地誌研年報12号，2003年3月
ANREG 12, March 2003

Globalization of Knowledge-Intensive Industries: the Case of Software Production in Bangalore, India

Yuko AOYAMA*

Abstract

This paper examines the process of globalization in knowledge-intensive industry, with a specific focus on software industries in India. It provides an overview of the emergence of software industry in India and how it is linked to globalization. Through this case study the paper considers whether a new mode of globalization is emerging in the information age, as compared with that in the age of industrial capitalism.

CONTENTS

I. Introduction

If you lose your luggage on British Airways, the techies who track it down are here in India. If your Dell computer has a problem, the techie who walks you through it is in Bangalore, India's Silicon Valley. Ernst & Young may be doing your company's tax returns here with Indian accountants. Indian software giants in Bangalore, like Wipro, Infosys and MindTree, now manage back-room operations - accounting, inventory management, billing, accounts receivable, payrolls, credit card approvals - for global firms like Nortel Networks, Reebok, Sony, American Express, HSBC and GE Capital.

—— *San Jose Mercury News, August 19th, 2002. (Friedman, 2002)*

*青山裕子；Graduate School of Geography, Clark University, USA

There is no question that India has emerged as a new and powerful player in the software industry. In 2001, 285 out of Fortune 500 firms had some kind of contractual relationships with software firms operating in India. India's software firms today handle all aspects of back-office operations for various industrial and service sectors, as the above-mentioned news article from the recent San Jose Mercury News have shown. Since its liberalization policy that began in 1991, India has successfully positioned itself as a subcontractor to the world's software industry, particularly to the United States. While the phenomenal growth of India's software industry in the past decade has been well covered in the media, the consideration on its impacts on theories in development and industrial geography has not been elaborated. Particularly intriguing is the question of whether we are facing a new mode of globalization, that is based increasingly on exploiting human resources, and especially skilled labor from the developing country contexts in the non-manufacturing sector.

This paper examines the emergence of software industry, with an emphasis on Bangalore, India, now dubbed as the Silicon Valley of India. The case of Bangalore and its software development is viewed in the context of regional and international competition, particularly arising out of China today. A comparison with China is particularly appropriate as they are emerging as two primary locations for software investment in Asia-Pacific.

II. Information-industry globalization

Contemporary globalization can be considered as an extension to the previous two modes of globalization, one that was dominated by international trade and another with an active engagement of foreign direct investment (FDI). FDI has traditionally been understood as an outcome of product life cycle (Vernon, 1966; 1979) or imperfect competition (Hymer, 1960), but the theory has not progressed much beyond the New International Division of Labor advocated by Frobel *et al.* (1980). More recently there have been discussions on the role of nationalities in FDI (Mason and Encarnation, 1996), the role of locations (Krugman, 1992; Dunning, 1977), and linkages (Aoyama, 1999, 2000). However, the fundamentals of foreign direct investment are changing in the information age. No longer are multinational firms seeking access to raw materials

nor low-cost labor. In fact they are increasingly seeking out expansion into local markets and skilled labor force, which are in short supply in the advanced industrialized nations. The skills required may not be at the top of the pile, however. More likely the skills required are that of *appropriate* and *adaptive* ones, which fill in as either volume-subcontracting or specialized-services.

With a number of coincidences, India has become well positioned to exploit a niche for developing a software industry. Today, most notable US and Japanese multi-nationals have operations in India. Their investment in India is relatively recent and, with a few exceptions, has not been well represented in scholarly research.

The paper aims at generating a series of empirical evidence which contribute to theories in economic geography. Specifically, empirical evidence will be examined with the following questions in mind: 1) how does the new global configuration of software production affect the division of labor within knowledge-based industries? and 2) how do emerging economies, such as India and China, employ their skill base to capture IT jobs? On the one hand, the development of software industry in the developing country context challenges conventional assumptions on globalization under industrial capitalism supported by offshoring of labor-intensive activities. On the other hand, globalization of software activities may indeed reinforce the division of labor observed under industrial capitalism, through increasing specialization and the division of labor within the software industry itself. The latter argument assumes that offshoring of software industry have been largely the result of the industry's increasing share of labor intensive activities.

What follows is an analysis based on a preliminary research conducted on the nature and extent of contemporary Indian software industry and its development. It is based on a survey of the literature and media reports on the subject. The purpose is to generate a set of hypothesis which will then be examined through planned field research. The paper therefore concludes with an outline of future research agenda.

III. The software industry in India

Arora *et al.* (2001) explains the rise of Indian software industry as "a combination of resource endowments, a mixture of benign neglect and active encouragement from a

normally intrusive government, and good timing." The software industry in India largely emerged after the country's shift toward liberalization of trade and foreign direct investment in 1991. While this does not mean that there was no development prior to this date, the bulk of growth occurred during the 1990s. IBM had an intermitted presence in India since the 1960s, and Texas Instruments started a software operation in India in 1986. While training in advanced engineering is heavily dependent upon the availability of up-to-date laboratorial infrastructure, training in software developed with foundations in mathematics, which India's educational system was well known for.

The effort to exploit the skills available in India was first initiated by the American multinational firms. Their initial strategy was known as 'body-shopping', in which Indian software programmers were brought to the United States on fixed-term contracts to work on specific projects. This strategy was complimented by hiring those who received graduate training in the United States, some of whom have subsequently opted for opening start-ups on their own (see Saxenian and Edulbehram, 1998; Saxenian, 1999). The Nonresident Indians (NRIs), who have consistently played a significant role as a source of capital and knowledge for the Indian economy, have also taken part in developing the software industry in India. Therefore, the Indian software industry has been founded upon two types of global networks; one that is established through conventional links by multinational firms, and the other which is based on the globalized, yet personified networks developed by NRIs. These two channels of networks have complimented, reinforced, fortified and ultimately enabled otherwise precarious long-distance business relationships to established and mutually-dependent networks.

These global networks have been combined with other circumstances, which are also sufficiently important and should therefore be mentioned and reiterated here. First, as already mentioned, the shift in policy since 1991 permitted these global networks to develop fully. This policy shift, combined with the policy toward the continued protection on the domestic manufacturing sector, provided further impetus to channel export-oriented private sector initiatives away from hardware and toward software production. Second, also already mentioned, there was a pre-existing under-employed labor force in India whose skills complimented those required in the evolving software industry at the time. Third, by the time the 1990s rolled around there was an

emergence of economically-middle class yet skilled workers who were craving for entrepreneurial opportunities which opened up as a result of policy changes. The interest of these middle class, some disillusioned by the decades of what they perceived as reverse discrimination policy and therefore missed opportunities but were unable to join the ranks of the NRIs, were matched with the opportunities of growth provided by software production. Some even characterizes the rise of the knowledge-based middle-class in India as the revolution against the traditional caste system, altering the longstanding economic and social hierarchy in India, while others characterize the reinforcement of traditional societal values that credit intellectual knowledge over practical industrial craftsmanship.

Finally, these factors coincided with the labor shortage in the IT sector in the developed world, and in particular, in the United States. The growth of software industry resulted in the acute shortage of software programmers, and the demand could not have been adequately and immediately met by hiring locally. This was documented by many of the experiences of Silicon Valley-based firms, which in turn played a major political role in rallying for the increases in the quota enforced on work-visa issued by the Clinton Administration in the 1990s. The growth was partly structural, i.e., the result of the growth of computer-use, but also coincidental, i.e., the Y2K problem necessitating a sudden surge of programming needs across the world. The shortage of IT professionals and subsequent policy changes to accommodate this problem not only had a significant impact in redirecting the overall U.S. immigration

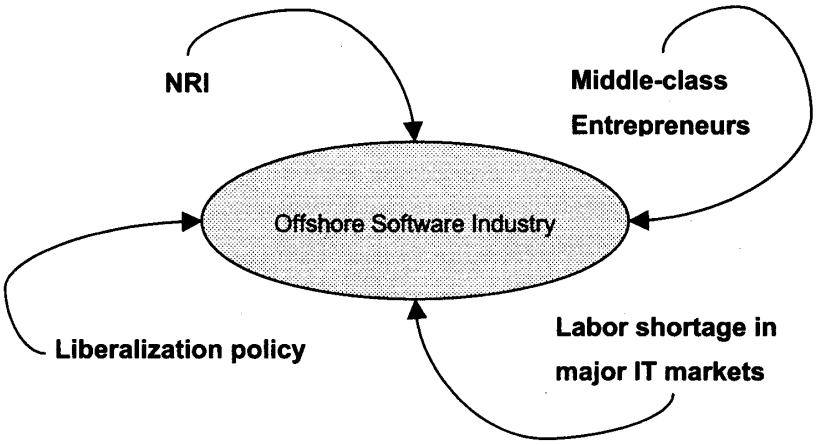

Figure 1. The Emergence of Indian Software Industry

policy from that with the emphasis on family relation to increasingly skill-conscious orientation, but also had ramifications for other advanced industrialized countries which faced similar shortages. Some countries, such as Germany, opted for implementing similar programs to counteract the concentration of IT professionals to US locations, while others, such as Japan, remain largely closed to the global flows of IT-related professionals.

There are some key features of the Indian software industry. First, the Indian software industry emerged initially and primarily as serving as subcontractors to U.S. firms, either through onsite or offsite contracts, and it continues to do so. This makes the industry dependent on the U.S. economy and technological progress, which on the one hand, have provided the key and privileged access, but on the other hand made the industry vulnerable to global trends with nothing to protect the Indian industry.

The U.S. multinationals played a key role in facilitating the development of software production in India. Still today, over 60 percent of all software exports out of India go to the United States, with Europe and Japan playing far minor roles (see Figure 2). The practice of 'bodyshopping' allowed the U.S. multinationals to exploit wage differentials to a degree, but the more important consequence perhaps out of this practice was the development of personal and corporate ties which led to the gradual shift from 'on-site' programming to 'offshore' programming. Instead of conducting work on-site at the client's location, offshore programming allowed work to take place in India and the work was transmitted to the clients' locations digitally.

Second, the Indian software production is largely a service activity, with package software production playing a minor role. This is particularly the case with respect to software exports. Over 80 percent of software production linked to exports is in the service categories (e.g., turnkey projects and professional services) (NASSCOM, 2002). In particular, Indian software industry focuses on custom application development and maintenance. The bulk of Indian software export is in low-level programming and maintenance (Arora *et al.*, 2001). Such tasks as maintenance for applications on large mainframe computers, small applications and improvements for existing systems, migration to client-server systems, and e-commerce related services are typical among software export firms in India. Yet, software exports are highly profitable, especially in comparison to producing package software for the domestic

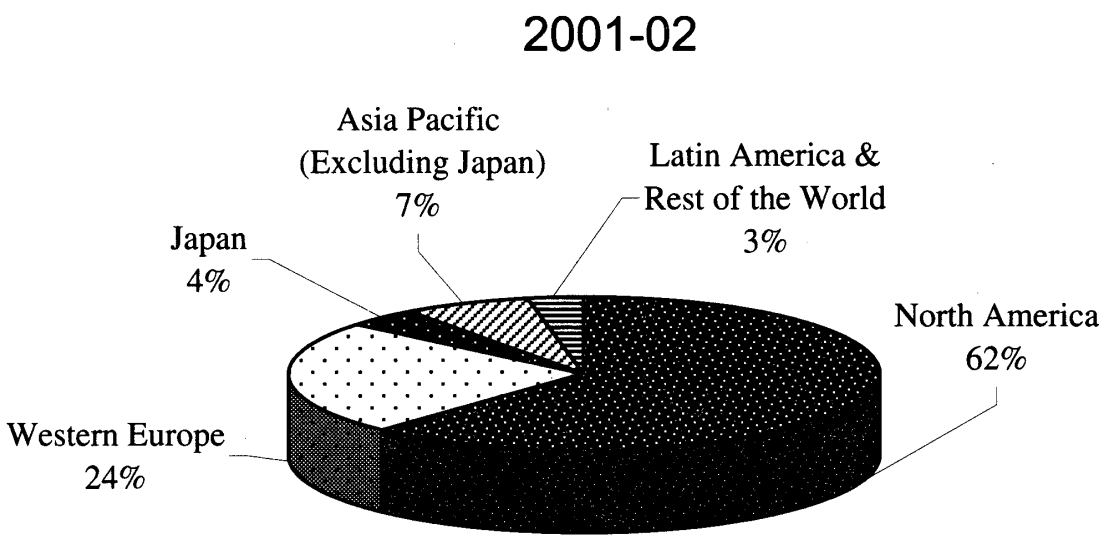

Figure 2. Regional Distribution of India's Software Exports

Source: NASSCOM, 2002.

market, which arguably squeezes out opportunities for growth in the domestic market. Also, data from NASSCOM shows that multinational firms in India are responsible for 73 percent of total exports in 2002, which suggests that software production in India is led and is dominated by global firms, effectively forming offshore enclaves catering almost exclusively to international markets. Some consider this as unfavorable, reminiscent of colonialism and post-colonialism, and the software global firms have simply replaced trading merchants and industrial investors of the previous eras, thereby maintaining the power relations that exist between India and the developed world. Others consider this as an opportunity, in the era of global competition for production sites, it is a positive sign that India has out-competed other potential locations and emerged as a premier site for software offshoring. Among Indian firms, few large firms dominate the industry, (top 25 firms account for roughly 60 percent of export in 1997-98 period). Arora *et al.* (2001) divide firms into two groups, one which initially emerged as part of existing large firms, such as Tata Consultancy, which is part of a major conglomerate, and Wipro, a large firm that specialize in edible oil, and the other start-ups, such as Infosys, which was formed in the 1980s by 5 entrepreneurs.

Third, as represented by the analogy of back-room operation, the Indian software

industry cater to a variety of sectors, which vary from retail, utilities, government, telecommunications (service as well as equipment), finance/insurance, to manufacturing. This in part reflects the nature of software industry as a horizontal industry, akin to logistics and distribution. It can be interpreted as strength in developing a specialty, yet some consider this as a weakness and the inability of the Indian industry to generate only a scattered sectoral knowledge and experience.

As Parthasarathy (2000) has shown, onsite programming was the overwhelmingly the practice of the Indian software production in 1990, comprising 90 percent of the total production. However by the mid-1990s the share declined to 61 percent and declined further to 58.2 percent by the end of the decade. In contrast, the share of offshore production rose from a mere 5 percent in 1990 to 29.5 percent by the middle of the decade, and to 33.9 percent by the end of the decade. The offshore production grew at 64% in the 2001-02 period, while growth in onsite production during the same period was at 7 percent. Despite the gradual shift from onsite to offsite production, however, perhaps the notable aspect of this trend may be the persistence of onsite work especially during the latter part of the decade. This may be an indication that onsite work is and will continue to be an important aspect of software production, with close coordination between the clients' demands and the service provided being a critical and required aspect of software production.

Typically, the shift from onsite to offsite programming occurs in staged development. Initially, a U.S. client offers a minor contract to an Indian software firm to provide onsite service to gauge capabilities. This allows the Indian firm to establish track record and develop networks through face-to-face contacts. If successful, the increase in volume and the scope of contracted work is handled partially through programming done at an offshore site. The final stage involves work done exclusively at offshore sites. This process permitted Indian software firms to gain experience and capture industry knowledge through learning.

There are a number of advantages for U.S. clients using Indian software firms as subcontractors. In addition to resolving labor shortage, outsourcing allows U.S. clients to save on in-house training, and at the same time frees up key professionals from handling more mundane tasks such as maintenance, and allows them to focus their efforts into development. This permits accelerated product development, which is

particularly important in the current context of shorter product life cycle in the software industry. Also, an offshore operation can exploit the time difference, and is particularly useful in providing maintenance work and increasing productivity on a project through round-the-clock operation. Cost is an important aspect of offshoring, yet some argue that its importance is decreasing. The cost of programmers in India is thought to be $1/14^{th}$ of that in the U.S., but $1/5^{th}$ for system analyst, and $1/3^{rd}$ for network administrator (Kattuman and Iyer, 2001). Research by Forrester, a major U.S. consulting firm with a focus on IT industries, in 2000 showed that 12% of total IT budget is directed toward services from offshore locations. It is expected that this share would grow to 28% by 2003 (Nikkei Computer, 2002). Offshoring on average reduced cost by 25%. Yet, Arora *et al.* (2001) showed from their survey that few client firms considered cost as a significant aspect of their practice of outsourcing. Instead, access to specialized skills (such as in telecommunications) and the quality of contracted work were more pronounced in their importance.

There are other forms of software emerging in India. Computer animation is one such example with an increasing popularity. The Indian computer animation industry is half-a-billion USD industry today and is growing at 30 percent per annum. About 40 percent of the industry produces for films, and production for games are still relatively minor, at 15 percent. The major destination for India's exports in computer animation is the United States, roughly comprising half of the total exports. Thus similar to other software production, India's computer animation industry also functions as subcontractor to the U.S. market (and in particular, its film industry), albeit to a slightly lesser extent. The largest Indian firm in computer animation is Pentamedia Graphics headquartered in Chennai, and the only Indian firm among the global top 10 firms in the industry. It employs 1,800 professionals, produces 2D/3D animation, with 100 million USD in annual revenue and is traded in London Stock Exchange. With an increasingly use of special effects and digital animation in the film industry, the demand is projected to grow dramatically in the near future. Accordingly, new training grounds are being set up in India to cater to this demand. One such trend is exemplified by Arena Multimedia, which launched Arena Animation Academy to train digital entertainment software programmers (IT People, 2002).

Another trend observed recently involves the effort to reduce dependence on the

U.S. market and simultaneously upgrade activities, by moving toward embedded software and IP block sellers. Embedded systems are application specific computers which have the hardware and software bundled together - DSL modems, anti-lock brakes, digital cameras, mobile phones, etc. Their tasks are specific and repetitive yet require a high-quality bug-free programming to ensure product safety. Embedded system is also an integral aspect that supports product minitualization and low-power wireless communications, which Japanese electronics firms displayed a competitive edge. The interest by Indian firms in forging alliances with embedded software vendors (Sony, Compaq, Samsung) is therefore reflected in their interest in expanding networks in the Asia-Pacific.

IV. India's Silicon Valley: the city of Bangalore

In contrast to Northern India, Southern India has generally been known for its relative political stability with higher economic growth and literacy rates, and a stable middle class. Today, Southern India is responsible for roughly half of software exports. In particular, the state of Karnataka, where the city of Bangalore is located, is known for the concentration of software industry. One in ten Indian scientist and engineers live in the state, and owing to its heterogeneous population, English is more widely spoken and the government is more business-friendly than the rest.

As the fifth largest city in India with population over 5 million, Bangalore has been known as a garden city renowned for its concentration of institutions in higher education, both in terms of quantity and quality. The city boasts 51 institutions in science and engineering, and is the location of one of India's traditional elite institution (the Indian Institute of Technology) as well as the location of the newly established Indian Institute of Information Technologies. The city has traditionally been the concentration of India's defense industry, and thus the tradition for research and development in high technologies has been an integral aspect of the city since independence. When NASDAQ decided to open an office in India in February 2001, it chose Bangalore as its location. In the city's residential areas today, one can observe signs for software start-ups. Such sights are new to India and there is a clear indication that a selected few educated software developers successfully exploited

opportunities. However, Bangalore is by no means the largest concentration of software firms in India. In terms of the volume of production (in monetary amounts) Mumbai and Delhi surpass Bangalore. Yet, what makes Bangalore significant is its specialization of its economy in software. The share of software industry in the economy is highest in Bangalore. Software is the second most important industry after finance, and 2 of the top 10 Indian software firms are headquartered in the city.

Bangalore grew to become a major center of software production in the past two decades. Bangalore is particularly known for its export orientation in the software industry (Kitagawa, 2000). The multinational firms that have a presence in Bangalore includes Siemens, SAP (Germany), Gemplus (France), Hitachi, Sony, Sanyo, Sharp, Makino (Japan), Philips (the Netherlands), Nokia (Finland), as well as Motolora, IBM, General Electric, Microsoft, Texas Instruments, Intel, Cisco and Cypress Computers (USA).

Bangalore is also the location of Number 2 and 3 software firms in India, that is Wipro and Infosys. Wipro, which was founded in 1946 and is in the business of hydrogenerated cooking fats, established a software division in 1980 and is now headed by an Indian Stanford alumnus. Today, it has 10,500 employees worldwide with three quarters of a billion USD annual sales, and is listed in New York Stock Exchange.

Infosys was set up in 1985 by 5 engineers/entrepreneurs in Mumbai, but was subsequently moved to Bangalore because CEO happened to be from the city. The firm has 10,000 employees with half a billion USD annual sales, and is listed in NASDAQ (USA). These firms are surrounded by a plethora of small software firms in Bangalore. Parthasarathy (2000) documented the dramatically different realities and challenges these firms face vis-à-vis their much larger and well known counterparts. Since software production is founded upon two elements, skills and wages, smaller firms face the challenges of local wage escalation, competition for employees (both locally as well as globally), balanced by the need for training and investment on human resources to ensure product quality. Some of these firms seem to be in a no-win-situation, as their competition is structurally and systematically cut by wage escalation, high employee turn-over, the need for investment in training and higher salaries offered by larger firms.

Bangalore is geared toward developing a more sophisticated software programm-

ing industry with a higher value-added that can wage through globalization and competition from other offshore locations. Bangalore boasts a 1,000-plus base of technology companies with more than 100 involved in semiconductor design and developing embedded software. Both embedded software and IP block development require some knowledge of hardware. The knowledge of hardware is derived from Bangalore's defense sector and research institutes, which amassed a considerable amount of technological knowledge albeit never linked to successful commercialization through mass production with exportable strengths.

The preliminary field research conducted in November 2002 confirmed these attempts to upgrade technologically. There is a precipitating sign for an emerging industrial district, comprised of local entrepreneurs. There are two primary backgrounds for local entrepreneurs, one group have previously worked with U.S. multinational corporations in information technologies, and the other have work experience in government-sponsored laboratories or large domestic manufacturing firms. The former focuses on software, and emerged out of multinational firms with knowledge of global markets and trends, experience in international contacts, and familiarity in global standards. The latter group specializes in hardware technologies, which India has been known to lack. Both groups are now joining hands to form alliances and information exchange, in order to begin competing against firms in Taiwan, South Korea and Singapore through developing hardware/software integrated systems. The Japanese multinational corporations with presence in Bangalore have yet to exploit these emerging local expertise and integrate them fully into their operations. One Japanese firm produces printer drivers for their U.S. subsidiary, and the other, while attempting to develop embedded systems in India, admitted that they still faced a number of challenges, such as training costs and labor mobility.

V. Regional competition for software production: India vs. China

As the discussions so far have shown, the Indian software industry is firmly and squarely founded upon the globalization forces, in terms of access to jobs, access to markets, access to contacts (both corporate and personal), and access to knowledge/training. In particular, what may be characterized as the hyper-mobility of

labor at the global scale, has played an important part in the development of this industry in India. This is in stark contrast to the development trajectory of software industry in Japan, which has retained its competitive strengths almost exclusively through isolation.

The challenges for Indian software industry arise from other offshore development sites, which include such locations as Czech Republic, Spain, Russia, Taiwan and China. In particular, China has been perceived as a major threat for their comparable economic standing. Both China and India are large economy with yet to be exploited markets. They function to undercut competition from much higher priced Southeast Asian countries. In comparison to software developed in China, Indian software is generally of better quality, yet higher priced. While China is projected to overtake Japan in PC market and already has 165 million cellular telephone users, its software industry is far behind that of India, exporting only one-tenth of that of India today. The Financial Times reported that China has 6,000 software and application development firms, but most have less than 50 employees (Financial Times, August 7, 2002). India has 32 of 58 global software firms which reached the Capability Maturity Model (CMM) Level 5 certification stage (allows to bid for many projects in the West), while China has only one.

Evidence from the 1990s showed that despite media attention on the emergence of China and the Philippines as potential competitors to India's software industry, the bulk of competition actually came from within, i.e., either US or Indian firms. A closer look at general economic and infrastructural indicators, however, shows that China surpasses India in many respects, and can potentially and quickly become a serious competitor.

Thus preliminary evidence shows that the ways in which these two locations are being used as production sites by Japanese and multinationals are very different: US dominates India, while Japan dominates China. Language and cultural explanations may work to a certain extent, but would certainly be insufficient. While directly comparative data are scarce, it is clear that Japanese multinationals play a more significant role in software investment in China, and there is clear evidence that they favor China over India for a variety of reasons. While India sends only 4 percent of its software exports to Japan, the share for China is expected to be far more significant for

Table 1. Comparative Economic and Infrastructural Indicators for China and India, 2000-2001

	CHINA	INDIA
GDP Per Capita	$1,080	$500
Total GDP	$1,120 billion	$500 billion
Growth Rate	7%	5%
FDI in 2001	$46.8 billion	$2.3 billion
Foreign Exchange Reserves	$165 billion	$50 billion
Inflation	0.40%	4%
Exports	$249 billion	$43 billion
Savings Rate	40%	25%
Foreign Tax Rates in Seizes	15%	45%
Power Available	277 Gigawatts	100 Gigawatts
Average Factory Wages	$87.50/month	$31.25/month
Telephone lines per 1,000 population (2000)	111.17	32.04
Cellular telephone subscribers per 1,000 population (2000)	65.82	3.53
IT as % of GDP (2000)	1.49%	0.92%
PCs per 1,000 population (2000)	15.90	4.54
IT hardware production (2000)	$23.075 million	$781.38 million
IT hardware exports (2000)	$10.169 million	$116.01 million
Internet hosts per 1,000 population (2000)	0.05	0.04
Internet users per 1,000 population (2000)	17.32	4.94

Source: Tang and Ouyang, Center for Research on Information Technology and Organizations, University of California, Irvine.

Japan. The data available from Toyo Keizai (2002) showed that there are 2,674 establishments with at least 10 percent equity owned by Japanese interests in China (244 in Beijing alone), while there are only 176 establishments of such kind listed for India. The largest majority of Japanese establishments in India was in transportation equipment, and only five claimed to engage in software development. Shimada (2001) reported that Japanese software establishments in India can be classified into three groups based on the geographic origin of investment. While the majority of investment is conducted directly from Japan (e.g., Sanyo), but some are investment from

subsidiaries of Japanese firms in the U.S. (e.g., Sharp), and some are investment from the subsidiaries of Japanese firms in Singapore (e.g., Sony)[1].

The relationships between Indian software firms and Japanese multinationals have been sparse at best. They are only 29 Indian firms present in Japan. With the miniscule number of Indians educated in Japan and the NRIs (nonresident Indians), that further minimizes opportunities for business interactions and development. Estimated there are half a million NRIs in the US and three quarters of a million NRIs in United Kingdom. In contrast, Japanese firms have set up 88 development centers in China, with 7,600 employees. Half of these centers are either in Beijing or Shanghai. Out of these development centers 48 are in software. China boasts many Japanese multinationals: Hitachi conducts software development in Shanghai along with Toshiba and Otsuka Shokai. Yamanashi software (YSK) set up development lab in Beijing in cooperation with China Agricultural University (Beijing). NEC set up software development center in Dalian (July 2001). Also On-the-Edge, the net venture set up a software center in Dalian. Fujitsu as set up a software facility in September 2001 in Xian, and Omron has a facility in Shanghai. Joint ventures are also a popular strategy in China: Toshiba and Alpine has a joint venture with China's large software development firm, Nuesoft. NTT Data, NEC, and Hitachi Software have allianced with China's large software development firm, DHC Dalian. US firms are also active in China: IBM, Mocrosoft, Sun, Motorola and Intel set up software development centers in Shanghai and Beijing in the latter half of the 1990s.

Thus, preexisting personalized global contacts observed between India and other nations do not play a significant role for Indo-Japanese economic relations. Japanese firms show more interests in China for its geographic proximity, cultural proximity (historical ties, language ties, and a large number of Chinese students in Japan's higher education) and the more immediate potential that the Chinese market seems to offer. In fact, while China's domestic software market is also dominated by multinationals, their efforts and objectives are typically geared toward both Chinese and other markets, unlike the case in India today in which multinationals have little interest in generating local demand. Some firms, such as Oki Electric, have relocated its software production recently from India to China.

The recent efforts by India to upgrade their software services to more

sophisticated programming, including embedded systems, also increases threats from China. Unlike India, China's strength is in the presence of electronics hardware production. With the already strong presence in hardware, localized learning potential for local firms is considered significantly higher in China.

VI. Conclusion and future research agenda

The preceding sections showed that Indian software industry has emerged as a major player. Their growth altered the ways in which we consider globalization. This poses questions as to a potential avenue that developing countries may explore as a model of development. As the 'developmental-state' model loses its support as a viable avenue of economic growth, neo-liberalism has taken over as a new means of accelerated growth, as evidenced in the case of China and India. Whether such shift is fundamentally different from the courses observed for industrial capitalism is still an open question. Also, to what extent would these avenues work in the short- and the long-run is another question to be answered.

The growth of Indian software industry prompted a yet another layer of complications in the globalization process. To respond to heightened competition, India's software firms themselves are globalizing their operations beyond the United States (Tawarada, 2002). For example, Wipro Bangalore recently set up a development center in Tokyo to cultivate Japanese clients. Tata set up an operation in China, with Shanghai being the HQ and an office in Beijing.

Finally, there is an issue of methodology. As the industry and products we seek to follow are increasingly digitized, it adds to the challenge for researchers as they are much more difficult to track than non-digital commodities. The problem is multiplied when digital products are transferred globally. We need to generate datasets that adequately respond to these questions.

Note

1) While direct investment from Japan to India in software may still be limited, evidence exists on the rise of software outsourcing to Indian firms. Hitachi, Toshiba, NEC and Fujitsu reportedly order

outsourcing from Indian firms. Also, Indian firms are setting up offshore facilities for Japanese firms.

References

Aoyama, Y. (1999): Locational Dynamics of Japanese Electronics Industry in Europe. Nicholas Phelps and Jeremy Alden eds.: *FDI and the Global Economy: Corporate and Institutional Dynamics of Global-Localization.* Stationery Office, London, pp.103-119.

Aoyama, Y. (2000): Keiretsu, Networks and Locations of Japanese Electronics Industry in Asia. *Environment and Planning A,* Vol.32 no.2, pp.223-244.

Arora, A., Arunachalam, V. S., Asundi, J., and Fernandes, R. (2001): The Indian Software Services Industry. *Research Policy,* Vol.30 no.8, pp.1267-1287.

Dunning, J. H. (1977): Trade, location of economic activity and the MNE: a search for an eclectic approach. Ohlin, B., Hesselborn, P.O., and Wijkman, P.M.K. eds.: *The International Allocation of Economic Activity.* Macmillan, London, pp.395-418.

Financial Times (2002): High hopes for second shindig in Shanghai. *Financial Times* August 7, 2002.

Friedman, T. L. (2002): Nukes are unthinkable if business is good. *San Jose Mercury News* August 19th [Online] Available: (http://www.siliconvalley.com/mld/siliconvalley/business/ columnists/3898598.htm)

Frobel, F., Heinrichs, J., and Kreye, O., (1980): *The New International Division of Labor: Structural unemployment in industrialized countries and industrialization in developing countries.* Cambridge University Press, Cambridge.

Hymer, S. (1960): The international operations of international firms: A study of direct foreign investment. Unpublished Ph.D. Dissertation. Massachusetts Institute of Technology.

IT People (2002): Arena Multimedia sets up Arena animation academy. *IT People* http:www.expressitpeople.com/20020506/careers4.shtml

Kattuman, P. and Iyer K. (2001): Kosuto appu ga kenen zairyo: indo no sofutouea sabisu sangyo. *Ajiken World Trend,* no.72 (September): pp.14-17.

Kitagawa, H. (2000): The Development of Indian Software Industry. *Annual Report of Research Center for Regional Geography,* no.9, pp.47-62.

Krugman, P. (1992): *Geography and Trade.* MIT Press, Cambridge.

Mason, M., and Encarnation, D. eds. (1996): *Does Nationality Matter?: Japanese Multinationals in Europe.* Clarendon Press, London.

NASSCOM (2002): The IT Industry. Facts and Figures, Resource Centre. http://www.nasscom.org/resourcecentre.asp

Nikkei Computer (2002): Sekai o makikomu beikoku no sofuto kaihatsu. *Nikkei Computer* (March 25), pp.38-40.

Parthasarathy, B. (2000): Globalization and Agglomeration in Newly Industrializing Countries: The State and the Information Technology Industry in Bangalore, India. Unpublished Ph.D. Dissertation, Dept of City and Regional Planning, University of California at Berkeley.

Saxenian, A. and Edulbehram, J. (1998): Immigrant Entrepreneurs in Silicon Valley. *Berkeley Planning Journal,* Vol.12, pp.32-49.

Saxenian, A. (1999): *Silicon Valley's New Immigrant Entrepreneurs.* Public Policy Institute of California, San Francisco, Calif.

Shimada, T. (2001): Indo IT gyokai no genjo to tembo. *Chapter 5 in the final report for the Study Group for South Asia Economic Issues.* Institute of International Monetary Affairs, Tokyo, pp.54-85.

Tawarada, M. (2002): Kokusai sukopu Indo yushitsu saki no takakuka o hakaru sofutouea sangyo. *JETRO SENSOR* 52, 616 (March), pp.92-93.

Toyo Keizai (2002): *Kaigai shinshutsu kigyo yoran.* Toyo Keizai, Tokyo.

Vernon, R. (1966): International investment and international trade in the product cycle. *Quarterly Journal of Economics,* Vol.80, pp.190-207.

Vernon, R. (1979): The product cycle hypothesis in a new international environment. *Oxford Bulletin of Economics and Statistics,* Vol.41 no.4, pp.255-267.