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Financing Industry-University Interaction: A Southeast Asian Perspective*

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In discussing the topic of financing industry-university interaction, the first question to ask is perhaps why we need industry-university interaction? The answer is that the university no longer has a monopoly over advanced knowledge and can no longer afford to remain isolated in an ivory tower when there are many mutual benefits to be derived from a closer interaction with industry. The second question could be: Why finance it? The answer is that present interactions are not as good as they should be and finance could be used to stimulate them. A third question is: What are the benefits from industry-university interaction? For the university, it could mean extra income to improve the quality and relevancy of the education offered. For industry, the university provides a knowledge-based resource with minimum investment. Perhaps one of the most important underlying reasons is for industry to make full use of this resource to develop international competitiveness.

Historically, the university has the mission to pursue knowledge. But in Southeast Asia, universities primarily train the high-level manpower required to develop a country. All universities have proclaimed mandates of teaching, research and service. In many, however, teaching still occupies the dominant role. Apart from a few well-established and well-endowed institutions, research activities in this region's universities, although well-accepted, generally do not have the scope and intensity of their counterparts in the developed countries, due to budget and manpower constraints. Furthermore, university research is often criticized as being too academic and producing few tangible results. Finally, university services mainly consist of free social services, such as public lectures, exhibitions, radio and television programs, and rural development projects.[1]

Industry, consisting of private enterprises, has the opportunity to use university results that make business sense. Unfortunately, many industrialists in Southeast Asia still concentrate on short-term benefits and hesitate to establish long-term relationships with universities except for philanthropic purposes.

This study will first describe the many forms of interaction between university and industry, citing some examples in, but not restricted to, Southeast Asia. It will also discuss the role of fiscal incentives and financial institutions, followed by a discussion and conclusions. The study refrains from addressing the philosophy of industry-university linkages, already well-covered in other studies. It instead concentrates on gathering fragmented facts on the financing aspects of university-industry linkages.

UNIVERSITY-INDUSTRY LINKAGES IN THE UNITED STATES

Baba (1988)[2] postulated that organizational inventions are related casually to changing environmental conditions. She observed that university-industry linkages in the United States flourish during periods marked by economic and/or technological turbulence, such as during the First and Second World Wars. These linkages were not very active from 1950 to 1965, when federal resources for universities were abundant. Over the past decade, technological change and declining federal support have stimulated a number of new forms of linkages. One survey, sponsored by the National Science Foundation, reported that 51 percent of the 462 industrial linkage mechanisms at 39 major research universities had been created from 1980 to 1983.

It is interesting to note that the new linkages formed after 1967 (see Table 1) involve novel functions and

structures, including new roles for universities, for example, as equity investors in faculty-owned firms; in new types of resources such as campus-based "incubator" facilities for start-up firms; and/or in an unusual combination of participants, for example, venture capitalists in partnership with university professors (see Table 2). These expanded university roles were made possible by internal policy change which, on the one hand, encouraged faculty entrepreneurship, liberalized consulting time and increased supplemental compensation benefits. On the other hand, new policies claimed university ownership of patentable inventions, required disclosure of software development, reports on outside business activities, and established guidelines for contracts between spin-off firms and universities.

At the same time, industry has also actively pursued university knowledge beyond cooperative research. Through partnership contracts, major corporations have invested multi-millions of dollars in research universities to build up scientific capability. In return for such investment, corporations gain first-hand access to research results, licenses on patents, top graduates and, in some cases, a role in faculty hiring. This recent linkage phenomena of capital interpenetration has caused some blurring or redefinition of organizational roles and charters which may signal a more fundamental organizational development process to be evident only in years to come.

INDUSTRY-UNIVERSITY INTERACTIONS IN SOUTHEAST ASIA

Southeast Asia as one of the world's fastest growing regions has witnessed many organizational development processes involving industry and universities. But this region's organizations and linkages have, of course, evolved in different ways from North America because of the differences in environmental conditions. This section describes various interactive modes between industry and university divided broadly into education, research and service.

Education

Education and training is closest to being the university's main function of teaching. We may broadly define this interaction as any teaching beyond regular classes, be it continuing education and short training courses or special degree courses set up for industry people. Some universities even offer special seminars and training courses tailored to meet the specific needs of a particular company. Industrial input can include offering scholarships and student sponsorship, staff secondment and providing equipment for teaching. Alternatively, industrial premises may be opened up for visits and training as part of the university's course requirements.

The fee for basic and general education courses may be charged at a low rate as a community service. For professional and business courses, the full market rate is generally the rule with high degrees of corporate sponsorship.

Moreover, some governments are involved in training industrial workers to increase productivity and competitiveness. The Hong Kong Productivity Centre, for example, organizes industrial training courses and Singapore's Skill Development Fund collects a levy on workers' earnings to subsidize training either in-house or in approved institutions.

To establish linkages with industry and to generate more income, most industrial liaison offices maintain at least some seminars and training activities. Unisearch Limited of the University of New South Wales in Australia, received over 20 percent of its revenue from such activities in 1990 (over 50 percent if regular courses are included),[3] while Chulalongkorn University's Chula Unisearch in Bangkok received 11 percent in 1989.[4]

Research

Basic research is usually funded by government and university research grants. Here, we would like to concentrate on programs that fund research for industry. The Singaporean government offers grants for private sector research and development (R&D) under the Research and Development Assistance Scheme

(RDAS). Up to 1989, RDAS funded 82 projects with a total committed budget of US$31 million. For 1991-1996, the fund has been increased to US$50 million for private sector projects and joint projects involving public-private sector cooperation and there is a condition providing full recovery of grants for commercially-successful projects.[5]

In Thailand, the government established the Office of the Science and Technology Development Board (STDB) in 1985, with assistance from USAID, to promote the country's technological capability. A large part of the program is for R&D funding of research projects in the areas of biotechnology, materials and electronics to be carried out mainly by universities. The Ministry of Science, Technology and Environment also established with government funding three National Centers in the same three priority areas. In 1991, STDB and the three National Centers merged and the new organization was called the National Science and Technology Development Agency (NSTDA).

Up to September 1991, STDB and the National Centers had funded 127 projects in biotechnology at US$12.3 million, 271 projects in materials at US$11.4 million, and 223 projects in electronics at US$6.7 million. Recipients of these fund are normally universities and public research institutions.[6]

As for funding of private sector R&D, there are three schemes:

- The Company-directed Research, Development and Engineering Loans and Grants Program from STDB. The program has provided US$1.4 million in soft loans for seven projects and a US$0.4 million grant for three projects to private industries, which in turn invested another US$3.2 million. The estimated benefits of these projects amount to US$8.7 million.
- The Revolving Fund for Technological Research and Development of the Technology Transfer Center, Ministry of Science, Technology and Environment. Since 1987, the center has provided soft loans to 18 projects totaling US$4.8 million.
- The Credit for Research and Development Project of the Industrial Finance Corporation of Thailand. This scheme has provided a soft loan of US$0.4 million to only one project.

In the Philippines, projects which pass screening by the Department of Science and Technology (DOST) can get soft loans from the Development Bank of the Philippines (DBP) under a program called DOSTDEP Special Financing Program. In 1990, DOST and its councils gave Grants-in-Aid (GIA) for R&D, sourced from the national government as well as from foreign loans and grants, amounting to US$6 million.[7]

As for collaborative research, the National University of Singapore has been successful in signing the Memorandum of Understanding for long-term collaborative research with a number of organizations beginning with Telecoms Singapore. In addition, since the mid-1980s, some 30 companies annually conduct collaborative research projects with the Faculty of Engineering.[8] In the Philippines, joint research projects between R&D institutes and the private sector numbered 150 in 1989. Top priority is given to industry and energy, for which there were 112 projects.[7]

Service

Consultancy

Engineers, architects, lawyers, accountants, and other professionals are occasioned many opportunities to act as consultants to industry. This is potentially the largest source of income that the university and its staff may generate besides teaching. More than 90 percent of the engineering faculties in three Canadian universities reported consulting activities.[9]

It is therefore not surprising that industrial liaison offices' bulk revenue comes from consultancies rather than research. Throughout Chula Unisearch's six-year history, consultancy services have always accounted for over 70 percent of its total revenue.[4] For Unisearch Limited, it was about one-third of its total revenue

in 1990.[3]

Commercialization of Research Results

It is increasingly recognized that university research results do have some commercial value. Some universities have tried to capitalize on this by setting up schemes to screen and patent research results and, at the same time, market the technology by licensing.

Although some unpatented inventions are tradable through contractual agreements giving exclusive rights to the buyer, patented products are usually preferred because they are innovative and, perhaps more importantly, protected. The number of patents granted to residents per 100,000 inhabitants may serve as an indicator. From 1986 to 1989, Singapore averaged 0.2 patents, compared to 43.72 in Japan, 41.98 in Switzerland, 31.32 in Taiwan, 18 in the United States[5] and 0.09 in Thailand.

Singapore's research institutes have commercialized 16 products from research work, but no start-ups have spun off.[5] In Thailand, Chulalongkorn University has set up a Patent Committee with Chula Unisearch as its executing body. So far, seven inventions are being processed, two of which have already received Thai patents and are awaiting international ones.

Universities have different ways of commercializing research results and sharing the revenue from such endeavors. Chulalongkorn University uses the Patent Committee to select research work for patent application in the university's name. Revenue beyond the expenses incurred is shared equally between the university and the researcher. Singapore's National University gives its staff two-thirds of the royalties or other income from commercialization. As for Unisearch Limited, the inventor receives only one-third of the net income. In all cases, the university makes an investment in filing for the patent and in marketing the invention. The variation in the benefits offered to researchers reflects the perception of the university on the cost of patenting and marketing without a direct subsidy.

Science Parks and Incubators

Science parks and incubators are facilities for housing new technology-based companies and for bridging the gap between laboratories and industrial production. Proximity and close interaction with universities are always cited as necessary ingredients. Some examples are Taiwan's Science-based Industrial Park at Hshin Hsu, where the Industrial Technology Research Institute is situated; Singapore's Science Park, which houses such supporting government agencies as the Singapore Institute of Standards and Industrial Research (SISIR) and its incubator, the National Computer Board and the National Science and Technology Board; Hong Kong's Technology Centre, located next to Hong Kong Productivity Centre, which concentrates on licensing foreign technology; South Korea's Daeduk Science Town; and Malaysia's Technology Park in Bukit Jahil. Thailand and Indonesia also have plans to establish their own science parks.

Science parks and incubators are usually government supported. The Singapore Science Park was a spin-off from Jurong Town Corporation (JTC) into a new JTC-owned, private firm—technology Park Pte. Ltd., which operates the Park. SISIR has a center for Technology Transfer with an R&D Incubator Program, providing incentives for enterprises to carry out R&D work within the SISIR building. The assistance package includes support in applying for grants, such as the Small Industries Technical Assistance Scheme (SITAS) and the Product Development Assistance Scheme (PDAS), which subsidizes laboratory equipment and rent for accommodation, external consultants, in-house development staff, technical information/patent searches, materials for development testing on prototypes and certification for product approval.

France has an interesting incubator program run by the School of Mines at Ales and supported by the regional government. It is open to anyone whose proposal passes the screening. Inventors are paid a stipend for up to 12 months, given access to the School's facilities and, upon completion, have the option to move to a business incubator or outside.

FISCAL INCENTIVES AND FINANCIAL INSTITUTIONS

Fiscal Incentives

The use of tax incentives to encourage R&D activities is widespread. Canada, for example, allows a 100 percent deduction for R&D expenditure and an investment tax credit can be claimed by taxpayers engaged in approved scientific research and experimental developmental activities. In 1983 and 1984, France allowed a tax credit on qualifying R&D expenses of up to 25 percent of the excess of expenses incurred during a given year over those of the preceding year, subject to a maximum of 3 million francs a year. In the United States, a tax credit is given to taxpayers engaged in qualified research and experimental activities while carrying on a trade or business. Australia allows companies a 150 percent tax concession for R&D work. This incentive allows companies to deduct up to 150 percent of eligible expenditure incurred on R&D activities, effectively reducing the after-tax costs of R&D to approximately 41.5 cents on the dollar based on a corporate tax rate of 39 percent.[5] The tax concession has recently been reduced to 120 percent, due to the inability to distinguish between R&D and routine activities in software companies.

In Malaysia, fiscal measures to support technology development have been incorporated in the country's 1991 budget.[10] These are:

- Five years' tax exemption for approved companies or institutions which are already established or are established to carry out research for a particular industry. Dividends distributed to these companies' shareholders are also tax exempt;
- Accumulated losses incurred by approved companies or institutions can be carried forward after the tax-exempt period;
- Double deduction for those contributing money to approved research institutions;
- Double deduction for companies which use the facilities and services of approved research companies or institutions; and
- Five years' tax exemption for new technology-based firms.

These incentives are in addition to those already in operation which include: 1) Double tax deduction on monies spent on approved training or on infrastructure and equipment for approved training to upgrade the work force's technical skills, and 2) Double tax deduction on monies spent on infrastructure and/or conducting R&D in-house.

The Philippines provides incentives for R&D programs in income tax holidays, capital equipment incentives, tax deduction for infrastructure work, among others. Under the country's Investment Priorities Plan, projects qualifying for incentives include establishing industrial estates with S&T Parks, S&T Centers and Technology Incubation Centers and R&D activities and modernization programs.[7]

Singapore has perhaps one of the most comprehensive incentive packages, giving complete exemption from tax on profits for up to 10 years, plus another three to five years at a concessionary tax rate of not less than 10 percent.

Singapore's National Science and Technology Board (NSTB) is recommending an extension of up to two years on these incentives. While companies can already claim double deduction for R&D expenses, NSTB recommends that the extension includes activities related to adaptation, modification, design and quality improvement of products or processes. To encourage greater technology transfer, NSTB is also recommending that the write-off allowance for capital expenditure in acquiring technology or patent rights be granted over a three-year period at a rate of 33.1/3 percent instead of the original five years. The 50 percent capital investment cost that a company is presently allowed to claim tax free should be extended to all fixed capital expenditure for approved R&D purposes. Furthermore, NSTB is recommending that if its R&D expenditure exceeds US$0.625 million, a company can claim tax exemption on the incremental income from the investment for a period not exceeding five years. Finally, companies should be allowed to set aside 20 percent of their taxable income over three years to fund R&D.[5]

In Thailand, the Board of Investment (BOI) grants the maximum available privileges and incentives to R&D projects. These include tax holidays on income, including royalty payments, and tax exemption on equipment and materials and importation of foreign experts. So far, 23 projects have been approved, amounting to an investment of US$56.6 million.

Financial Institutions

Conventional financial institutions are intermediaries which transfer funds from one group to another and, therefore, cannot take part in projects with high risks and long gestation periods. That is why most R&D projects are funded either by the government or by the enterprise itself. Venture capital, which is used to make equity investments in non-publicly-traded companies to profit through capital gains after a certain period of time, can be prepared to take higher risks. Its activities may be subdivided into the following major classifications:[11]

1) Stage zero. Equity investments to develop completely new and unproven ideas, products, processes or services to the prototype stage and to the point where the market is defined.

2) Start up. Equity investments in new enterprises selling promising products or services in a well-researched market.

3) Development. Equity investments in a company that is already operational but needs to be able to break even on a regular monthly basis.

4) Expansion. Equity investments in a well-established, profitable company which lacks the necessary funds.

5) Turn-around. Equity investment in a company experiencing difficulties, but which can be re-established on a profitable basis by the injection of new capital and other internal changes.

6) Buy-out. Equity investment in an established profitable company whose owners seek to reduce their present holdings or to sell out completely to a new group.

It is important to recognize that not all venture capital covers every one of the preceding types of equity investments. Most venture capitalists, especially those in developing countries, prefer to invest in companies at the development or expansion stage. Some venture capital companies with government subsidies will finance stage zeros and start-ups.

In Canada, *Venture Economics*[12] estimated the country's total venture capital at US$3 billion at the end of 1990. Only 12 percent of the funds under management was focused on the early stages of development. Forty-eight percent of venture capital companies do not target funds toward investments in particular industries or at particular stages of development, while 40 percent invest in companies at the later stages of development. The trend toward industry specialization is much less pronounced, with 17 percent of the industry's capital targeted toward high-technology sectors.

The Korea Technology Development Corporation[13] (KTDC), established in 1981, has supplied about US$1 billion to finance approximately 2,600 technology development projects. KTDC also provides financial and all-round support services in such areas as venture financing, international joint ventures, business mergers and acquisitions, intermediation for technology transfer and cooperation, and management consulting services. It has two subsidiaries. The Korea Technology Investment Corporation (KTIC), established in 1986, provides venture financing services to companies at the start-up stage. KTIC-invested companies are also entitled to a wide variety of financial and tax benefits. KTDC Consultants Incorporated was established in 1990 to provide management consulting services, including those for mergers and acquisitions, and training services.

In the Southeast Asia region, since 1987, the Japan Asean Investment Company[14] (JAIC) has encouraged portfolio investment in the unquoted stocks of small companies in ASEAN. JAIC has invested US$80 million in 30 unlisted companies in ASEAN. The Asian Development Bank (ADB) has an equity-financing arm and the International Finance Corporation (IFC), an affiliate of the World Bank, is engaged in similar business.

Singapore's venture capital industry tends to finance the more mature start-ups rather than the earlier phases of research.[15] Indonesia's four venture capital companies and Vietnam's two venture capital funds do the same.[15] Thailand's dozen or so venture capital companies also deal in lower risk businesses with one exception. In February 1991, the Regional Business Development Project, a joint venture between the Canadian International Development Agency (CIDA) and the Thai private sector, set up the Thai Canada Venture Company (TCVC) with offices in Chiang Mai, Korat and Hat Yai and a coordinating unit in Bangkok. TCVC has agreed to make equity investment in a new company set up by Dr. Pichet Wiriyajitra and associates at Chiang Mai University to produce a fish poison called "SWIMTOP" made from an indigenous plant to kill fish in prawn farms. "SWIMTOP" is the product of a research program funded by the International Development Research Centre (IDRC). This is a very good example of commercializing university research, as well as venture capital investment in a start-up venture in a developing country.

DISCUSSION

From the sketchy evidence available, it may be gathered that many South East Asian universities offer training courses and consultancy services for industry, a number establish collaborative research programs with industry, and a few university research results have been commercialized. These interactions are not as diversified nor as intensive as in American universities. Nevertheless, they are a far cry from the "teach only" universities of only a few decades ago. The reason for these changes is not that governments spend less on higher education, but rather that there is an increasing demand from society. Furthermore, industry's fast development outstrips that of the university in terms of personnel and facilities, causing some countries to consider reform of their universities. The technological infrastructure needed for successful application of R&D results are: 1) R&D in universities and research institutes, 2) adequate supply of S&T manpower, 3) a network of consultants in key technology and business areas, 4) support industries including suppliers, distributors and customers, and 5) financial sources ready to invest in high risk ventures. This infrastructure is not present in abundance in Southeast Asia.

Many universities set up industrial liaison offices to formally link with and make their resources available to industry and to show the university's contributions to society other than solely manpower production. In countries where university professors' salaries are much lower than their counterparts in the private sector, this serves as a venue to provide extra compensation to retain commercially-oriented faculties. It also helps to placate criticisms from other faculty members as part of the income is channeled to the university for other pursuits. Although these linkages do generate income, quite often expectations are too high. Some university administrators believe that these services can generate substantive income for the university. However, while Chula Unisearch has been expanding at an average rate of over 80 percent per annum for the six years since its establishment, its revenue of US$1.2 million in 1991 represents only 2 percent of Chulalongkorn University's budget. Another factor to be reckoned with is that even in developed countries the contribution of industry to university research is not high. A recent World Bank paper reports that industrial contributions in the United States, the United Kingdom, Japan and Italy were 7 percent, 7 percent, 2 percent and one percent respectively in 1989.

In newly-industrialized economies (NIEs), governments invest heavily and provide incentives to build up technological infrastructure, often independent of the university. In Korea, the government created the Korea Institute of Science and Technology (KIST) in 1966 to conduct contract research for industry and the Korea Advanced Institute of Science (KAIS) in 1971 to produce Master and Ph.D. degrees for industry. In 1980, KIST and KAIS merged to form the Korea Advanced Institute of Science and Technology (KAIST), but was separated again into KIST and KAIST in 1989. KAIST has been successful in helping industries through research contracts. The amount of royalty earned and patents registered, however, is more modest (see Table 3). Taiwan established the Industrial Technology Research Institute (ITRI) in 1973 to

undertake applied research with the mission of accelerating the development of industrial technology. Its technology accomplishment is shown in Table 4.

As for commercialization of research results, none of the universities in Southeast Asia has earned a significant sum. Unisearch Limited with its 33 year history is one of the few industrial liaison offices in the world which receives an annual income of more than US$1 million through technology licensing. Furthermore, not all patents yield commercial returns. Bill Stadelman, retired president of the Ontario Research Foundation of Canada warned that "98 percent of patents never generate any real money. In my 20 years at the Ontario Research Foundation, I have only seen two patents that generated more than $1 million."[16]

To facilitate the commercialization of technology from research institutes, Korea established a special institute called Korea Technology Advancement Corporation (KTAC) in 1974 as a subsidiary of KAIST to conduct techno-economic feasibility studies and offer a wide range of services, including technical and managerial assistance; the sale, licensing or purchase of technology; and the establishment of new enterprises based on appropriate technology through joint investments with the business community.

Science parks and incubators are invested in and subsidized by governments. While many are situated close to universities, the technologies employed in these organizations generally do not come from university research results.

Although fiscal incentives for R&D activities are possible tools for financing industry-university linkages, there is still no case where it has been used significantly in Southeast Asia. Venture capital companies tend to avoid start-ups, especially those using new technology which have even greater risk of failure. The one exception is TCVC in Thailand.

CONCLUSION

Industry-university interactions are increasingly supported by internal policy changes by universities and external demand for more services from universities. In Southeast Asia, most of the industry-university linkages are financed by industries in exchange for university services. Governments can greatly influence such linkages by providing research grants to finance joint industry-university projects and by offering fiscal and financial incentives to industries. Venture capital can play a role in financing university technology-based start-up firms. The successes of all these linkages in monetary terms in Southeast Asia, however, are few. Further changes in attitude between university and industry and further accumulation of knowledge and intellectual property rights in universities are required before these linkages can be developed to a higher level.

If the underlying aim for promoting industry-university linkages is to increase indigenous technology usage in industry, then the university should not be viewed as the role organization providing knowledge-based resources to industry. Other agencies such as research institutes, calibration and testing services, consulting services, and information services are essential components of the technological infrastructure, upon which local firms may rely to develop their own technological capabilities. Some universities are presently offering some of these services to industry. But we should not go so far as suggesting that universities must go all out to please industry for the sake of strengthening the linkages. It should be remembered that both university and industry belong to society and that universities are accountable to society in performing mandates of teaching, research and service in that order.

This is not to say that industry-university interactions are not important and should be judged only in financial terms. While these linkages should be further developed to promote organizational development of both industry and university, the development of other dedicated institutions to fill gaps in the technological infrastructure should not be overlooked so that a balanced institutional structure for science, technology and industry can eventually be developed.