Globalisation of Knowledge Development and Delivery: An Overview

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I Introduction

This paper deals with an overview of the conference theme. The conference deals with three important aspects of globalisation of knowledge development –

1) Globalisation of R&D and in particular Foreign Direct Investments (FDI) in R&D.
2) Recent trends in mass collaborations using the internet/web revolution, strategic alliances between enterprises and between enterprises and individuals, open source and peer production.
3) Networking of universities, research institutions and enterprises

With regard to these three aspects, the conference will analyse evidence from Asia (in particular India) and Europe. However, this overview paper will cover a wider range of literature.

II FDI in R&D

The phenomenon of multinational enterprises (MNEs) setting-up R&D units in host countries is a recent one. Till recently, most if not all MNEs preferred to conduct their R&D in their respective home countries. If at all they decided to perform R&D in the host countries, it was mainly to adapt their technology to the host country environment –

markets, materials and consumer tastes. By and large, the R&D units were part of the manufacturing units and not separate stand alone ones. Later on some of the firms established R&D units in developed countries, in particular the USA, to benefit from the US technological atmosphere. However, since the early 1990s MNEs have started establishing their R&D units in developing countries like China and India. Two motives are usually identified for starting R&D units in developing host countries: access to market and access to science. There is evidence to believe that the rationale of access to science need not be confined to setting-up of units in developed countries. Countries like China and India also have some advantages and contribute to knowledge development. However, some of the earlier studies like Li and Yue (2005) found low cost of production and the need for product localisation the main reasons for setting up of R&D units in China. Nevertheless, later studies found science motive equally important. For example, activity of the R&D unit of General Electric in India is in areas as diversified as aircraft engines, medical equipments and consumer durables. These are not for product localisation reasons. Furthermore, Pharmaceutical companies such as Astra-Zeneca, Eli Lily, GlaxoSmithKline, Novartis, Pfizer and Sanofi-Aventis all run research activities in India.

The changing perception regarding establishing R&D units in developing countries is brought out by the UNCTAD survey of most attractive prospective R&D locations presented in Table 1

Table 1

Most attractive prospective R&D locations in the UNCTAD survey 2005-09, (percent of responses)

China	61.8

United States	41.2
India	29.4
Japan	14.7
UK	13.2
Russia	10.3
France	8.8
Germany	5.9
The Netherlands	4.4
Canada	4.4
Singapore	4.4
Taiwan Province of China	4.4
Belgium	2.9
Italy	2.9
Malaysia	2.9
Republic of Korea	2.9
Thailand	2.9
Australia	1.5
Brazil	1.5
Czech Republic	1.5
Ireland	1.5
Israel	1.5
Mexico	1.5
Morocco	1.5
Norway	1.5
Poland	1.5
Romania	1.5
South Africa	1.5
Spain	1.5
Sweden	1.5
Tunisia	1.5
Turkey	1.5
Viet Nam	1.5

If a survey had been conducted a decade or two earlier the results would have been very different. China and India now ranked one and three would not have found a place. The US would have been ranked one and the west European countries would have found a prominent place. In the Table 1, apart from China and India several Asian countries figure as important destinations. It is, therefore, important to explain not only the phenomenon of establishing R&D units in host countries but also in developing countries.

II.1 Reasons for FDI in R&D

Kummerle (1999) was one of the earliest to analyse the determinants of FDI in R&D. While analysing the determinants he made a distinction between what he called "home base exploiting (HBE)" R&D and "home base augmenting (HBA)" R&D. In his view HBE units aim at slightly modifying the technology developed at their home base to suit the host country environment. R&D performed is mainly adaptive and not innovative. It is more of a minor development and less of research. HBA on the other hand, is knowledge enhancing R&D, innovative and has more research content. He found the differential R&D spending relative to the GDP between the home and host countries and the skill levels of population between the countries as important determinants in deciding in favour of HBA. Continuing with a similar logic Shimizutani and Todo (2008) while analysing the Japanese FDI in R&D made a distinction between R and D. They considered the investment R type if the host country R&D expenditures to GDP are high. D type investments would depend on the host country's local market based on brisk economic growth. They found the probability of Japanese enterprises performing R&D of both types was negatively related to the distance of the country from Japan. However, these two variables, namely, R&D expenditures to GDP and distance between the host and home country, cannot explain the FDI in R&D in developing countries like China and India – the two most favoured destinations.

Developing the HBA and HBE concept further, Kurokawa et al (2007), argued that if the aim of the investment was to (1) strengthen their R&D capabilities, (2) take advantage of the better technological environment in the host country, (3) employ and utilise researchers in the host country, (4) monitor technologies in the host country, and (5) to create global R&D synergies then it could be considered HBA investment. Conversely, if the investment was to respond to the needs of the host country market and establish an integrated system from R&D, production to sales it could be classified as HBE investment. In addition, the choice of HBA would also depend on the importance given to R&D alliance, namely, collaborative R&D projects with local firms, universities and research institutions. Firms that don’t give importance to these features may not go for HBA investments. Furthermore, the choice of HBA and HBE would also depend on the method of evaluation of R&D personnel and autonomy granted to R&D units. HBA units were invariably the ones where R&D personnel were given freedom to select their project and network with other research units. Prior permission of the head quarters was not insisted upon. Belderbos (2001) also found that firms that were R&D intensive (measured by patent to sales ratio), that had internationalised manufacturing operations, and also export oriented invested in FDI in R&D. Very rarely domestic oriented firms with low R&D budgets invested abroad in R&D.

Some of the studies classified foreign R&D units differently. Instead of HBA and HBE classification, Ito and Wakasugi (2007) classified them as support oriented R&D and knowledge sourcing R&D. They considered support oriented R&D units as those conducting R&D at the manufacturing plant without a separate R&D units, and knowledge sourcing R&D units as those having in addition to a R&D plant at the manufacturing site having a separate R&D unit functioning solely as a research laboratory. They also found that large and export oriented firms tended to vest in R&D overseas. The host countries technological status indicated by royalty receipts (as a proportion of GDP) and proportions of researchers in workforce contributed significantly to investment in knowledge sourcing R&D units.

There is a general agreement that the technological status of the host country is important for FDI flows in R&D unless the R&D unit is a part of the manufacturing unit. Such cases are normally not termed as FDI in R&D. The problem is one of measuring or evaluating the technological status of the country. Measures like royalty receipts may not capture the technological status of developing countries like China and India. In this context Hegde and Hicks (2008) use several innovative ways to measure the technological strength of a host country. They use the number of USPTO patents invented in the host country and not assigned to US companies or investors as one of the indicators to measure the technological status. They also introduce the national output of scientific and engineering articles published in professional forums as another indicator. This variable, they argue, measures the world-class scientific enterprise in the host country. The introduction of these determinants, they claim, explains the emerging R&D investments in China and India. In 1990 China and India accounted or only 0.1% of FDI in R&D. This figure increased to 2.3% in 2003. During this period, China and India increased their science and engineering publication output from about 4.5 to 7.2% while Europe's numbers hovered around half the total share of non-U.S. articles. They conclude that public investments in science and technology institutions are more likely to attract investments in R&D than manufacturing investments.

In addition to the technological status of the country, technological status of the firms is also important. As shown by Xiaolan Fu and Yundan Gong (being presented in this conference), in the case of Chinese industries rapid technological change took place in sectors where the Chinese firms enjoyed a lead. Firms with a better knowledge base benefited more from internal and external technology spillovers. On the negative side, their study reveals that R&D activities of foreign firms had a negative spillover effect on the domestic firms.

Most of the studies on international innovation activities deal mainly with large MNEs. Unlike the mainstream studies, the three papers being presented in the session on the European experience mainly deal with the innovative activities of small and medium firms (SMEs). The paper by Rammer and Schmiele investigates the drivers for international innovative activities of German SMEs. They also analyse the effects of international innovative activities on performance in the domestic market. Such an analysis is important for the ongoing policy debate, namely, whether shifting innovative resources abroad is beneficial or harmful to the firms' home market activities. Their study shows that internationalisation of innovative activities strengthens the SMEs domestic performance.

Innovations and R&D productivities also depend on agglomeration and cluster benefits as suggested by the study by Filip de Beule and Ilke van Beveren. Their study clearly shows that cluster membership is an advantage in innovative activities. Even after controlling for R&D intensity, industry effects, export orientation, size, and regional differences, they found clusters to be an important catalyst in the renewal process of membership firms' product portfolio. In other words, firms belonging to a cluster put their R&D to better use. However, there could be exceptions to this rule as the paper by Odaka (to be presented in this conference) shows that for IT software firms in Bangalore cluster, external international linkages and the internal firm structures are more important in inducing innovative activities. Okada's paper, to use her own words "challenges the notion of localized knowledge spillovers through close inter-firm linkages within the cluster, which is widely cited in the literature as a critical factor that promotes innovation".

Furthermore, as shown by Kaushalesh Lal and Theo Dunnewijk, innovation strategies of firms that mainly serve the local market are very different for firms that are globalised. Their study shows that firms that mainly targeted local markets adopted occasional innovative policies. On the other hand, firms that targeted European or global markets followed continuous innovation approach. They argue that in a globalised world it is important for SMEs to target international markets. In this context they also advocate clusters wherein SMEs could benefit from agglomeration advantages. The study by Narayanan et al (being presented in this conference) also shows that export oriented MNEs in the Indian pharmaceutical industry perform more R&D. Thus, by and large, most studies find a strong link between export orientation, international orientation and in-house R&D activities.

Some of the firms from developing countries have augmented their knowledge and technology base through outward foreign direct investments (OFDI). The study by Jaya Prakash Pradhan and Neelam Singh (is being presented in the conference) shows that OFDI is an important determinant of domestic R&D performance of the Indian auto sector firms. Indian automotive firms have succeeded in gaining access to technological and marketing information from foreign countries through their OFDI and that has been instrumental in their increased spending in in-house R&D.

II.2 Determinants of R&D Collaboration

In addition to investing in R&D multinationals have also been collaborating with several R&D units, universities and research laboratories. In this context Becker and Dietz (2004) found that technological opportunities coming from universities and scientific research have a positive influence on collaborations. In India several MNEs are collaborating with the Indian Institute of Science at Bangalore and Indian Institute of Technology located in a number of Indian cities. Furthermore, there is evidence to show that joint ventures are more likely to emerge in sectors where technological knowledge diffuses fast (Hernan et al. 2003). This result indicates that a strong intellectual property regime stands in the way of R&D and joint venture research collaboration. Some other studies also show that legal measures like strengthening patents and copyrights stand in the way of R&D collaborations (Bonte and Keilbach 2005). Firms get round this problem by entering into informal collaborations. However, it also possible to give counter examples like the study by Wilfred Dolfsma and Loet Leydesdorff that is being presented in this conference.

III Mass Collaborations, strategic alliances, open source and peer production

Prospects of informal R&D collaborations have opened up new opportunities and several innovations in collaboration modes and methods. Quite a few MNEs have started sourcing ideas relating to new products and processes from sources outside their company (Tapscott and Williams 2006). For example currently Procter & Gamble sources 50 percent of their new product and service ideas from outside the company. These companies register on the *InnoCentive* network to solve their R&D problems for a cash reward. They pose their R&D problems in the network and announce cash reward to technologists who could come with a convincing solution. A number of academics from countries like China and India have been participating and benefiting from these newly emerging schemes. From the MNEs point of view, they could tap the global scientific and technological talent without having to employ them. Firms such as Boeing, Dow, DuPont, etc are also using *InnoCentive*. However, in order to tap the global talent, the MNE would have to make some of their closely guarded secrets and intellectual property public. They don't mind doing this, as the returns resulting from mass participation are more than the costs of sharing their intellectual property. Abandoning their proprietary R&D projects to support open collaborations has become popular with some of the leading pharmaceutical companies. These were the very companies that were actively advocating stricter intellectual property protection during the 1980s. The pharmaceutical majors have been supporting SNP Consortium and Alliance for Cellular Signalling – two important projects wedded to open source databases.

The most important reason for this major change in the attitude of the MNEs is the ongoing web revolution. Tapscott and Williams (2006) argue that internet has drastically cut down transaction costs thereby substantially reducing internalisation advantages, which has made outsourcing and networking more profitable compared to performing all R&D in-house. They therefore go for "open innovations" (Tether and Tejar 2008). In this context, universities, government funded research labs, private research organisations and consultants are clubbed together and referred to as specialist knowledge providers by Tether and Tejar (2008). They found that most of the firms that sought knowledge from external knowledge providers have impressive in-house R&D units and the firms did not consider specialist knowledge providers as competitors - substituting their in-house R&D work. Instead, they complemented their in-house R&D efforts. In fact mainly firms with first-rate R&D base networked with research laboratories and individuals. Thus open innovations involve actively seeking and assessing external ideas that is practiced primarily by firms with a high-quality in-house R&D unit.

Firms like Proctor and gamble have been going in for open innovations and have benefited by peer production. Tapscott and Williams (2006) cite several examples of well-known firms that have embraced open sources and peer production. For example, IBM's choice of Linux – open source software is well known. IBM spends about $100 million on Linux per annum. The other example is that of BMW, another R&D intensive firm releasing a digital design kit on its website to encourage interested customers to design new telematic features for future models like GPS navigation systems. In fact BMW hosts a "virtual innovation agency" on its website where small and medium sized business can submit ideas. Likewise Intel and its academic partners have agreed to an Intel's open collaborative research agreement, which grants nonexclusive IP rights to all parties. Similarly, many bio-tech firms have voluntarily placed their DNA related work on the open websites. Tapscott and Williams (2006) consider open platforms mass collaborations in action, which extends productive capacity of business without having to incur huge fixed costs. In this context they cite examples of eBay , Google, and Amazon.

With open platforms partners can add value to the platform in addition to building new business.

Having said this, it is important to recognise that patents and intellectual property protection continues to be relevant for a good number of R&D decisions. For example, Rajan et al (paper being presented in this conference) argue that in the current WTO regime, it is not prudent to perform R&D first and then go in for patenting later. It is important to examine the whole status of IPR in a particular product line before embarking on new knowledge development. Most products have several inter-connected patents and the legal risks are very high.

They argue that "in the emerging areas in biomedical fields, renewable energy, advanced electro-optics, biotechnology, nano-technology etc., the firms from the developed countries have positioned themselves very well with IPR's well in advance of actual commercial global operations, making it very difficult for a new comer to enter. The knowledge delivery will be on their terms." In this context the paper by Wilfred Dolfsma and Loet Leydesdorff to be presented in this conference suggests that the Dutch innovation system is greatly dependent on the intellectual property law.

With regard to networking and strategic alliances the paper by Okada (to be presented in this conference) reveals several interesting features. Her study of Bangalore IT cluster shows that the firms have developed several channels to engage in what she calls 'long distance conversations' with client firms, institutions and universities. These channels have made it possible for the flow of new knowledge and information for promoting innovation and climbing the value chain towards higher end activities.

IV Globalisation of Academic Institutions

Several universities have placed their entire curriculum (including lectures) on their websites. MIT was one of the first institutions to start this tradition. In addition, collaboration between academics belonging to different institutions and countries has also been in the rise. For example a study conducted by Santa Fe Institute found that the average high-energy physicist has around 173 collaborators.

University research plays an important role in product development, regional innovation and industrial patents. There is evidence that it can enhance faculty research performance. 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).

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.

From the point of view of enterprises, the paper by Narayanan and Bhat (to be presented in this conference) shows the importance of ownership advantages and networking with other firms, universities and institutions to overcome the size disadvantages of small and medium Indian IT firms to emerge 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. Some studies are also sceptical about university industry collaboration. For example, Guellec and Potterie (2004) argue and show that private funding of university research does not contribute to productivity growth. They, therefore, suggest that universities should do what they are good at, namely, basic research and government should fund basic research at university labs.

The two papers to be presented in this conference on networks follow social network framework but address two different issues. They also make methodological contributions. The paper by Dolfsma and Leydesdorff examines innovation systems using patent networks. They group patents into two classes – primary and secondary. They argue that "co-classification of a patent in two classes signifies a relation between these classes that is significant from the point of view of knowledge development and thus for a knowledge-based innovation system". Using social network analysis they map the co-classification among classes to determine to analyse the characteristics of national innovation system. The paper by Paul and Krishna examines two related aspects of knowledge output, namely, degree of concentration and nature of social networks.

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