University – Industry Collaborations
Asian Experience

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I Introduction

Literature on the relationships and collaborations between universities, government aided research institutions and industrial enterprises is very rich. However, most of the studies deal with the European and the US experience. Universities in these countries have a history of collaboration with industrial ventures and several high tech industrial clusters have developed around the universities. In recent years, universities from Asian countries have also started developing links with industrial firms and in-house R&D units. In addition, they have also been collaborating with other universities and government aided research institutions. This paper will concentrate on discussing some of the Asian research studies published in professional journals.

Literature in the area of university – industry collaborations has raises several issues:

- Why should universities collaborate with commercial enterprises? Till recently a widely held view in India and other Asian countries (also in some European countries) was that it is not the business of a professor to dabble in business. Academics should confine themselves with teaching and conducting basic research. They are paid only for academic activities and not for indulging in commercial activities to earn extra income.
- What is the impact of commercial collaborations on the quality of academic research and teaching?
- Is this a win-win situation for both institutions?

The findings of some of the studies for European countries and the US show a positive impact of university – industry collaborations for both. What about the Asian experience? This paper will discuss this in some detail.

A related issue deals with the characteristics of firms that decide to collaborate with universities and research institutions.

- Are they R&D intensive firms or firms that prefer to outsource their R&D rather than perform them in-house?
- Do their managements differ compared to non collaborating firms?
- Are they headed by technologists?
- From the universities point of view, is there a need to change the legal structure for effective collaborations?
- What kind of research institutional structure is needed to facilitate collaborations?
- Finally, how important is the role of the government?

For example it is frequently argued that the Bayh-Dole Act of the US that gave university and scientists the right to intellectual property of products and processes created using government grants gave a boost to patents filled by universities. In this context China has enacted similar acts that in some respects are more generous to the scientists than the Bayh-Dole Act.

II Chinese Experience

The Chinese government considered university research crucial for the development of new products and processes that would make the Chinese industry internationally competitive. To facilitate this China enacted several laws. In this section I propose to survey three studies on China. The first one deals with the changes in the laws and their contribution to national innovative capacity. The second study examines the details of university – industry linkages, namely, linkages with domestic, Asian and western universities, and their impact on the introduction of new products and processes. The third study discusses issues relating to heterogeneous quality of Chinese universities and the problems posed by the gap in the quality of research and teaching among Chinese universities. It argues that university – industry collaborations have increased the gap among Chinese universities.

The paper by Hu and Mathews (2008) reveals the strong role played by the Chinese universities in building China's national innovative capacity. They argue and show that China relies heavily on universities for innovative activity and enterprises spun-off from universities are the main source of innovative activities. These university spin-off ventures are either wholly owned by universities or operated jointly with other entities. They give examples of university affiliated enterprises such as Lenovo, Huawei Technologies (main telecommunications equipment producer), Semiconductor manufacturing International (Shanghai) Corporation, and Positec Power Tools. The main point to note is the creation and role of university affiliated enterprises. The study shows that by 2004, 52% of all the university and research labs affiliated enterprises are in advanced technology fields and they produce more than 80% of the total revenue. The university established science parks employ more than 100,000 persons in 1200 R&D centres supported 5500 high tech companies.

The study by Hu, Li and Hughes (2012) discusses the following important questions relating to the Chinese universities collaborations with the Chinese industry.

- Do the universities mainly contribute to basic, cutting-edge research that result in ground-breaking new technology?
- To what extent are the universities relevant in the diffusion and assimilation of imported frontier technology?
- Is there any difference between collaborating with domestic and foreign universities?

They argue that these questions are important as in their view most of Chinese R&D are spent on development rather than on basic and applied research. They quote the Second National

R&D Resources Survey which reveals that about 83% of gross R&D expenditure and 99% of total industrial R&D expenditure in China was spent on development in 2009. They note the rapid increase in research papers published in areas of science and technology but point out the below average citations per paper compared to papers published by the US and European scholars. Thus the average citations per Chinese articles was 5.87 while it was more than 10 for the US and European papers.

They argue that the Chinese version of the Bayh-Dole Act introduced by China in 1999 allowing universities to own inventions that were funded by the government went far beyond the US Act in rewarding academic inventors. This has resulted in a rapid increase in the transfer of knowledge to industries from the universities. Furthermore as stated by them the Law on Science and Technology Progress introduced in 2007 specified that 'IPR rights of invention patents, copyright of computer software, ownership rights of electronic circuit and new biological variety obtained under S&T funding projects sponsored by fiscal finance or S&T program will be granted to the Investigators of the project according to law, except those related to national security, national interest and major public interest'.

The econometric part of the paper has two **dependent variables**: First, the proportion of sales accounted for by products which were ground-breaking at the world level, and, second, the products that were new to China or to the firm. The data set contains 802 firms and more than 90% of them have innovated in their products. Their results showed that cooperation with other organizations, cooperation with domestic universities, intramural R&D expenditures, positively influenced innovation diffusions (the second dependent variable); they did not influence novel innovations. Firm size was not important in influencing innovations.

In their regression results, the novel innovations (the first dependent variable) were mainly determined by collaborations with universities from newly industrialized countries, from developed countries like EU, Japan and US, and universities from other countries. Firm size had a negative sign. In sum, novel inventions crucially depended on collaboration with world class universities. The Chinese firms have been collaborating with foreign universities and such collaborations have paid off and have made Chinese goods globally competitive. It is also important to note that most of these innovative firms were not large firms. On the other hand, diffusion of inventions depended on collaboration with domestic universities. Thus university collaborations played a vital role in making Chinese firms globally competitive.

University – industry linkages could also have some negative consequences and spillovers. A study by Hong (2008) shows that in the case of China less favoured regions have been further left behind due to shortage of local university resources and the roles of different provinces in the National Innovation Systems. The study further revealed that dramatic increase in patent co-applications by university and firms have been mainly confined to a few provinces in China. Furthermore, the study showed that many less favoured regions did not succeed in building up their knowledge transfer networks with universities and in all probability they would be further left behind in their innovation capabilities and economic performance.

In sum, university – industry collaborations in China plays a crucial role in making the Chinese goods globally competitive. Collaborations in foreign universities have enabled Chinese firms to introduce new products and processes. Collaboration with domestic Chinese universities has accelerated diffusion of technology. However, on the negative side, they have also increased regional and inter-university disparities.

III Japanese Experience

In order to enhance global competitiveness of Japanese firms in high tech industries and promote active collaboration between universities and public sector laboratories Japan enacted the “Strengthening Industrial Technology Bill” which was passed by the legislature in April 2000. The new law allowed the faculty in national universities to assume management positions in companies established to develop their technologies, to work after office hours with pay, and to take up to three years off to commercialise discoveries and then return to their faculty positions (Lehrer and Asakawa 2004). Furthermore, the Japanese lawmakers allowed universities to set up their own technology licensing organisations. In 2004, a ‘radical’ change was introduced in Japan through the National University Incorporation Law which granted the national universities (NUs) autonomy from government. This Law intends to promote greater organizational diversity and distinctiveness, more active and socially engaged institutions, and may also have promoted greater inter-university competition and networking with industry thereby laying the foundation for “entrepreneurial universities” (Woolgar 2007).

In addition to enacting laws conferring autonomy to the universities and intellectual property rights to the scientists, Japan also encouraged industrial clusters. The Industrial Cluster Project (ICP) of Japan promotes autonomous development of regional universities, supports R&D and networking with universities and other research institutions and enterprises. Nishimura and Okamuro (2011), in their paper evaluate the impact of the policy to promote clusters, R&D and networking. Their research is based on data collected from a survey of industrial units in 2009. To begin with they use a *probit* model to analyse the determinants of the use of ICP. In the next stage based on propensity scores they deploy difference-in-difference (DID) models to analyse the degree of industry-university-government collaborations before and after participation in ICP. Further, they use Heckman's two-step procedure and the negative binomial model to examine the effect of support programs on firm performance. Their sample consisted of 322 users and 189 non users.

Their results showed that firms that used ICP facilities were more R&D intensive, employed more labour per firm and participated more in academic societies and trade associations. The sample firms revealed that their main motivation to participate in ICP programme was to benefit from R&D support and facilitation for networking with university and other research institutions. Their DID estimation of network formation clearly showed that the firms overwhelmingly enhanced the collaboration with other firms, universities and government institutions after joining ICP. In particular, they found that the users are more likely to enter into collaborative agreements with universities than non users. Furthermore, more than 70 per cent of the university collaborators were located in the cluster.

Another feature of the Japanese industrial scene is the emergence of several new high tech enterprises popularly called "start-ups". Some of these enterprises have been collaborating with universities and other research units since their inception or factoring in university collaborations while launching the enterprises. Okamuro, Kato and Honjo (2011) analysed the determinants of R&D cooperation in Japanese start-ups. In their econometric work, they had two dependent variables –1. cooperation with universities and 2. cooperation with other firms. They classified the determinants in to three groups – founder, firm and industry specific characteristics. Under founder specific characteristics they included education levels of the founder, prior experience in innovations, patents, work and managerial experience. In addition they also included the experience of the founder in academic associations and societies. Firm specific characteristics include firm size, R&D intensity, nature of the firm, namely, independent firm or a subsidiary/affiliate, and reasons for location – technological and other reasons. Industry characteristics include degree of appropriability and technological opportunity.

For the collaboration with universities founder specific characteristic variables like university qualifications of entrepreneurs, past innovation records and membership of academic associations emerged important determinants. On the other hand for collaboration with other firms innovation record and patent records turned out to be significant. Thus the only common variable that was significant for both was the innovation record of the founder. In the case of firm specific characteristics only R&D emerged important for both collaborations. Among the industry specific characteristics appropriability was important for collaboration with universities. None of the industry specific variables tried emerged significant in explaining collaboration with firms.

IV Korean and Malaysian Experience

The study by Eom and Lee (2010) analyses the main determinants and the impact of university – industry and government research laboratories collaborations. For this purpose it makes use of the Korean Innovation Survey data. The Korean Technology Transfer Promotion Law of 2001 resulted in the establishment of Technology Licensing Offices in all Public Universities. These offices are in-charge of technology transfer and training of officials. The enactment of the law of Industrial Education and Industry – University Cooperation in 2003, resulted in the establishment of Industry – University Cooperation Foundation in 2004. These laws gave a boost to university cooperation with industry.

Their sample consisted of 538 firms out of which they classified 388 firms as innovative firms and 150 firms as non-innovative. They estimated separate equations to determine Industry – University cooperation and Industry – government aided laboratory cooperation. None of the firm specific characteristics like R&D, size etc., turned out to be important in explaining cooperation. Mainly regional dummies and membership of industrial conglomerates (CHAEBOL) were important. For the impact on patent types they considered three dependent variables – new product innovation, product improvement and process innovation. The study found the size of the firm and R&D intensity important for product innovation and process innovation. University – industry collaboration was significant mainly for new product innovation.

Rasiah and Chandran (2009) analysed the drivers of University – Industry collaborations in Malaysia. The paper shows that that the R&D activities of some of the Malaysian universities play a notable role in driving firm level innovations. The government has been following explicit policies since early 1990s to promote collaborations. They have set-up Technology Development Corporations to encourage university – industries collaborations and have stepped-up R&D resources considerably. The paper uses a probit model to analyse the drivers of collaborations. Their sample consisted of 150 firms from automobiles, electronics and biotechnology sectors – the sectors that mainly had collaborations with universities. Their results showed that R&D intensive firms collaborated more with universities. Thus the two were not substitutes. They went together. Research intensive universities having access to multiple channels university innovative activities collaborated more. However, the small and medium R&D intensive firms collaborated more. Large firms didn't. As seen from these results the Malaysian experience has not been very different from that of other Asian countries like China, Korea and Japan.

V International Experience

Perkmann et al (2013) recently reviewed the literature on university – industry relationships with emphasis on academic engagements and commercialisation. They were concerned with what they termed as knowledge related collaborations by academic researchers with non-academic organisations. In addition to formal research collaborations like collaborative research, contract research, and consulting, they also considered informal activities like providing ad hoc advice and networking with practitioners. Their main research question related to the antecedents and consequences of academic engagements with industry. In particular, they discuss the extent and type of academic engagement, the determinants and consequences to the universities and other stake holders.

Their main findings based on a survey of 36 papers published in scholarly journals like *Research Policy, Journal of Technology Transfer, Innovision and others:*

- Male academics are significantly more likely to engage with industry
- Seniority is often positively related to collaboration. More experienced researchers are likely to have larger networks, and more likely to find potential partners in the private sector
- Previous experience with commercialisation, patenting or venture creation increases the likelihood of academics' participation in collaborative activities
- The best and most successful scientists are also those who engage most with industrial partners. There does not seem to be a conflict between good academic research and industrial collaboration. They are not substitutes.
- Commercialisation is undertaken mainly by better quality research departments.
- Most authors find that faculty with industrial support publish at least as many scientific articles as their colleagues, if not more
- Academics with industry exposure support more students.

These findings are based on a survey of international literature. It is important to note that the Asian literature survey presented in this paper is more or less in agreement with the international literature. These findings are also valid for Asia.

VI The Indian Scene

Unlike other leading Asian countries like China, Japan and Korea, Indian educational institutions collaborations with industry has not resulted in the introduction of new products. They are mainly confined to collaboration in introducing courses and training programmes that would help the universities to produce graduates who could be absorbed by the industry. One of the complaints of the Indian industry is that the Indian universities do not train graduates who could be readily absorbed by the industry. Academic scholars have also been acting as consultants to several industrial enterprises. But these consultancies are not aimed at creating new products.

The study by Joseph and Abraham (2009) uses firm level data and covers different manufacturing industries in four of the most industrialised states in India. It throws light on a number of issues relating to university – industry relations. The sectors identified by the study include information technology, chemicals including pharmaceuticals and biotech firms, automobiles, textiles and clothing and machine tools. The following four states were included: Maharashtra, Bangalore, Tamil Nadu and Delhi. The survey covered 460 firms and 735 professors/scientists. The universities covered in the survey were either purely technical universities or technical/science departments in general universities. The survey covered a large number of engineering colleges and research institutions.

Their results suggested that universities and publically funded research laboratories did not play an important role as sources of information either in terms of suggesting new projects or help in completing the existing ones. They mainly got information and ideas from firm's manufacturing operations and customers. Incidents of interaction with universities were also low; hardly 10 percent of firms reported any interaction with universities and research laboratories. The firms that interacted with universities and research institutions stated that they approached them for mainly to help in quality control and help in using their equipments for testing and other purposes. Firms with stronger R&D base preferred to collaborate with research institutions rather than universities. More than 96 percent of the firms surveyed (both collaborating and non collaborating firms) claimed that they have introduced new products. However, most of them turned out to be new products only for the firm in question and not for the country or the world.

There could be several reasons for this low level of collaborations and absence of introduction of new products that are new to the country and the world. India has not enacted laws to facilitate university-industry collaborations. In India, by and large, the output of government-sponsored research is considered the property of the government and the researcher has very little say in its commercialisation and application. In this context the Indian Cabinet gave its nod for a bill - Protection and Utilisation of Public Funded Intellectual Property Bill 2008 (October 30, 2008) - giving scientists share in the intellectual property. This bill has been modelled on the Bayh-Dole Act in the US which spurred applied research in the US Universities. The proposed bill allocates one third each of the royalty receipts to the scientists, the research institution, and to the funding agencies. Earlier the entire sum went to the funding agencies. However, this bill has not yet been passed by the parliament. Despite the absence of a legal framework, some of the government departments have been following the policy of allocating one third of the benefits to the scientists.

For an effective and productive collaboration between universities and industry, the Indian universities should improve their quality to international standards. While some Indian institutions have world class standards, several universities have poor faculty standards. In many universities even senior professors have poor publication records. In order to improve faculty standards publications in mainstream professional peer reviewed journals should be insisted upon for fresh appointments and promotions. Furthermore, importance should also be given to citations of the work in other peer reviewed scientific journals.

Currently no Indian institution figures in the top 200 universities in the world. As seen from the Appendix, among the top 200 universities 27 universities from Asia figure - China 7; Japan 7; Korea 5; Israel 3; Hong Kong 2; Taiwan 2; Malaysia 1. Thus as seen from international ranking Indian universities and institutions are not on par with our Asian competitors. One of the important reasons for this could be the publication record of Indian academic institutions. As per international criterion only publications that are included in the citation index are considered as professional publications. In India, UGC and other organisations don't insist on this. They only demand refereed publications. This has resulted in a proliferation of refereed journals with irregular publications and poor quality. Other Asian countries have been insisting on international norms for evaluation of their faculty. Furthermore, Indian Universities have not been going by citation records of their faculty for their promotions and appointments. Unless the Indian standards are on par with world standards Indian institutions will lag behind. Some of the Indian institutes are of world standard. However, they are not included in the ranking of universities as their coverage of disciplines is not broad enough to be classified as universities. They focus on few select disciplines and do not have a strong graduate programme.

World ranking also depends on international faculty and students. Several Asian countries including China have been consciously employing international faculty. Here also India lags behind. Regarding collaboration with industry and academic organisation, Indian institutions have just started initiating them.

India has done very well in terms of quantity at the cost of quality. Indian universities are very heterogeneous in nature. Even the best ones do not figure in the top 200 world universities. To achieve international standards, India needs to emphasise publication record of the faculty in mainstream professional journals and give importance to citations. Global knowledge sharing is also important and India should make their faculty and students more international as the other successful Asian countries have done. It is also argued that the universities are under severe financial constraint and very little sum is spent on research. Even the library budget is poor. Therefore, if one considers research output per rupee or dollar spent on research then the performance of Indian universities could be considered above average. In this context university-industry collaborations would to some extent ease the financial constraints.

Nevertheless, India does have world class science and technology institutions like the Indian Institute of Science. However, they will not figure in the international university ranking due to two reasons. First, they do not concentrate on graduate or under-graduate teaching. Second, they do not offer wide variety of disciplines like universities: from medicine – technology – natural sciences – social sciences. These two factors mainly keep them out of university ranking. On the other hand, these specialised institutions attract multinationals to set-up R&D units in India (FDI in R&D) to take advantage of the presence of these institutions and in particular the Indian Institute of Science (Reddy 1997, 2011).

VII Conclusions

Studies surveyed in this paper clearly show that university – industry relationships have been mutually beneficial to both. Firms from China, Japan and Korea that collaborated with universities were more innovative, introduced new products, developed new processes and emerged globally competitive. Universities also benefited. Academic excellence and industrial collaborations went together. One did not stand in the way of the other. In fact universities that enjoyed high ranking were the ones that collaborated with industry more.

However, for successful commercialisation of research output and for fruitful collaboration with the industry, the governments should enact new laws that would give freedom to the universities and grant intellectual property to the faculty that created the property. China, Japan and Korea have been enacting such laws and have been benefiting from collaborations and research output. Universities from these countries also occupied high global ranks. In this respect India has been lagging behind. Not a single Indian university/academic institution finds a place in the top two hundred universities. This is mainly because the Indian authorities and the UGC unlike the leading Asian countries and developed countries have not been insisting on publications in mainstream journals, that is, journals that are included in the citation index for appointments and promotion in faculty positions. Importance is also not given to citations. India has also not enacted appropriate laws to encourage commercialisation of products and processes created by researchers. India should urgently introduce university reforms to reap benefits from research and development. The budget allocation for research should also be increased substantially to obtain world class results. Industries could play an important role in providing funds for research and development.

Appendix

CRITERIA OF WORLD UNIVERSITIES

http://www.topuniversities.com/university-rankings

40% Peer Review : Composite score drawn from peer review (which is divided into 5 subject areas)

5% International Faculty : Score based on international faculty International Outlook

5% International Students : Score based on proportion of international students

10% Recruiter Review : Score based on responses to recruiter survey Graduate Employability

Teaching Quality Research Quality Criteria Student Faculty : Score based on student/faculty ratio Citations per Faculty : Score based on research performance factored against the size of the research body Indicator Times Higher Education Survey Ranking Bodies Weight 20% 20% Criteria

- 20% Articles published in Nature and Science Research Output

20% Articles in Science Citation Index-expanded, Social Science Citation Index, and Arts & Humanities Citation Index

20% Staff of an institution winning Nobel Prizes and Fields Medals Quality of Faculty Size of Institution Quality of Education Criteria Academic performance with respect to the size of an institution Highly cited researchers in 21 broad subject categories Alumni of an institution winning Nobel Prizes and Fields Medals Indicator Shanghai Jiao Tong World University Ranking Ranking Bodies Weight 20% 10% 10% Criteria

- Quantity and Quality of Research Quantity and Quality of Researchers Criteria 100 Number of recognitions/awards/ stewardsip conferred by national and international learned and professional bodies With balanced distribution of staff with >20 yrs experience, 10-20 yrs and <10 yrs experience Research Experience At RM50,000/staff/yr of which at least 20% is from international sources and 20% from private sector

Ranking of Indian Universities

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222 Indian Institute of Technology Delhi (IITD) ☐

233 Indian Institute of Technology Bombay (IITB) ☐

295 Indian Institute of Technology Kanpur (IITK) ☐

313 Indian Institute of Technology Madras (IITM) ☐

346 Indian Institute of Technology Kharagpur (IITKGP) ☐

401 Indian Institute of Technology Roorkee (IITR) ☐

441 University of Delhi ☐

Asian Universities Among the Top 200

24 National University of Singapore (NUS) ☐

26 University of Hong Kong ☐

32 The University of Tokyo ☐

34 The Hong Kong University of Science and Technology

35 Kyoto University

35 Seoul National University

39 The Chinese University of Hong Kong

41 Nanyang Technological University (NTU)

46 Peking University

48 Tsinghua University

55 Osaka University

60 KAIST - Korea Advanced Institute of Science & Technology

66 Tokyo Institute of Technology

75 Tohoku University

82 National Taiwan University (NTU)

88 Fudan University

99 Nagoya University

104 City University of Hong Kong

107 Pohang University of Science And Technology (POSTECH)

114 Yonsei University

123 Shanghai Jiao Tong University

133 Kyushu University

141 Hebrew University of Jerusalem

144 Hokkaido University

145 Korea University

161 The Hong Kong Polytechnic University

162 Sungkyunkwan University

165 Zhejiang University

167 Universiti Malaya (UM)

174 University of Science and Technology of China

175 Nanjing University

183 Technion - Israel Institute of Technology

193 Keio University

196 Tel Aviv University

199 National Tsing Hua University

Total number 27 - China 7; Japan 7; Korea 5; Israel 3; Hong Kong 2; Taiwan 2; Malaysia 1.

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