introduced. The program is now transferred to

Enterprise Development Board (EDB). which is a major source of government grants. EDB provides academic grants and R&D grants for companies through a variety of grant schemes. EDB places a special emphasis on supporting start-ups. It runs a special program, called Startup Enterprise Development Scheme (SEEDS).This scheme offers equity matching fund for early stage startups. So far some 100 companies have successfully obtained SEEDs funding. National University of Singapore (NUS) has its own venture support fund.

88. In general terms, small and medium enterprises (SMEs) tend to be left out from national R&D programs, since their technological prowess is limited. But, SME are in dire need of technical support from outside. Their needs are not always in the most advanced scientific fields, but rather at more mundane and practical levels. All Asian governments place importance on transferring technology to SMEs. In China, SMEs have access to a special government fund. The fund was formed in 1999 with an initial annual endowment of one billion RMBs. The level of funding ranged between RMB 0.5 and 1 billion with a priority being given to U-I partnership projects with IPRs of their own. This fund offers not only straightforward grants, but also low interest loans and capital injection.

89. The Korean Small-Medium Business Administration runs a program to support joint research between universities and SMEs. The program, named Small & Medium Business Technology Innovation Development, supports consortiums consisting of university or research organizations and SMEs with matching funds. SMEs that encounter specific technical problems can form a consortium if more than seven of them agree to participate and if they can identify a universities or public research institute that could help them to resolve their technical problems. If such a consortium is organized, the technology development funds are made available to fund the work of the consortium. 50% of the funding comes from the central government and 25% from local governments. The remaining 25% is to be covered by the participating SMEs. In Philippine, a great proportion of U-I collaborations is taking place in agriculture and food processing. Presumably, this is due to the high dependency on agricultural sector of the country and strong need from local agricultural communities. SMEs are the forceful driving force in these sectors. In addition, DOST is supporting SMEs in the fields of energy, manufacturing and health/medicine in acquiring technology from universities. In Singapore, financial support for patent filings and support for technology

capability upgrading are in fact utilized mostly by SMEs.

90. In Thailand, universities are expected to do more in the field of training of workers in SMEs. Some private SME have contracts with universities for part time jog of training, sometimes during weekends. A new initiative has been taken since 2004 by the Ministry of Industry to create 50,000 new SMEs through incubation joint product developments with universities. Universities have the role of sending new graduates to such projects, and train workers, retired people who want to become owner of business. Those new SMEs are in such fields as auto parts, fashions, IT, food processing and tourism. At a province level. "One Tambon (region), One Product" campaign is underway. This is a government policy to boost the best product of each tambon in the national and if possible global market. Universities are requested by the central government to assist local SMEs to achieve this goal.

91. As noted above in this section, all Asian countries have a variety of funding mechanisms for U-I collaborations. A few observations can be made that are common to all or most of the countries. First, in general, there are too many programs administered by too many government ministries. While in theory, each one of such support schemes has its own rationale and goals, the fact is that there is a risk of duplication. From the university and industry perspectives, there are many sources of funds that they can tap. Each one of them calls for different application and different paper work. Such fragmentation of the funding scheme may result in overall inefficiency. Second, while such funding programs aim to support research activities, the cost of administrative work associated with research is not always taken into full account. Such administrative costs include marketing of technology, negotiation with companies, patent filing and cost of maintaining offices. In certain cases, they are subsidized by governments, but in most cases, they must be covered by general research fund. Third, it is important to ensure that public fund must be allocated and spent under clear and transparent rules. While most funds are available on equitable basis, often new comers find it difficult to have full access to such programs. No funding program should be monopolized by existing vested interest. Last, the risk of creating excessively cumbersome procedure must be borne in mind. Burden of complying with rules and preparing documents in the evaluation of the progress and outcome of the project is the matter to be looked at..

８. Training for talents for U-I collaborations.

92. Asian universities suffer very much from the lack of talents who are capable of handling complex and meticulous work associated with U-I collaborations. The need for well trained talents who can handle administrative work associated with U-I collaboration and technology transfers is becoming increasingly acute. Such talents should have a combination of scientific and engineering understanding and legal knowledge, particularly the management of IPRs. They must be able to understand how two different communities, academic and business, work.

93. Singapore is one of the first countries which became aware of the importance of developing human resource of this type. Other Asian universities are now running programs for training course for young engineering and science students, but they are far too inadequate. In India, a general course on technology transfer is being taught at management schools, but as student do not have adequate engineering background, it tends to fall short of expectation. In Japan, since 2002, under the initiative of the Ministry of Economy, Trade and Industry (METI), management of technology (MOT) began in some universities at a post graduate level. This is a major departure from the long standing tradition of the Japanese society which believed in only on the job training (OJT). Some of natural science universities in China have degree programs on management of IP. In addition to formal courses at universities, there are many seminars, symposium and workshops of short duration provided by private consulting firms and industry associations. One problem is that those who should take such courses are middle level managers with the working experience of more than ten years, they are too busy to leave their jobs for an extended period of time. The maximum time duration for them would be two to three weeks.

94. The other problem is who should pay for such training. As far as staff in TTOs are concerned, they must be paid out of their general budget. In general in Asia, there is no specific budget set aside for training human resources. At the present, they count on the voluntary support of the business for sending experienced talents of IP, often free of cost.

95. While need for formal education is not to be questioned, much of learning must be

only through actual practice, Class room lecture is not viewed as effective as case studies. Negotiating technology transfer contract and marketing new inventions are next to impossible to teach except by using actual cases. A growing number of litigations and court cases that involve management of IPRs points to the enormous complexity of using new technologies for commercial purposes, hence difficulty of conducting training in this field. It must be recognized that as technology becomes ever more important determinant of commercial success, the risk of mishandling technology transfer will continue to rise. Mangers in TTOs and university laboratories handling specific cases must be equipped with professional expertise. A question remains whether or not such a talent should have engineering background, or, as is often the case in the US, law background. In Asian universities, division between natural science and social science still remain very deep.

96. Asian countries are dealing with the issues arising from U-I collaborations largely within their national contexts. Situations are so diverse that it does not make a lot of sense to look at foreign countries. However, while institutional arrangements differ from country to country, business activities are becoming increasingly global. The flow of trade and investment is growing dramatically among Asian countries. This implies that sooner or later, such flow will be accompanied by the flow of people. Movement of people is the best way to transfer of technology. Asian countries should prepare themselves for new era where movements of researcher and business people will force national government to ensure more compatibility in the way national innovation system operate. One particular subject is increasing mobility of researchers. New ideas can be better generated when there is a great deal of interaction and contact between scientists and engineers of different laboratories. Such interaction can be greater if researchers feel free to move from one laboratory to the other. Conversely, a low rate of mobility remains a major obstacle to improving U-I linkages in Asian countries. Take Japan as an example, where life long employment is still very much the dominant practice in the government sector which includes state funded universities. Only 20% of engineers change jobs more than once in their career, and job changes between the public and private sectors are even less frequent. A sharp contrast to this is the United States, where engineers change jobs every four years on average. But Japan is not an exception. In many European research laboratories, situations look more like that of Japan rather than that of the US. In 1997, Japan introduced

a fixed term employment system at universities and national research institutions to facilitate greater mobility. On the other hand, increasing mobility tend to raise the risk of causing conflict of interest between research organizations and research and education.

97. Mobility for engineers and scientists cannot be discussed in isolation from the overall rigidities of the labor market. Employment practices, wage systems and pension portability are among the issues where changes are needed if U-I collaborations is to move ahead. In Japan, since the year 2000, professors of national universities have been allowed to act as board members of TTOs, and are allowed to participate in commercial activities outside of their regular work hours. While legal barriers are diminishing, it is still unclear to what extent non-legal, less formal barriers exist. For example, how their career prospect within universities will be affected as a result of their participation in such joint research with the industries is not known. At the present moment, it is all left to individual universities. Their overall human resource management rules are still in the stage of discussion. In addition to scientists and engineers, research assistants and detached employees are of equal importance to the efficient conduct of research. They have often been forgotten about in many Asian countries.

98. Recruiting foreign researchers is yet another challenge for many Asian universities and research organizations. As the world moves to a knowledge-based economy, there is even fiercer competition to recruit good talent on a global scale. It is generally well known that the success of US universities and private sector laboratories are very much due to the high levels of recruitment of Asian scientists. Research institutions that confine themselves to a local labor market will find themselves at a severe disadvantage. Without a doubt, the English language is one factor that accounts for the advantage of the US, but there are many other reasons that need to be carefully thought about. The general rigidity that dominates national labor markets and employment practices are far more important barriers to attracting good scientist from abroad. Insufficient rewards for commercially valuable innovations are yet another deterrent. Earlier 2004, an interesting court ruling was handed down by a Japanese court. The court ordered a Japanese company that allegedly made millions of dollars of profit by commercializing LEDs (blue light emitting lasers) to pay 20 billion yen to the scientist who had invented it. The company had only given a 20 thousand yen

reward to the scientist. Early 2005, the Tokyo District Court ordered a mediation at 0.6 billion yen. While this case is not directly relevant to U-I collaborations, it does reveal the ignorance of the Japanese society toward importance of appropriate incentive and reward. If there is no common ground for determining commercial values of inventions among different countries, there would be more and more troubles arising as result of deepening U-I collaborations across the borders.

９. University Mandate and Mechanism for Managing Conflict of Interest

99. The call for more U-I collaborations is well grounded in the trend of intensifying global competition and the drive towards a knowledge-based economy. But these changes should not take place at the expense of the fundamental mission of universities. It remains that universities must pursue several different goals that mutually conflict. Universities must still fulfill its primary mission to teach students and this goal cannot be compromised under any circumstance. While university professors are given greater freedom to work with the private sector than before, it is not to suggest that there should be no separation between their academic activities and their commercial ones. There is a real risk of running into a conflict of interest. In general such a conflict is defined as a situation in which a public obligation competes with financial interest. Research priorities may be skewed towards applied research that tends to produce immediate financial benefit. Universities may inhibit intellectual freedom and thus foster public mistrust and distract from universities basic functions, such as teaching and basic research.

100. Situations are different among the Asian countries on this particular issue. In Japan and China, this is a hot issue and is looked into carefully by the government Ministries concerned. In Thailand and Philippine, potential risk is well recognized, but has not become an immediate issue of substantive magnitude. Certain aspects are arising as an issue of particular concern. Some specific issues stand out. Confidentiality is of particular concern in some Asian countries since the joint project may hamper free flow of knowledge between those researchers who are involved in a joint research with a private company and those who are not. Use of students as workers is another specific issues that are widely recognized by Asian experts.

101. The first major conflict of interest occurs in regard to time allocation of university researchers between academic and educational responsibility and commercial interest. It is generally agreed in Asian universities that, if a university researcher intends to take on commercial responsibility, they should at least notify the university of such intention and obtain approval. In order to be able to deal with such requests for approval, universities must have certain rules. A university researcher should take a leave or a sabbatical or at least draw line in the schedule, so that there is always a line separating the two activities. Such leaves should be taken in a manner that would not disrupt the educational duties of the university or the other research activities of the professor. One example in this connection is the 20 % rule, which is widely observed in the US universities, under which faculty members are allowed to spend up to 20 %, in other words, one day in one week outside the university. The National University of Singapore (NUS) has more or less the same guideline of less than 50 days per year to be spent outside the campus. But in general, few Asian countries have clear policy in place nationwide.

102. In addition to proper time management, there is a need for managing economic gains that may arise. This is likely to occur when a university researcher holds some stakes in the business that utilizes the knowledge of the university. A successful start-up may bring about millions of dollars of profit for a single researcher. But, if U-I collaboration leads to a situation where university researchers make a fortune by using the knowledge of university and its facilities, there may arise sentiment of unfairness, disappointment or even opposition to U-I collaboration. In order to avoid a situation like this, there must be clear rules for them to follow. Whether or not a university researcher can be a corporate director, executive or non-executive, is a moot point. If, yes, under which conditions should they be allowed to do so? While this can be left to individual universities, it will be in the interest f all universities and business to have basic guidelines agreed in advance by the joint association of university and industry.

103. It remains questionable whether there is a set of rules that could be applicable to all universities in one country, let alone in all countries. The contributions from the representative national experts of this project indicate that there is no one-size-fits-all solution. Individual universities should develop their own rules. Such rules should be made public so that outsiders can understand how the universities govern themselves. But when pecuniary interests are involved,

disclosure and transparency is of utmost importance. An internal body should be put in place to provide advice for individual cases.

104. Although not all Asian countries are keenly aware of the conflict of interest, practical problems are numerous in a variety of ways. In 2004, a Japanese university researcher participated in a university startup project by investing into its equity. While nothing was illegal about his conduct, a newspaper picked this up and wrote a story in a manner to create suspicion. The faculty was obliged to issue a statement that it does not approve of its faculty member holding equity participation. Although university, business and government are enthusiastic about U-I collaboration, the general public is not quite ready to accept university professors who devote part of their time on a commercial undertaking. The Ministry of Education and Ministry of Economy Trade and Industry conducted a study on this and drew up some guidelines. This guideline concludes that, with the explicit agreement of the university, a researcher at a national university can become a non-executive board member of a company to which technology of the university is transferred. He can work for the company outside the official working hours, provided that adequate report is presented on his financial interest in the project.

105. In theory, if a university researcher gets involved in a collaborative project on which confidentiality is agreed, it may well happen that he cannot talk about the project even with his colleagues of the same faculty. University students may not be able to write his thesis in the same scientific field. But such a strict interpretation of the rules would stifle free research environment and be counterproductive. There is a need for more practical handlings. What about transferring a technology developed by a university researcher to a firm in which one of his relatives works? Generally speaking, it is hard to draw distinction between the invention by university and the one that was produced by the collaboration with the industry. A common sense based on years of experience is the only one guide to deal with these cases.

106. While not all Asian universities have a concrete guideline for avoiding conflict of interest, some have taken concrete actions. The National University of Singapore identifies six potential situations that are likely to arise. They are (i) misuse of students by using them as cheap labor, (ii) transmitting to the company information that is not generally available, (iii) undertaking or changing the orientation of research, (iv) using university resource for activities of company, (v) purchasing of

equipment for university research from the company in which the researcher has interest, (vi) funding by the company of a project related to the licensed technology. In addition to these, NUS regards consulting, equity ownership, royalty interest and family ties as potential areas for conflict. For each one of these situations, NUS provides certain policy and guideline to minimize the risk.

１０．Guidelines

107. U-I collaboration is a multi-faceted activity. Governments and universities must take into account various considerations that often go in different and even opposing directions. A right balance must be struck when conflicts are inevitable. While past experience and the present set of rules give practitioners some guidance, there is a need to establish a clear set of rules for them to refer to in dealing with increasingly complex cases. The many considerations discussed above regarding the present state of U-I collaborations in the seven Asian countries lead us to a set of policy recommendations and guidelines for ensuring the effective implementation of U-I collaborations. This is not meant to be comprehensive; rather it is an attempt to lay down a starting point for Asian countries in an effort to improve the overall effectiveness of U-I collaborations.

１）Coherent and well coordinated body for strong leadership

108. U-I collaborations hinges on a broad range of public policies, including industrial competitiveness, education, health and welfare, protection of the environment and public finance. While expectations are rising that new technologies find solutions to a number of existing problems, these expectations are often in competition with each other. Too many government ministries and departments are coming into play to expand their stakes, overlapping and inefficiencies are also on the rise, often with differing ideas. It takes strong leadership, perhaps that of a leader at the highest political level, if the national government is to sent out consistent and coherent policy directions. Prime Ministers and Presidents should be kept informed and, when necessary, should be called upon to make decisions. While details and matters of a technical nature can be left to coordinators at official levels, the situation in which the entire national innovation system is torn apart into different bureaucratic subsets, with many overlaps and redundancies among them, should be avoided. A strong leadership is also needed to decide on the allocation of increasingly tight

government resources, Calling meetings of Councils and Committees is the right approach to ensure overall coordination, but the views of the science and industry communities as well as those of NPOs should be adequately integrated. Well-balanced representation is crucial if the administration of U-I collaborations is to meet the interest of society as a whole. In this regard, members of such councils and committees must always be updated and kept abreast with the current needs of society.

２）Continuous Review of Effectiveness

109. Open and vigorous mechanisms for evaluating effectiveness of U-I collaborations should be developed. In light of a relatively young history in the Asian countries, there is a lot to be gained from actual experience of other countries. Mechanisms of feedback and learning, and modifications of these systems based on such evaluations should generate a maximum benefit for improving U-I relations. Such reviews and evaluations should entail setting up overall objectives and periodically measuring the progress made to date towards such objectives. In the event that such objectives are not met or deemed unlikely to be met, detailed examinations should be conducted by independent parties. Remedial actions should be promptly taken or the appropriateness of the objective should be looked into. Such objectives should be put in numerical terms as much as possible, though it must be borne in mind that some of the experiences of industrialized countries suggest that no single numerical target can capture the multi dimensional nature of U-I collaborations. Perhaps a combination of set numerical targets and qualitative statements would be the right approach. In a case where conflict arises among different goals to be achieved, order of priorities should be clearly stated.

３）Open and Transparent Funding Mechanisms

110. In many of the countries that participated in this project, there are many government ministries and agencies that fund collaborative activities. Often they administer programs in different ways in a manner to confuse recipient universities and industries. Duplication is not rare among different programs. Close coordination among the funding agencies should be maintained. Funding mechanisms should be clearly documented in a simple and straightforward language. While eligibility for government support programs is often subject to the judgment of government

officials, it is desirable that room for such judgments is as limited as possible. In the case that the pool for funds is limited, which is normally the case, an open and competitive bidding process is desirable. Information as to who gets what funding to do what should be made publicly available, so that potential bidders can get an idea as to what are the proposals that have a better chance of being funded. Information about the companies which will benefit from the result of the university research should be released. The financial statements of TTOs should be also released. In the event university researchers get involved in commercial undertaking, such activities should be reported to university.

４） ffective Management of IPRs

111. Intellectual Property Rights remain the most complex issue for successful U-I relationships. Currently, the allocation of ownership and licensing revenues is determined basically by individual universities in many different ways throughout Asia. The experience in managing U-I collaborations is still diverse and information is not well collected. Universities in Asia should have clear and coherent set of policies for managing its IPRs. This does not suggest that that inventions of universities should be more protected. Experience in the OECD countries suggests that excessive protection is detrimental to the maximum use of the knowledge developed in academic communities. In order to identify the best balance between use and protection of knowledge of universities, they should expand their dialogue with other universities, even with other Asian countries with a view to improving their current regimes for management of IPRs by learning from others. Consultations with industry should also be pursued, to reflect their concerns in the IPR policies of universities.

112. Improper management of IPRs may result in unfair benefits for some private businesses or loss of revenues for governments that offered support through taxpayer money. At the present, so much of the substance of cooperation is left to the bilateral negotiation between university and company, that there is real risk of losing clarity and consistency among universities, companies and projects. Therefore, government and universities should keep track of projects and activities that involve U-I collaborations. Such information should periodically be made public in order to ensure proper and equitable use of research results. In addition, governments and/or universities should establish and make public their policies in respect of a)

ownership of patents and IPRs that have been developed as a result of U-I collaboration, b) licensing policy, c) any policy taken to avoid conflict of interest and commitment, and d) types of collaboration that universities can engage in. In the event TTO is set up, the role of the TTO should be clearly spelled out. TTOs should be staffed by competent experts, so that it can handle complicated technical and administrative matters arising from U-I collaboration.

5) Developing Right Human Resource Through Training

113. Issues arising from U-I collaborations call for skills of diverse nature. People who handle such collaborations should have adequate knowledge of technological and legal aspects. In addition, they must be familiar with the working practice and different cultures of academic community and industry. In all of the Asian countries, such experienced talents are difficult to find in adequate number. Government, university and industry must pull together their hands to offer trainings to expand the supply of such human resources. This shortage of talents is most acute in TTOs. TTOs in Asia are all complaining of shortages of people with adequate knowledge about patent and commercial laws, accounting practices and actual business experiences. In general awareness about IPR is low in Asian countries. Governments and industry should take leadership to develop such human resources through organizing workshop and seminar. In addition, industry can offer opportunities for university to better understand the industry's expectations on universities. Internship and summer jobs are useful ways to achieve this end. Universities should give further consideration to strengthening their degree programs for educating students on management of IPR and technology transfer. Creation of a pool of such scarce human resources who are capable of offering professional service, is a useful approach. International organizations, particularly WIPO, in collaborations with the national governments, should take leadership to help develop such human resource in Asia.

6) Collecting Basic Data and Indicators.

114. One of the points that emerged from this project on U-I collaborations in Asia is that Asian countries are not collecting statistics and data that are necessary to understand the present state of affairs, let alone making comparisons among them. Number of patents filed and granted by universities is not collected by all

participating countries in regular and mutually comparable manner. Flow of funds is difficult to keep track of. Qualitative information is also essential for understanding how IPR regimes work in different countries. Laws and regulations governing operations of universities change with time. If U-I collaboration is to succeed across borders within Asia, it is essential that such data is collected and shared among potential partners. Asian countries can learn from the experience of the industrialized countries. Here again, WIPO can plan a leadership role to make this happen.

7) International Benchmarking

115. Lastly, a joint benchmarking exercise should be carried out by Asian countries for the purpose of making comparisons not only among themselves, but also with more industrialized countries. Such comparisons enable policy makers to identify the strengths and weaknesses of U-I collaborations in Asia and thus take necessary actions quickly. While expectation is rising in Japan for increasing university-spin-off ventures, there are some undesirable cases happening recently. Not all U-I collaborations have been satisfactory. There is a need to look into and learn from unsuccessful examples as well as from successful ones. Such learning process can be more effective if experience is shared across the entire Asian region, rather than within national context. Already, the contributions from the six national experts confirm that a great deal of statistics and information has already been collected, but in disparate ways, so that some of them are not directly useful for the purposes of international comparison. The OECD conducted such a benchmarking in the years of 2001 and 2002, and came out with many findings and suggestions for member countries to reflect upon. In light of the young history of U-I relationships in Asian countries, the value of such learning from other countries will be even greater. It may be a good idea to invite APEC to consider the possibility of conducting such a benchmarking. With the help of WIPO, such an exercise will generate a great deal of insights and practical ideas that would help to raise the effectiveness of U-I collaborations in Asian countries. (over)

List of reference

1. Patents, innovation and Economic Performance (OECD 2004)
2. OECD Science Technology and Industry Outlook (2002)
3. OECD Science Technology and Industry Outlook (2004)
4. OECD Science, technology and Industry Scoreboard (2003)
5. Korea and the Knowledge-Based Economy (OECD-World Bank Institute 2000)
6. Mechanism and Conduct of Managing the Conflict of Responsibility and Interest at Japanese National Universities (Tohoku University 2004)
7. The Present Situation and Issues for the University-Industry Partnership in Japan (Koji Nishio 2004)
8. Promoting IPR Policy and Enforcement in China—STI Working paper (OECD 2005)
9. Towards University-Industry Partnership in a New Era (Science and Technology Council Japan 2003)
10 China and the Knowledge Economy (World bank Institute 2002)
11. APRU Report on Technology Transfer and Wealth Creation Survey & Conference (Cornelius Sullivan and Choon-Fong Shih)
12. University-Industry partnership (Yuko Harayama RIETI 2003)
13. Strategies for University Spawned Ventures (Masayuki Kondo, Yokohama National University 2002)
14. Benchmarking Industry Science Relationships" (OECD 2001)
15. Issues and Trends in Enforcement and Use of Patents and Other IP Pools by Universities and Other Non-profit Institutions (Edward G. Poplawski, 2005)

Footnote 1. Asian experts use both technology licensing office (TLO) or technology transfer offices (TTOs). In certain cases technology transfer organization is also used. Since there is no substantive difference among these different words, the word TTO is used for the purpose of this chapter.

Table 1 Key R&D Numbers of Asian Countries

Table 1	Income per Capita (US$)	Total Expenditure on R&D (US$millions)	R&D/GDP (%)	Total R&D personnel (1000persons)	Number of scientific article	
India	570	3743	0.85	308	9217	
Singapore	22000	1901	2.2	22	1653	
Thailand	2380	328	0.26	32	470	
Philippine	970	51	0.078	16	164	
China	1090	15558	1.2	1035	11675	
Korea	12700	13849	2.5	190	6675	
Japan	36400	127923	3.1	892	47826	

(SOURCE) Income per capita (2003) –International Financial statistics
Others (2002)---IMD World Competitiveness Yearbook 2004

Table 2 Science linkage by countries

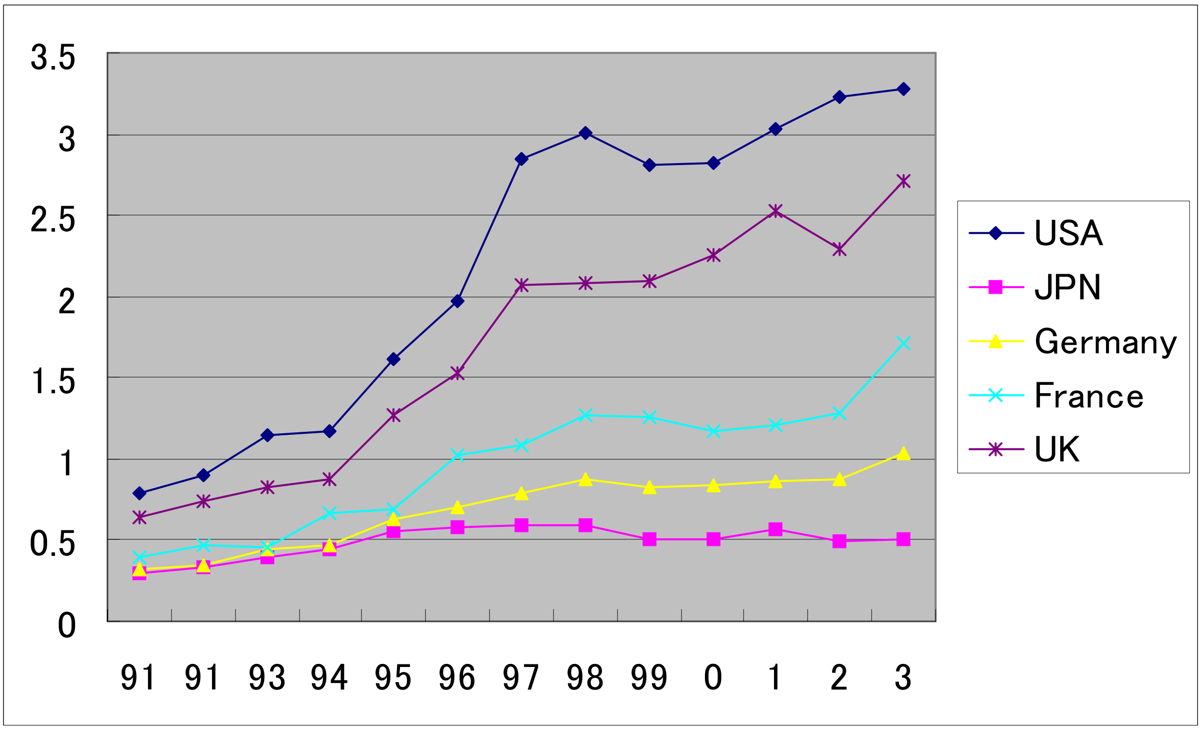
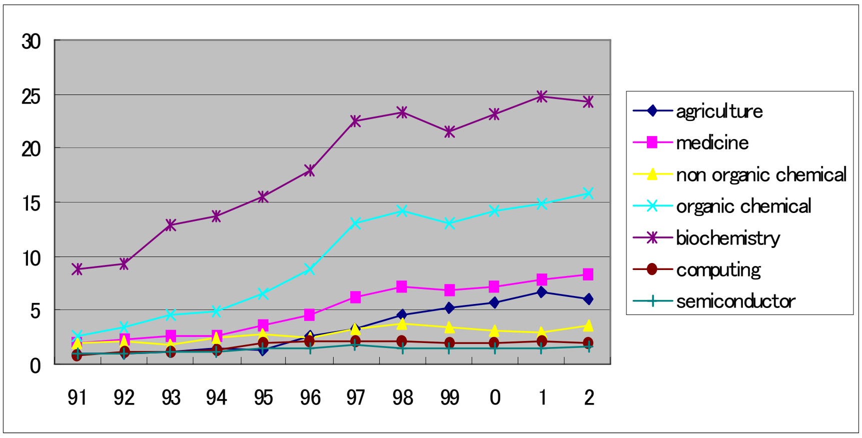


Table3 Science linkage by Sector



THE POSSIBILITIES ARE INFINITE FUJITSU