ELSEVIER
www.elsevier.com/locate/worlddev

World Development Vol. 39, No. 7, pp. 1249–1260, 2011

0305-750X/$ - see front matter

doi:10.1016/j.worlddev.2011.03.003

Patterns of Innovation Practices of Multinational-affiliates in Emerging Economies: Evidences from Brazil and India

ELIANE FRANCO
University of New South Wales, Sydney, Australia

SANGEETA RAY
University of Sydney, Australia

and

PRADEEP KANTA RAY [*]
University of New South Wales, Sydney, Australia

Summary. — Little is known about how MNE-affiliates are using their linkage capabilities to source or combine technological inputs in emerging economies. This paper attempts to address this critical gap in the literature by comparing and contrasting innovation practices (IPs) employed by MNE-affiliates in two large emerging economies, India and Brazil. Using a sample of over 1200 MNE-affiliates, factor analysis and segmentation techniques identified different combinations of technology inputs for innovation and the factors that influence the knowledge linkages between MNE-affiliates and national innovation systems. Our findings demonstrate the critical role played by host nations' industrial policy in shaping IPs of MNE-affiliates.

Key words — multinational affiliates, innovation practices, industrial policy, emerging economies, Brazil, India

1. INTRODUCTION

Multinational Enterprises (MNEs)—the main engines of innovation in the world economy—have traditionally concentrated their technological activities in their home countries, located in the 'triad'—United States, Europe, and Japan (Kumar, 2001; Papanastassiou & Pearce, 1999; Patel & Pavitt, 1998). In these locations, MNEs have extensively used their linkage capabilities to combine a variety of internally created technology inputs with external immobile or less fluid sources of technology for innovation. Among the spectrum of activities associated with innovation, in-house research & development (R&D), acquisition of patents, trademarks, know-how, technical assistance, as well as the adoption of capital equipment are commonly identified to be critical technology inputs (Kumar & Joseph, 2007; Lall, 2004).

Prior to the mid-1970s, some of the reasons stated by MNEs for not internationalizing R&D beyond the triad were the difficulties involved with the supervision and control (Mansfield, 1974) and the higher appropriability of technological learning efforts at home (Granstrand, Hakanson, & Sjolander, 1993; Kurokawa, Iwata, & Roberts, 2007). However, rapid technological change and growing technological inter-relatedness between the triad nations and emerging economies have led MNEs to consider a more decentralized knowledge seeking pattern (Cantwell & Piscitello, 2001; Dunning & Narula, 2000). In fact, the ability to tap into pools of scientific skills and low cost research infrastructures are key elements behind globalization of knowledge-based activities (Dunning, 1998:128). By dividing finely their global value creating activities into optimum locations (Buckley & Ghauri, 2004)—elsewhere called "the slicing and dicing of the global value chain" (Ramamurti, 2001)—MNEs are integrating their ownership-specific with location-specific advantages to create innovation capabilities. High cost factors, shortage of R&D personnel in developed countries and the increasing demand for talents are contributing to this trend. [1] On the other hand, the availability of large cadres of research personnel at substantially lower wages and adequate infrastructure in emerging economies, particularly in the BRIC (Brazil, Russia, India, and China) countries have increasingly attracted knowledge based FDI. [2] Rapid advances in new Information and Communication Technologies (ICT) have significantly contributed to extend the scope for global technology sourcing (Brenner, 2007) even from developing countries, thereby creating new opportunities for these countries to insert themselves into the global innovation system (UNCTAD, 2005).

However, not much is known about how MNE-affiliates are using their linkage capabilities to source or combine technological inputs in emerging economies (Lall, 1992). The aim of this study is to identify such *innovation practices* (IPs) of MNE-affiliates: activities employed to combine technological inputs, internally created, or externally acquired from local or foreign sources, so as to exploit location specific opportunities for innovation. Contemporary typologies of innovation practices (IPs) that illustrate interactions between firm and location-specific assets in MNE-affiliates in emerging economies have yet to make an appearance in the empirical

* We dedicate this paper to the memory of Sanjaya Lall. We thank the two anonymous reviewers for their valuable comments which helped us to improve the quality of this paper. The authors also thank SEADE Foundation, the São Paulo State Statistics Agency, for providing access to the Brazilian database and helping with data processing. Final revision accepted: May 20, 2010.

literature, barring a handful of studies (Franco & Quadros, 2003). Little research has been devoted to systematically understanding and theoretically framing the ways in which heterogeneous knowledge elements are combined inside MNEs (Foss & Pedersen, 2003). Thus far, most of the extant literature has focused on MNEs in China and their role in transferring knowledge from their parent network to their Chinese affiliates (Fu & Gong, 2008). Little information exists about what actual inflows of technology has been taking place into MNE-affiliates in other BRIC countries such as Brazil and India.

This is surprising, given that both Brazil and India have large markets and have attracted significant amount of Foreign Direct Investment (FDI) especially in their post-liberalization periods. Both countries have pursued an Import Substituting Industrialization (ISI) strategy prior to liberalization. Despite these similarities, there are many differences in their institutional contexts, FDI policies and national innovation systems. These differences spawn distinctive technological capabilities and industrial specializations in the two countries, which then determine their unique location-specific advantages. Such host country factors have significant impact on the MNE's ability to "internalize externalities" (Dunning, 1993) from the local environment and hence are likely to influence their IPs.

This critical gap in the literature motivates us to ask some germane questions: what patterns of IPs in MNE-affiliates are emerging in Brazil and India, and, more specifically how MNE-affiliates are combining technology inputs giving rise to these observed patterns? Thus our core research objectives are to compare and contrast IPs of MNE affiliates in Brazil and India by (a) identifying the different combinations of technology inputs and the sources from which these are acquired by MNE-affiliates in Brazil and India and (b) identifying which factors influence the technology combinations and the knowledge linkages between MNE-affiliates and national innovation systems. Examining which location-specific assets are being endogenized with firm specific assets is important as this would have implications for policymakers in the two countries insofar as how they might calibrate incentive mechanisms to catalyze MNE knowledge spillovers into the national production systems for higher value added activities (Lall, 2002).

Above all, it provides new insights distinct from those obtained in developed countries, where most studies on innovation activities have been conducted thus far—uncovering as yet unrealized phenomena. We believe our paper is a novel contribution in this sense and what is more, the richness of data we present makes the analysis particularly useful.

2. THEORETICAL BACKGROUND AND EMPIRICAL EVIDENCE

According to Dunning's OLI eclectic paradigm, MNEs performing value adding activities in host countries internalize location-specific spillovers from firms and other institutions to create new ownership-specific advantages (Dunning, 1998). Host country national innovation systems (NIS) give MNE-affiliates access to a wider range of solutions to technological problems to enhance their innovative capability (Bartholomew, 1997). MNEs can tap into local fields of expertise, and acquire new sources of technology that can be integrated into their global operations (Dunning & Narula, 1995; Le Bas & Sierra, 2002; Rugman & Verbeke, 2001). Close geographic proximity and good connectivity with technology suppliers are required for successful spillovers to take place (Carlsson, 2006). This is primarily due to the nature of knowledge which is drawn upon during R&D: often tacit and idiosyncratic, and difficult to transfer without interpersonal interaction (Sole & Edmondson, 2002; Szulanski, 1996; Bell, 1985).

(a) *Country factors guiding IPs of MNE-affiliates*

Countries evolve differently in their trajectories of development and in their institutional framework and policy stance. Such differences are likely to shape dissimilar patterns of IPs of MNE-affiliates. Each country has "different natural factor endowments, path dependent effects of industrial organization and specialization, different national stocks of knowledge, and different national economic and political institutions" (Niosi & Bellon, 1996, p. 156). Elsewhere Pavitt (1998) argues the national science base which forms the foundation for the country's technological capabilities is socially constructed: it is influenced by the country's level of economic development and the composition of its economic and social activities. Therefore, knowledge spillovers are mostly local, not international. Moreover the type of knowledge spillovers is related to the institutional factors. Since local technology inputs can vary substantially between country to country due to institutional differences, this can result in differences in the nature of IPs of MNE-affiliates in and their linkages with different host environments.

An equally important factor is industrial policy of host-countries, which not only shapes technological capabilities, but also influences the connections of their local production and innovation systems with the global value chain activities of MNE-affiliates (see Pietrobelli & Stewart, 2008). Firm level capability building efforts are affected by external factors such as industrial and trade policy orientation—whose incentive structure acts as a stimulus for capability building (Bell, 1985; Figueiredo, 2008; Lall, 1995). Greater openness and competitive pressures give higher incentives to accumulate learning and technological capabilities and conversely (Bell & Pavitt, 1993).

Lall (2004) distinguished four broad stances in industrial strategies calibrated with trade and FDI policy that shape national technological capabilities. The first is autonomous strategy based on building technological capabilities indigenously while restricting FDI, but not technology imports, as in Korea and Taiwan. The second is 'strategic FDI dependent' strategy, which relies heavily on FDI but uses industrial policy extensively to induce it to deepen into advanced activities and linkages, as in Singapore. The third is 'passive FDI dependent' strategy—also driven by FDI but relying largely on market forces, not industrial policy, to deepen technological structure, as in Hong Kong. The fourth is 'Import Substituting Industrialization (ISI) restructuring' strategy that focus on established import substituting industries where competitive capabilities are harnessed to promote export growth, as in China, India, and Brazil (ibid. p. 36). In the latter mode MNE-affiliates in particular are guided by previous restrictions imposed during the ISI phase, like local content policy (content protection), taxes on technology remittances, and phased indigenization programs, trade and tariff restrictions which had compelled them to substitute imports with local content.

The industrial policies and national innovation systems that shape national technological capabilities and how these might influence the opportunities for local linkages of MNE affiliates in Brazil and India are discussed next.

(i) *Industrial policy in Brazil and India: from ISI to economic liberalization*

From the 1960s to early 1980s Brazil and India both pursued ISI strategy during which time, their governments made intense use of classical protectionist instruments, such as high tariffs and import licensing requirements to protect their domestic manufacturing sector (Nassif, 2007). Interestingly, during ISI period even while imports were restricted to leverage local technological capabilities, a large number of MNE-affiliates established their presence in Brazil, in response to the government's orchestration of the harmonious tripod strategy (local-state-foreign owned capital firms) (Figueiredo, 2008; Neto, 1991). Unlike Brazil, during the ISI period in India, high restrictions and tariffs on technology imports were accompanied by an anti FDI bias that took the form of bans on foreign brands, import bans on raw materials, semi-finished and finished goods, and requirement for local content and employment. India's inward protectionist ISI policy resulted in virtually little reliance on foreign investment with low levels of technology imports (Lall, 1992; Ray, 2005). Hence indigenization through local content policy and high tariffs rendered the character of its industries to be locally oriented.

During the ISI period, both Brazil and India promoted several large public research organizations as well as set up a large network of science and technology (S&T) institutions (Lall, 1992). In Brazil, ISI supported the development of local capabilities in industries, such as minicomputers, aircraft, special steels, chemicals and pharmaceuticals, armaments and so forth (Lall, 1992). India targeted specific key industries through different periods that included steel, aluminum, chemicals and pharmaceuticals, fertilizers, capital goods, heavy engineering, electrical equipment, machine tools, and information technology (Kumar & Joseph, 2007). In particular, the Indian government encouraged process innovation in the pharmaceuticals industry for lowering costs of drugs through the enactment of Indian Patents Act, 1970—and provided licenses to multiple local firms to establish the industry. Also capital equipment to support the pharmaceuticals sector was given strong support. This strengthened and engendered export capabilities in the pharmaceuticals sector. In contrast, licensing restrictions in the motor vehicles sector limited the international competitiveness of this industry—which meant it could only cater to local markets.

From the mid 1980s, both countries shifted their industrial strategy to ISI restructuring. This shift occurred in parallel with the rise of the global phenomenon of the digital age which saw many manufacturing processes and goods incorporating semi-conductors and software. In Brazil, the ISI policy was revised in 1988 with the introduction of the "new industrial policy" (NIP). With the NIP, the Brazilian government recognized the necessity to establish mechanisms of cooperation with private agents to develop four industries: (i) capital goods; (ii) semiconductors; (iii) software; and (iv) pharmaceutical products. Economic liberalization in the early 1990s saw average tariffs being brought down from 116% in 1987 to 14% in 1997 (Baer, 1994; Figueiredo, 2008; Moreira & Correa, 1998). By 1996, rapid liberalization measures in Brazil resulted in some sectors to become chiefly dominated by import penetration (imports/domestic demand), such as industrial machinery (48.3%), electronics and communications (41%), motor cycles (31.5%), chemicals and compounds (27.4%)—paving the way for extensive import competition (Moreira & Correa, 1998). By 1997, with the influx of MNCs, FDI was 5.97% of gross domestic investment (GDI). Intensive competitive rivalry hastened technological capability building among firms while at the same time made the scope of Brazilian industries to be more global. By 1990s, several local firms also restructured and reinvented their business models to build technological capabilities and stand up to foreign competition. Meanwhile, many MNC subsidiaries in Brazil in electronics and motor cycles industries began to be driven by their global strategies and came to be more recognized and integrated within their global network. Reverse knowledge flows to parent and sister companies from the early 1990s are reflected in the case of Philips and Sony which found new process innovations—later adopted by other sister subsidiaries of Philips and Sony world-wide (Figueiredo, 2008). With liberalization, many MNCs like Honda that pursued a vertically integrated strategy earlier began to develop a local chain of suppliers as well as engage in an internationally integrated network of innovation (Figueiredo, 2007). Once again, because of the salience of MNCs in Brazil, national technological capabilities were at par with the global system enabling a window of opportunity for MNCs to strike linkages with local firms and provide beneficial spillovers to local skill creation (see Lall, 2004).

In the case of India there was a move toward partial liberalization in 1985 and by the 1990s, this was transformed into full scale liberalization. By 2003–04 average tariffs fell to 20% from 110% in 1992–93. However unlike the Brazilian case, tariff cuts and import penetration was much lower (Table 1). In 2002, tariffs in the manufacturing sector were at least three times higher than in Brazil. Import penetration (as percent of sales) in 1992 for industrial machinery (11.5%), electronics and communications (31.1%), chemicals (25.25%) was lower than that of Brazil for similar industry categories. In fact, barring five industry categories, import penetration in the rest of the 91 industry categories was lower than 28% compared to Brazil (Sathe, 1997). Sales of foreign firms in total sales in 36 out of 55 product sectors including steel, textiles, cement, chemicals, fertilizers, paper, textiles *etc* was <3%. This meant that local companies in India held sway in most sectors except in consumer goods where foreign penetration was as high as 67% of total sales in 1997 (Ganesh, 1997). As compared to Brazil, FDI inflows were a lot lower as well (Table 2). In 1997 FDI was only 2.46% of GDI and much of it was essentially found to be domestic market seeking, accounting for less than 10% of India's manufacturing exports (UNCTAD, World Investment Report 2003). By 2003 the share of FDI stock in GDP in India was 5.4% against 25.8% in Brazil (Nassif, 2007).

In the post liberalization phase, India's already established capabilities in pharmaceuticals and IT sectors was responsible for generating innovations, attracting FDI and earning high export revenues resulting in high economic growth (Nassif, 2007). The IT industry in particular has been responsible for providing services to MNE-affiliates including those in the manufacturing sector.

Table 1. *Import tariffs in Brazil and India after economic reforms*

(Simple average(percent))	Brazil 2004	India 2002
Applied tariffs	10.4	32.3
Agriculture	10.4	41.7
Manufacturing	10.4	30.8
Textile and Apparel	17.2	31.3
Duty free tariff lines*	10.4	1.1

Source: Adapted from Nassif (2007).
* Percent of all lines.

Table 2. *Brazil and India: Flows and Stocks of FDI*

	1970	1980	1990	2000	2003
BRAZIL					
FDI flow/GFCF	4.9	3.5	1	28.2	11.4
FDI stock/GDP	n.a	7.4	8	17.2	25.8
INDIA					
FDI flow/GFCF	0.5	0.2	0.3	2.3	4
FDI stock/GDP	n.a	0.2	0.5	3.8	5.4

Source: Nassif (2007): UNCTAD.

Table 3. *Research intensities across Brazil and India 1996–2002 (GERD/GDP ratio) & structure of R&D spending*

Year	Brazil	India
1996	0.77	0.55
1997		0.7
1998		0.74
1999	0.87	0.78
2000	1.04	0.85
2001		0.82
	Brazil*	India**
Business	45.50%	23%
Government	11.00%	74.70%
Higher education	43.50%	2.40%

* 2002.
** 2000.

Table 4. *Patents granted to Brazil and India in the US (1996–99)*

	Brazil	India
1997	62	47
1998	74	85
1999	91	112
2000	98	131
2001	110	178
2002	96	249
2003	130	342
2004	106	363
2005	77	384
2006	121	481
2007	90	546
Compound rate of growth (1994–2007)	3.17	26.02

National level R&D spending in the two countries is also a good indicator of technological capabilities within the national innovation system. R&D effectiveness is higher when it is linked to productive activities such as manufacturing. R&D effectiveness is, therefore, higher when performed and financed by the private sector. In Brazil research intensity (measured in terms of GERD) in 2000 was 1.04% of GDP (World Bank, 2005). In terms of R&D composition, private enterprises (45.5%) and higher education (43.1%) comprise the bulk of R&D expenses in Brazil, with government spending 11%. Technological innovation activities between 1998 and 2000 concentrated mostly on purchase of machines and equipment (52.22%) and Research and Development (16.75%) (Mani, 2008).

When compared with Brazil, we note two key R&D related differences in the case of India (Table 3): India's research intensity was lower at 0.85% of GDP in 2000 (World Bank, 2005). Moreover another important difference was that most of India's R&D spending was undertaken by the government (74.7%) rather than by private enterprises which spent only 23.0% (Mani, 2008). Although over the period between 1997 and 2007 India's research intensity was lower than that of Brazil, the total patent count filed in the US by Indian enterprises was higher, with Indian Government Research Institutes (GRIs) being primarily the patent holders (Table 4).

3. PREDICTIONS ON INNOVATION PRACTICES (IPS) OF MNES AFFILIATES IN BRAZIL AND INDIA

Today many of the technological inputs used by MNEs for innovation stem from local institutions and national innovation systems of emerging economies. Differences in national innovation systems will give rise to different technological resources which can be drawn on and combined with firm-specific and global sources of knowledge by MNE-affiliates for innovation. Given the idiosyncrasies in the institutional contexts of Brazil and India discussed in the foregoing section, we predict there will be differences in IPs of MNE-affiliates across the two countries.

First, due to the greater openness of the Brazilian institutions to FDI relative to the Indian institutions, as reflected in the much larger and longer presence of MNE affiliates in the former, greater opportunities exist for interaction with the MNE parent network and local institutions in Brazil. With a longer period of interaction with the global innovation systems, national technological capabilities and technology inputs such as capital goods from local suppliers in Brazil are more likely to be at par with international quality, specifications and technical standards—typically used by MNEs. Thus, it is likely there will be greater overlap between the knowledge bases of local firms and MNE-affiliates in Brazil relative to those in India—enabling the pooling of similar types of technology inputs such as patents, or capital equipment from local suppliers and its global-networks. In contrast to the Brazilian case, when host country environments are less open to FDI such as in India, technology inputs from local firms may not meet the quality and specifications corresponding to international standards. In such an environment, MNE-affiliates may not be able to combine similar types of technology inputs from local sources with those from its global network. Thus we predict MNE affiliates in Brazil are more likely to pool similar types of technology inputs from foreign and local sources as part of their IPs vis-à-vis India.

Second, since industrial policies in the two countries targeted certain industries as priorities, national technological capabilities in those industries are likely to be more advanced and specialized as compared to industries that were not targeted. Thus we predict MNE-affiliates will differ in their ability to access technology inputs depending on the industry sector to which they belong which suggests that the industrial sector is an important factor in influencing their IPs.

Third, lower tariffs in Brazil as compared to India may provide greater impetus to the MNE-affiliates in the former to import technological inputs from foreign sources. In contrast, higher tariffs in India may compel MNE-affiliates to use local technology inputs more intensively. However, this will only be possible for those industrial sectors targeted for development—where the locally available technology inputs meet the MNE-affiliate's requirements.

Fourth, the age of MNE-affiliates is a good predictor of acquaintance with local contexts: the longer the time since establishment, the greater will be a subsidiary's propensity to get involved in knowledge intensive relationships (Saliola & Zanfei, 2009). Moreover, it seems plausible that the number of years in operation give them a greater opportunity to build absorptive capacity through R&D to effectively tap into local sources of technology and assimilate these into their production processes. Hence we predict greater the age of the MNE-affiliate greater is the likelihood to perform R&D and integrate new technologies from local suppliers into their knowledge base.

Therefore, since MNEs are not 'a monolithic block', their IPs will differ significantly (a) across countries, depending on the nature and extent of differences in the institutional environment they face in each country and (b) within a country due to different learning paths for knowledge accumulation and technological capabilities across industrial segments (Bell & Pavitt, 1993; Bell & Pavitt, 1995).

4. THE SAMPLE OF MNE-AFFILIATES IN BRAZIL AND INDIA

In this study we focused on data pertaining to 2001 in Brazil and India to allow at least a ten year transitional period for the institutional context in the two economies to have adapted to and stabilized in the full scale liberalization that was introduced in 1991. For analyzing IPs of MNE's affiliates in Brazil and India, this study takes advantage of two databases: PAEP (*Pesquisa da Atividade Econômica Paulista*) and PROWESS. PAEP is produced by Foundation SEADE (*Sistema Estadual de Análise de Dados*),[3] while PROWESS is produced by the Centre for Monitoring the Indian Economy (CMIE), India. As per IMF norms, firms with foreign ownership of more that 10% are labeled as MNE-affiliates.

The Brazilian economic survey was conducted among 11,000 industrial firms in the State of São Paulo for data pertaining to 2001. The sample of firms used in this study was categorized as MNE-affiliates in the Brazilian PAEP database. For the purpose of our analysis, the sub-sample of MNE-affiliates which responded to the economic survey comprises 689 firms (out of a total population of 1,100), located in the state of São Paulo. This state is extremely representative in terms of FDI participation, accounting for 70% of all MNEs affiliates in Brazil. Furthermore, it is the most important economic and technological region of the country, concentrating on approximately 50% of the Brazilian industrial value-added and employment, and 70% of industrial R&D.

The Indian dataset was constructed from the Prowess version 2.5 database, which contains cross-sectional information at the level of firms, both domestic and foreign affiliates, and classified by industry, age, equity holding information, and the like. The database consists of 10,029 companies in all industries; from this population, a sub-sample of 545 MNE-affiliates which had 10% or more foreign ownership (as per IMF norms) was selected. The industries to which these MNEs belonged, were all manufacturing based, so as to ensure country comparison was taking place on equal lines.

Notwithstanding the fact that the population of MNE's affiliates in Brazil and India comprise less than 10% of total manufacturing firms, their significant economic participation can be seen in the largest sectors of Brazilian and Indian industry, such as motor vehicles, chemicals and pharmaceutical, and food products and beverages (Table 5).

5. METHODOLOGY

(a) *Techniques for analysis*

In order to test the propositions mentioned above, we used a combination of descriptive statistics methods, that is, Factor Analysis (FA) and the Answer Tree Technique (ATT). FA is a correlation technique, which provides the best combinations between a set of variables; the model also reduces the variables into a small number of most representative factors. The

Table 5. *Sample of MNE's affiliates in Brazil and India 2001*

Manufacturing activities	Brazil		India	
	No. of firms	% sales	No. of firms	% sales
Mineral and oil extraction	2	0	12	0
Food products and beverage	52	12	42	8
Textiles	17	1	40	2
Clothing	2	0	6	0
Leather products and footwear	4	0	3	1
Pulp and paper	13	3	11	1
Publishing, printing and recorded media	19	1	2	0
Oil refining and alcohol	3	0	4	7
Chemicals and pharmaceuticals	125	17	123	25
Rubber and plastic products	58	4	39	4
Non-metallic mineral products	14	1	24	2
Basic metals	19	3	48	12
Metals products	45	3	11	1
Mechanical machinery	133	10	59	6
Computers and office machines	5	0	6	0
Electrical machinery	48	5	22	5
Electronics material and telecom	21	8	27	3
Instruments and automations equipment	15	1	6	0
Motor vehicles	63	29	42	13
Other transport (aircraft and rail equipment)	7	0	7	3
Others (tobacco/furniture/wood products *etc.*)	24	1	11	8
Total	689	100	545	100

Sources: SEADE/CMIE.

rationale for applying FA technique is that firms differ in their combination of technological inputs for innovation, giving rise to different IPs. Thus the factors obtained through FA will show the predominant IPs in the sample firms of the study.

The rationale for using ATT is to test the reliability of selected predictors in explaining the IPs identified through FA. This technique will segment the population of firms into sub-groups according to the predictors that best explain the IPs identified through FA. In other words, the segmentation tree will classify predictors and sub-groups of firms according to the most statistically significant differences between predictors and within categories of each predictor. So, the tree 'grows' as long as the 'null hypothesis' of independence between predictors is rejected.

Before processing data in FA, normalization was required, as the variables presented large standard deviations in their distribution. The high level of asymmetry occurred due to the large number of firms with low expenditures for a given technology input with values near to "zero", on the one hand, and a small number of firms with high expenditures for the same technology inputs, on the other. In order to tackle this problem, each variable was weighted by the net revenue of the firm. Thus we avoided over-estimations about the firm's technological expenditures by deflating it by revenue to control for firm size differences. In doing so, we use firm size as a control variable and ensure a valid comparability of data in both datasets.

(b) *The variables*

Technology inputs for innovation (referred to as innovation inputs) may represent different types of knowledge which differ in its form (embodied or disembodied); the source by which it was obtained (externally acquired or internally created); and the ease of transferability (codified or tacit). Accordingly, knowledge may be classified along three dimensions: (a) disembodied-codified and externally acquired (e.g., patents, licenses, knowhow *etc*), (b) embodied-tacit and externally acquired (e.g., capital equipment) and (c) disembodied-tacit and internally created (*via* R&D). Tacit knowledge is hard to articulate and hence difficult to transfer. In contrast, codified knowledge refers to knowledge that is transmittable in formal, symbolic language. When knowledge is codified, transfer across individuals involves transmission of documents or operating manuals *etc*. For example, the codified knowledge in manuals that accompany capital equipment can instruct on what settings to use for optimal performance—hence enabling the tacit knowledge embodied within the capital equipment to be put to use. Also, tacit knowledge is acquired through experiential learning and is often rooted in action (Lall, 2004; Polanyi, 1966). Thus knowledge created internally *via* in-house R&D is tacit (OECD, 1997).

The innovation inputs used by MNEs affiliates in both countries are the variables used in the FA to identify IPs (Table 6). These variables were extracted from 2001 Brazilian and Indian databases, whose financial information are based on standard accounting procedures used by firms for measuring economic activities. Variables were selected to preserve high international comparison standards and guarantee a consistent comparative analysis across countries.

Variables 1 and 2 are measured by expenditures on royalty payments for the purchase of patents, licenses, knowhow *etc* (disembodied codified technology), while variables 4 and 5 are measured by expenditures for purchases of capital equipment (embodied technology). In other words, variables 1, 2, 4, and 5 are expenditures by firms to acquire external technologies, from local or foreign suppliers, which may include the parent network. Variable 3 is measured by expenditures made by the firm for in-house R&D on human capital. The five variables used as proxies for innovation inputs are commonly used in the academic literature (Kumar & Joseph, 2007). Moreover, these measures were also common to both the Indian and Brazilian databases.

Specific technology inputs may be pooled or combined using a 'related complimentary' or 'related-supplementary' strategy (Sen & Egelhoff, 2000). Firms that strike linkages to combine different types of technology inputs are considered to pursue a related-complementary strategy. Such a strategy may be employed when pooling technology inputs corresponding to two different stages of the value chain or to product and its subsequent process innovation activities. Thus MNE-affiliates that strike vertical linkages may combine 'related-complimentary' technology inputs. For example, MNE-affiliates that pool an externally acquired design patent for a product with externally acquired capital equipment for its production pursues a related-complementary strategy. In contrast, firms that strike horizontal linkages, to combine similar types of technology inputs to accomplish a specific task pursue 'related supplementary' strategies (Salter & Weinhold, 1979; Sen & Egelhoff, 2000). For example, supplementary knowledge combinations for a given product innovation may include combining codified knowledge from two different design patents for a new or improved product.

The pattern of IPs revealed by the FA that examines if the interactions between 5 innovation inputs used by MNE-affiliates can be used to make inferences regarding the use of complementary and supplementary strategies. Subsequent to determining the diversity in firms in terms of their IPs, we will examine the reliability of selected exogenous variables in predicting the IPs of firms. The predictors inserted in Answer Tree segmentation model, to explain the IPs (dependent variables) are age and industry sector as below. The choice of these predictors is based on the fact that these are robust and not prone to random fluctuations:

1. *SECTOR* is represented by 2 digit level of ISIC or NIC codes: empirical studies suggest technological nature and degrees of knowledge embodied in production and innovation activities varies by industry.

Table 6. *Variables which represent innovation-inputs, type of knowledge represented and measures*

Innovation Inputs	Type of knowledge	Measure (ratio of expenditures/ sales revenue)
[1] Local royalties (patents, trademarks, know-how)	Disembodied-codified & externally acquired	Local royalty/sales
[2] Foreign royalties (patents, trademarks, know-how)	Disembodied-codified & externally acquired	Foreign royalty/sales
[3] Internal Research and Development (R&D)	Disembodied-tacit & internally created *via* R&D	R&D/sales
[4] Local capital goods (machines and equipments)	Embodied-tacit & externally acquired	Local capital equipment/sales
[5] Foreign capital goods (machines and equipments)	Embodied-tacit & externally acquired	Foreign capital equipment/sales

Sources: Brazilian database (SEADE/PAEP, 2001); Indian database (2001).

Table 7. *Percent of MNE-affiliates investing in innovation inputs Brazil and India, 2001*

Innovation inputs	% of diffusion[a]	
	Brazil	India
Local royalties	5.7	27.9
Foreign royalties	11.9	27.0
Local capital goods	67.8	76.9
Foreign capital goods	30.9	45.3
Internal R&D	45.6	30.6

[a] The percentage corresponds to the frequency of foreign firms which had expenses with any kind of the innovation inputs above in 2001.

2. *AGE* is represented by year of firm's constitution, which is an indicator of learning 'path-dependence'.

6. EMPIRICAL RESULTS

Table 7 compares the percentage of MNE-affiliates in India and Brazil in terms of their use of the different innovation inputs. Although developing countries are generally believed to be intensive users of foreign technologies, the data show that less than 50% of MNE subsidiaries depend on foreign sources of embodied and disembodied technologies. This suggests that MNE affiliates in these two countries rely more on local innovation inputs than those sourced from overseas. In terms of the type of knowledge inputs employed, a greater percentage of MNEs in both countries appear to rely on embodied (capital goods) rather than disembodied (i.e., royalties) forms of knowledge inputs. This implies that process rather than product innovations are important to compete in these emerging economies. Product innovations are more common in firms that usually compete on the basis of advanced or customized product features rather than price. Product innovations typically entail intensive use of disembodied knowledge inputs, such as patents, licenses, knowhow *etc*. (Klepper, 1996). In contrast, process innovations, that are used to maximize appropriability from earlier product innovations, are more common where firms compete on the basis of lower prices and scale economies—advantageous in large mass markets. Process innovations intensively use embodied technologies such as capital equipment for improvements in manufacturing techniques and production efficiency.

More importantly, local rather than foreign sources of capital equipment appear to play a predominant role in providing innovation inputs in both countries. These results lend support to an earlier innovation survey by Mani (2008) which suggests that MNEs in both countries have strong linkages with local suppliers for acquisition of embodied technology such as machines and equipments.

Despite these similarities, there appears to be large differences between MNEs in these two countries in their use of types of knowledge inputs. Relative to Brazilian counterparts, a larger percentage of affiliates in India depend on externally acquired knowledge, both disembodied and embodied, suggesting that MNE linkages with the local innovation system are deeper and more widespread. In contrast, a larger percentage of Brazilian subsidiaries are involved in internal knowledge creation through R&D activities (45.6%) relative to Indian subsidiaries (30.6%). We next report the results from factor analysis, which captures the predominant innovation practices (IPs), that is, combination of innovation inputs prevalent in MNE-affiliates in India and Brazil (Table 8). The main results are summarized as the following:

The factor analysis identified 3 pre-dominant categories of IPs, that is, 3 combinations of innovation inputs each for MNE-affiliates in Brazil and in India, respectively. Among MNE-affiliates in Brazil, the three main IP categories labeled as IP1, IP2, and IP3 comprise the following combinations of innovation inputs:

- **IP 1**: innovation practice of firms in this category mainly relies on combining externally acquired **disembodied-codified technology** from both local (L) and foreign (F) sources. This IP essentially reflects combining two similar types of knowledge assets horizontally, both of which are disembodied-codified. In this category firms are acquiring related **supplementary inputs** from both local and foreign **(L + F)** sources.
- **IP 2**: innovation practice of firms in this category mainly relies on combining externally acquired **embodied-tacit technology** from both local (L) and foreign (F) sources. This IP essentially reflects combining two similar types of knowledge assets horizontally, both of which are embodied-tacit**.** Like in IP1, firms in this category (IP2) are also acquiring related **supplementary inputs** from both local and foreign **(L + F)** sources.
- **IP 3**: innovation practice of firms in this category mainly relies on internally created **tacit knowledge** through in-house **R&D**.

In the case of MNE-affiliates in India, the three main IP categories labeled as IP4, IP5, and IP6 comprise the following combinations of innovation inputs:

- **IP 4**: innovation practice of firms in this category mainly relies on combining externally acquired **disembodied-codified technology** from local sources with internally created **tacit knowledge** through in-house **R&D.** This IP essentially reflects combining two different types of knowledge assets vertically—disembodied-codified with tacit, indicating a combination of "**complimentary**" **inputs**.
- **IP 5**: innovation practice of firms in this category mainly relies on combining externally acquired **embodied-tacit technology** with externally acquired **disembodied-codified**

Table 8. *Components extracted from factor analysis, which represent the main interactions between technological inputs selected*

Innovation inputs	Brazil			India		
	1	2	3	1	2	3
Local royalties	**0.831**	0.084	0.019	**0.763**	0.265	−0.001
Foreign royalties	**0.818**	−0.052	0.039	0.290	**0.665**	−0.162
Local capital goods	0.085	**0.801**	0.013	0.045	0.003	**0.978**
Foreign capital goods	−0.053	**0.786**	−0.013	−0.196	**0.735**	0.133
Internal R&D	0.046	0.000	**0.999**	**0.758**	−0.203	0.045
Innovation practice	**IP1**	**IP2**	**IP3**	**IP4**	**IP5**	**IP6**

Extraction method: principal component analysis.
Rotation method: varimax with kaiser normalization.

technology. This IP essentially reflects combining two different types of knowledge assets *vertically*, embodied with disembodied, indicating a combination of "**complimentary**" **inputs** both from foreign sources **(F + F);**

- **IP 6**: innovation practice of firms in this category mainly relies on externally acquired **embodied-tacit technology** from local (L) sources.

Finally the influence of industrial sector and age of the firm in predicting IP was determined by using the Answer Tree Technique (ATT). The results of this analysis (Table 9) show that the industrial sector to which the firm belongs is highly predictive of IPs in both countries. However, in the case of Brazil, the *age* of the firm also appears to be highly predictive of firm IP involving internally created knowledge.

7. DISCUSSION OF EMPIRICAL RESULTS

Differences in location bound resources and capabilities resulting from unique institutional contexts and national innovation systems were predicted to result in distinct patterns of IPs of MNE affiliates in Brazil and India. The results of our factor analysis have confirmed these distinct patterns for the two countries. In Brazil, MNE affiliates pursuing IP1 and IP2 seek *supplementary assets* for innovation by striking horizontal linkages with foreign and local entities. Under IP1 they acquire disembodied technologies—licensed know-how from foreign and local sources; under IP2 they purchase embodied technology—capital goods from foreign and local sources.

According to the ATT results, specific industrial sectors are associated with firms pursuing IP1 and IP2. IP2, that is, the practice of combining local and imported embodied technology (capital goods) is characteristic of process-oriented innovations which become critical in mature industries with standardized products. As may be expected, the industries in which IP2 is most prevalent include mineral and oil extraction; textiles; pulp and paper; rubber and plastic; basic metals; transport equipment, that is, mature industries. Hence this points to strong technological capabilities in capital goods sector in Brazil which MNE affiliates rely heavily on for innovation activities.

IP1, that is, the practice of combining local and imported disembodied technology (local and foreign know-how) may be important in more dynamic and growth oriented industries, or, those sectors which focus on intellectual property creation. Industries in which IP1 is most prevalent include publishing and printing, electronics and telecommunications, computers and office equipment *etc*. that are driven by new emerging information technologies.

Yet another category of firms pursuing IP3 appear to be focused on internal knowledge or intellectual property creation through in-house R&D rather than external acquisition of knowledge. Firms that depend on internal capabilities alone are often engaged in a line of research activity for generating emerging new technologies in Brazil. According to ATT results in the present study, the most representative group of firms which have been adopting internal-knowledge creation (IP3) are older affiliates that were established in Brazil during the import-substitution period (from 30's to 70's). These results confirm, on the one hand, that firm-age can strongly explain the deepening of local technological effort. On the other, it confirms that industrial policy in Brazil induced the development of productive and technological capabilities during ISI period. Firms pursuing IPs thus compete solely on the basis of higher levels of internal technological competency induced by industrialization process and national policies that existed until the end of 70's—such as national content requirements and import restrictions. The technological capabilities accumulated during the import substitution period in Brazil appear to have created a 'good locking' between local and foreign firms. This is despite the liberalization process in 90's and the abolishment of national content requirements for FDI after WTO.

Interestingly, the results of factor analysis (FA) for innovation practices (IP) of MNEs in Brazil differed significantly from an earlier study by Franco and Quadros (2003). Using the same technique (FA) and key-variables to identify technological strategies in a sample of foreign firms operating in Brazil using 1996 data, the authors found a strong positive correlation between local capital goods investment and internal R&D activity.

In contrast, results in this study for IP using 2001 data show that firm acquisition of locally produced capital goods is not correlated with their internal R&D activity, but is strongly correlated with the acquisition of foreign capital goods. This shift in IP over time indicates that MNE-affiliates in Brazil are broadening their sourcing primarily from local suppliers to also include global ones for external innovation inputs. In other words, a shift toward a 'local technology substitution' seems to have occurred. IP3 from FA for Brazil suggests that some affiliates have intensified their local technological effort based on internal R&D activity.

India liberalized in 1991, however, its tariff cuts and FDI liberalization regime was much more conservative than that of Brazil. There still exist a large overhang of pre-liberalization institutions and policies, the impact of which is likely to endure on the IPs of MNE subsidiaries in India, especially those established prior to 1991. In the pre-liberalization era, India's national innovation system was geared toward building strong capabilities in chemical technologies and process skills. This resulted in developing strong technological capabilities in certain sectors, such as pharmaceuticals, chemicals, minerals and oil, steel, and other heavy industries. However, high import tariffs and other policy distortions restricted technological development in others such as motor vehicles, consumer goods *etc* (Kumar, 1997; Lall, 1987). Therefore, MNE subsidiaries have responded by adapting IPs that are able to leverage the local technological strengths in certain industries and redress weaknesses in others by using their own proprietary technologies developed in their home countries.

The results of FA for MNE affiliates in India suggest that the predominant IPs appear to involve seeking "*complementary inputs*"—one where two different types of knowledge are combined for firm innovation by pursuing vertical interfirm linkages with others. Complementing internally created tacit-knowledge through R&D, with locally purchased disembodied knowledge (IP4), provides firms with access to rare firm specific advantage. This practice, which relies on combining tacit and codified know-how, may be important in industries which have grown under the import substituting regime, focusing on indigenous development of technologies that are appropriate for the local market (see Lall, 1987). Industries in which IP4 is most prevalent include mineral and oil extraction, publishing and printing, non-electrical machinery, computers and office equipment *etc*. The products of many of these industries are now incorporating new information technologies in which an abundance of skills exist in India.

IP5 also involves acquiring "*complementary assets*", since it combines embodied (capital goods) with disembodied technologies (know-how) both acquired from overseas. IP5 may be viewed as a 'local-substitution' orientation since relies entirely

Table 9. *Main Results of Factor Analysis (FA) and Answer Tree (ATT)*

Manufacturing sector						
2001						
Country	Main correlations from FA	% Variance in FA	Innovation Practice	Main predictor in ATT	Best representative group of firms for ATT (node; mean-score)	Second predictor
BRAZIL (no.of foreign firms = 689)	Local (L) and Imported (F) royalties	28	IP1: Acquired (L + F) disembodied technology	Sector	Pulp and paper; publishing and printer; computers and office materials; electronic and telecom. (node 1; mean-score = 0.75;% of firms = 7.4)	–
	Local (L) and Imported (F) capital goods	25	IP2: Acquired (L + F) embodied technology	Sector	Mineral and oil extraction; food and beverages; textile; pulp and paper; rubber and plastic; basic metals; computer and office materials; motor vehicles; other transport (node 2; mean-score = 0.2; % of firms = 31%)	–
	Internal R&D	20	IP3: Internally created knowledge	Age	1930> year of constitution ⩾1970 (node 3; mean-score = 0.2; % of firms = 22%)	–
INDIA (no. of foreign firms = 532)	Local (L) royalties and internal R&D	26	IP4: Complimentary (L) technology (internal plus acquired disembodied)	Sector	Mineral and oil extraction; publishing and printing; non-electrical machinery; computers and office materials; motor vehicles (node 1; mean-score = 0.4; % of firms = 23%)	–
	Imported (F) royalties and imported (F) capital goods	21	IP5: Complimentary (F) technology (acquired embodied plus acquired disembodied	Sector	Mineral and oil extraction; textiles; clothing; pulp and paper; publishing and printing; non-metallic products; non-electrical machinery; computers and office materials; electrical machinery; motor vehicles (node 1; mean-score = 0.3; % of firms = 41%)	–
	Local (L) capital goods	20	IP6: Acquired (L) embodied technology	Sector	Textiles; clothing; pulp and paper; chemical and pharmaceuticals; computer and office materials (node 2; mean-score = 0.14; % of firms = 34%)	Age 1985> year of incorporation ⩾1996; for Group of firms included in 'node 2'

Sources: SEADE/CMIE.

on foreign innovation inputs. This practice may be important for subsidiaries that exploit technological gaps in local innovation system in India to serve the local markets with new products based on advanced foreign technologies—as in the case of motor vehicles. Equally, MNE subsidiaries in India may be combining two streams of foreign knowledge and exploiting the local cost advantage to serve as export oriented platforms as maybe expected under an ISI-restructuring industrial strategy. MNE subsidiaries adopting IP5 belong to industries, such as non-electrical machinery; computers and office materials; electrical machinery; motor vehicles in which the need to facilitate the transfer of corporate parent's technology to subsidiary is very important.

IP6 indicates a strategy of relying entirely on acquiring embodied knowledge (capital equipment), from local sources. This strategy appears to be driven by the imperatives of cost-advantages and may be expected to be pursued by MNE subsidiaries to serve local markets and compete with local players that have developed strong process capabilities. Results of the ATT show that IP6 is pursued in industries such as chemicals and pharmaceuticals, computers and office equipment, textiles—all of which are known to have spawned strong local competitors (Ray, 2005; Kumar & Koseph, 2007). A second predictor associated with IP6 is the age of the firm. Firms adopting this practice were typically established between 1985 and 1996. Despite liberalization, many foreign firms in India are continuing to rely on capital goods from local suppliers for process innovations. Embodied technology purchase from local sources has to do with efficiency enhancing mechanisms undertaken by MNEs. Imports are substituted by locally produced capital goods due to the comparative advantage that exists in the capital goods sector. The promotion of heavy and capital goods industry since the 1950's has resulted in India's present ability to produce sophisticated capital equipment, even for high-technology industries (Lall, 1987). Therefore, the location specific advantages embodied in locally produced capital equipment and the linkages spurred by MNEs with local suppliers through years of cooperation are significant enough for older MNE affiliates to draw on for their IPs.

In sum, the way MNE-affiliates combine innovation inputs (IP) differ both within and between the two countries, resulting from their unique institutional contexts and national innovation systems. As well, we saw that firm age and industry sectors play an important part in shaping their IPs in these two countries.

We take this opportunity to point to some inevitable and unavoidable limitations of this analysis. Our study focuses on five distinct innovation inputs to examine IPs in firms in India and Brazil. However, innovation and knowledge creation involve many other inputs for capturing tacit elements of knowledge creation, such as cumulative efforts of learning, which are developed through interactions between individuals and their social/business networks. Mapping such interactions require longitudinal studies, which was beyond the scope of this paper. Even so, the selected inputs used in this paper are widely accepted as being highly important to firm innovation. Moreover, the fact that robust measures for these inputs exist for both India and Brazil, allows a reliable comparison of firm IPs between the two countries. Another limitation in the study is in the fact that country of origin of the MNE affiliate was not considered as a predictor of IP since the individual databases of Brazil and India did not include information about country of origin. However, it is well known that the majority of MNE-affiliates in emerging economies come from the triad region.

8. POLICY IMPLICATIONS

Information about what role policymakers should be playing in stimulating foreign investment in Brazil and India is of critical importance given that these countries are competing with each other, as well as with countries in the OECD to attract FDI. Finding out if MNE's IP's in both countries are complementary, or supplementary, or what exogenous and endogenous variables explain patterns of interactions, can help policy makers to design more accurate strategies to integrate the local innovative capacity building to the global value-chain.

Hence three policy implications arising from this comparative study are salient. First, since MNEs draw on particular combinations of local and foreign produced embodied and disembodied technologies, it may imply that reductions in trade and tariff distortions in innovation inputs from overseas would have the impact of encouraging external inflow of specific intermediate innovation inputs; such inputs can have positive externalities for internal R&D efforts of MNEs who may then be motivated to perform more technology intensive IPs. Equally, however, wholesale import of technology from foreign sources, without any coherent policies, such as requirements for technology absorption, local content and the like, can have a very deleterious effect on technological capabilities in host countries (see Lall, 1996; Lall, 2004).

The second policy implication is whether there are sufficient incentives that promote R&D expenditures by private enterprises, apart from expenditures by public R&D and educational institutions. For example, R&D grants and tax offsets (Lall & Teubal, 1998) in Japan, Korea, and Taiwan spurred vigorous R&D spending among productive enterprises in these countries, with the result they are among the top 10 R&D spenders (as% of GDP) in the world today (Lall, 2004). For India much of the R&D was conducted in the government sector consisting of government research institutes and public sector undertakings (Mani, 2001). This structure needs to shift toward private R&D, and in particular, MNEs should be encouraged to do more R&D.

The third implication is the encouragement given by the government to patent intellectual property created—the outputs of innovation resulting from R&D. Any innovation generated through this R&D is significant for the host country, not only in terms of the resources employed but also in terms of potential tax revenues from intellectual property rights (IPRs) that result. Unless governments can ensure that patents (and appropriate royalties) are generated and reside in the country, incentives and subsidies to encourage R&D may not provide the desired results to the local economy (Ray, 2005).

Finally, as is clear from the results, MNE-affiliates' IPs draw heavily on the capital equipment sector which seems to have a very powerful influence in both in Brazil and in India. Lall's, 1987 study showed that by 1984, India had achieved global competitiveness in capital goods. It is up to the policymakers to sustain this performance today—perhaps by inducing local suppliers to expand globally—as many pharmaceuticals, automotive and electronic component makers are doing in India; or by giving more incentives to perform higher level R&D.

9. CONCLUSIONS

The different IPs found in both countries suggest that geographic and institutional contexts matter for analyzing the way multinationals capture, manage and create strategic assets for innovation in developing host-countries. Therefore, despite the fact that both countries have had similar industrialization processes—based on import-substitution and development of production capacity—the local knowledge-based assets created by specialization and domestic investments differ significantly. Differences in the way in which MNE-affiliates in India and Brazil combine innovation inputs, appear to suggest each country is moving along different technological trajectories, even in the post liberalization phase. Thus, differences in IPs in the two countries are leading to different streams of specialization and technological capabilities.

Our study attempted to understand these germane issues by examining at which level the MNEs and host countries are connected to the global innovation system. By analyzing their IPs in selected industries, we have obtained ‘clues’ as to what factors determine the global linkages between MNE-affiliates and emerging economies. Linkages can generate spillovers for the host country as the MNE’s customers, suppliers, and firms in related industries pass their newfound knowledge onto each other, including competitors in the industry (UNCTAD, 2001; Spencer, 2008). Linkages thus play a key role for the technological catching-up process of late-industrializing countries. For MNEs in question a more precise knowledge about the costs and benefits of different kinds of knowledge linkages between foreign and local suppliers in two specific emerging economies would enable them to position better in the transnational network of knowledge creation.

Our study provides the basis for a future research agenda which connects IPs to innovation performance in MNE-affiliates in the two countries—which will enhance our understanding of the specific effects of individual IPs on performance.

NOTES

1. The Science and Technology Agency in Japan estimated that by 2050 there will be a shortage of some 480,000 researchers in Japan. This will be about half of the estimated requirement for R&D personnel by that year (Swinbanks, 1992, pp. 34).

2. For example, Granstrand & Sjölander (1992) estimated that costs of performing R&D in India are only about a tenth of that prevailing in the OECD. (p.10)

3. Fundação SEADE is the government agency for the production of statistics in the state of São Paulo.

REFERENCES

Baer, W. (1994). *The Brazilian economy: Growth and development*. London: Praeger.

Bartholomew, S. (1997). National system of biotechnology innovation: Complex interdependence in the global system. *Journal of International Business Studies, 28*(2), 241–266.

Bell, M. (1985). Learning and the accumulation of industrial technological capacity in developing countries. In M. Fransman, & K. King (Eds.), *Technological capability in the third world*. New York: Macmillan.

Bell, M., & Pavitt, K. (1993). Technological accumulation and industrial growth: Contrasts between developed and developing countries. *Industrial and Corporate Change, 2*(2), 157–210.

Bell, M., & Pavitt, K. (1995). The development of technological capabilities. In I. Haque (Ed.), *Trade, technology, and international competitiveness*. Economic Development Institute of the World Bank.

Brenner, T. (2007). Local knowledge resources and knowledge flows. *Industry and Innovation, 14*(2), 121–128.

Buckley, P. J., & Ghauri, P. (2004). Globalization, economic geography and the strategy of multinational enterprises. *Journal of International Business Studies, 35*, 81–98.

Cantwell, J. and Piscitello, L. (2001). The location of technological activities of MNCs in European regions. Fifth Seminar of the Mesias Network, Reading.

Carlsson, B. (2006). Internationalisation of innovation systems: A survey of literature. *Research Policy, 35*, 56–67.

CMIE, Center for Monitoring the Indian Economy, Prowess, Version 2.5.

Dunning, J. (1993). *Multinational enterprises and the global economy*. Wokingham, United Kingdom and Reading, Mass: Addison Wesley.

Dunning, J., & Narula, R. (1995). The R&D activities of foreign firms in the united states. *Int. Stud. Mang. Org., 25*, 39–73.

Dunning, J. (1998). Location and the multinational enterprise. *Journal of International Business Studies, 29*(1), 45–66.

Dunning, J., & Narula, R. (2000). Industrial development, globalization and multinational enterprises: New realities for developing countries. *Oxford Development Studies, 28*(2), 141–167.

Figueiredo, P. (2007). Industrial policy changes and firm-level technological capability development: Evidence from Northern Brazil. *World Development, 36*(1), 55–88.

Figueiredo, P. (2008). Government policies and sources of latecomer firms’ capability building: A learning story from Brazil. *Oxford Development Studies, 36*(1), 59–88.

Foss, N and Pedersen, T. (2003). The MNC as a Knowledge Structure: The Roles of Knowledge Sources and Organizational Instruments In: MNC Knowledge Management. Working Paper 2003–4, Center for Knowledge Governance, Copenhagen Business School, (<http://www.cbs.dk/ckg/working.php>).

Franco, E., & Quadros, R. (2003). Patterns of technological activities of transnational corporations affiliates in Brazil. *Research Evaluation, 12*(2), 117–129.

Fu, X. and Gong, Y. (2008). Direct technical change, indigenous and foreign innovation efforts and drivers of technology upgrading: evidence from China. Paper presented in the SLPTMD conference, University of Oxford, May 2008, Oxford.

Ganesh, S. (1997). Who is afraid of foreign firms? Current trends in FDI in India’, *Economic and Political Weekly*, 31 May, 1265–1274.

Granstrand & Sjölander, S. (1992). Internationalization and diversification of multi-technology corporations. In O. L. Granstrand, Håkanson, & S. Sjölander (Eds.), *Technology Management and International Business Internationalization of R&D Technology* (pp. 181–207). John Wiley and Sons.

Granstrand, O., Hakanson, L., & Sjolander, S. (1993). Internationalisation of R&D: A survey of some recent research. *Research Policy, 22*(5&6), 413–431.

Klepper, S. (1996). Entry, exit, growth and innovation over the product life cycle. *American Economic Review, 86*(3), 562–583.

Kumar N. (1997). Technology generation and technology transfer in the world economy: recent trends and implications for developing countries. *INTECH*, Discussion Paper Series, September, 9702.

Kumar, N. (2001). Determinants of location of overseas R&D activity of multinacional enterprises: the case of US and Japanese corporations. *Research Policy, 30*, 159–174.

Kumar, N., & Joseph, K. J. (2007). *International competitiveness in knowledge based industries in India*. New Delhi: Oxford University Press.

Kurokawa, S., Iwata, S., & Roberts, E. (2007). Global R&D activities of Japanese MNEs in the US: A triangulation approach. *Research Policy, 36*, 3–36.

Lall, S. (1987). Multinationals and technology development in host LDCs. In J. H. Dunning, & M. Usui (Eds.), *Structural change, economic* *interdependence and world development* (pp. 193–209). Macmillan: London.

Lall, S. (1992). Technological capabilities and industrialization. *World Development, 20*(2), 165–186.

Lall, S. (1995). Policy in the New NIEs: Introduction. *Journal of International Development, 7*(5), 741–743.

Lall, S. (1996). Transnational corporations and economic development. In T. Moran (Ed.), *Transnational corporations and world development*. London: International Thomson Publishing Company.

Lall, S. (2002). Linking FDI, technology development for capacity building and strategic competitiveness. *Transnational Corporations, 11*(3), 39–88.

Lall, S. (2004). Introduction and overview. In Sanjaya Lall, & Shujiro Urata (Eds.), *Competitiveness FDI and technological activity in East Asia*. Cheltenham: Edward Elgar.

Lall, S., & Teubal, M. (1998). Market stimulating technology policies in developing countries: A framework with examples from East Asia. *World Development, 26*(8), 1369–1385.

Le Bas, C., & Sierra, C. (2002). Location versus home country advantages in R&D activities: some further results on multinationals locational strategies. *Research Policy, 31*(3), 589–609.

Mani, S. (2001). Role of government in promoting innovation in the enterprise sector: An analysis of the Indian experience, The United Nations University INTECH Discussion Paper Series #2001–3 (in collaboration with Nagesh Kumar).

Mani, S. (2008). Innovation surveys in developing countries: what can we learn from it for public innovation policies? Paper presented at the conference on *Micro evidence on innovation developing countries*, May 31–June 1, UNU-MERIT, Maastricht, The Netherlands.

Mansfield, E. (1974). Technology and technical changes. In John Dunning (Ed.), *Economic Analysis and the Multinational Enterprise* (pp. 147–183). London: George Allen and Unwin.

Moreira, M. M., & Correa, P. G. (1998). A first look at the impacts of trade liberalization on Brazilian manufacturing industry. *World Development, 26*, 1859–1874.

Nassif, A. (2007). National innovation systems and macroeconomic policies:Brazil and India in comparative perspective. *UNCTAD Discussion Paper, 184,* May.

Neto, R. (1991). The whole of transnational companies in the Brazilian defence tripod. *Journal of Latin America Studies, 23*(3), 573–597.

Niosi, J., & Bellon, B. (1996). The globalization of national innovation systems. In J. De La Mothe, & G. Paquet (Eds.), *Evolutionary Economics and the New International Political Economy* (pp. 138–159). New York: Pinter.

OECD (1997). National innovation systems. Paris: OECD.

Papanastassiou, M., & Pearce, R. D. (1999). *Multinationals, technology and national competitiveness*. Cheltenham: Edward Elgar.

Patel, K., & Pavitt, K. (1998). *National systems of innovation under strain: the internationalization of corporate R&D*. University of Sussex, Brighton: Science Policy Research Unit.

Pavitt, K. (1998). The social shaping of the national science base. *Research Policy, 27*(8), 793–805.

Pietrobelli, C., & Stewart, F. (2008). Introduction. *Oxford Development Studies, 36*(1), 1–9.

Polanyi, M. (1966). *The Tacit Dimension*. London: Routledge & Kegan.

Ramamurti, R. (2001). Developing countries and MNEs: Extending and enriching the research agenda. *Journal of international Business Studies, 35*, 277–283.

Ray, P. K. (2005). *FDI and industrial organization in developing countries-the challenges of globalization in India*. Ashgate: Aldershot.

Rugman, A., & Verbeke, A. (2001). Subsidiary specific advantages in multinational enterprises. *Strategic Management Journal, 22*(3), 237–250.

Saliola, F., & Zanfei, A. (2009). Multinational firms, global value chains and the organization of knowledge transfer. *Research Policy, 38*, 369–381.

Salter, M., & Weinhold, W. A. (1979). *Diversification through acquisition strategies for creating economic value*. New York: The Free Press.

Sathe, D. (1997). Import intensity of India's exports: Some fresh evidence. *Economic and Political Weekly,* Feb 22–28, 31–44.

SEADE (2001). Sao Paulo Economic Survey (PAEP).

Sen, F., & Egelhoff, W. G. (2000). Innovative capabilities of a firm and the use of technical alliances. *IEEE Transactions on Engineering Management, 47*(2), 174–183.

Sole, D., & Edmondson, A. (2002). Bridging knowledge gaps: Learning in geographically dispersed cross-functional development teams. In C. W. Choo, & N. Bontis (Eds.), *The Strategic Management of Intellectual Capital and Organizational Knowledge*. New York: Oxford University Press.

Spencer, J. (2008). The impact of multinational enterprise strategy on indigenous enterprises: Horizontal spillovers and crowding out in developing countries. *Academy of Management Review, 33*(2), 341–361.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*, 27–43.

Swinbanks, D. (1992). More Yen for Japan's university research system. *Research, Technology, Management, 35*, 3–4.

UNCTAD (2001). *World Investment Report*. Promoting linkages. New York and Geneva, United Nations.

UNCTAD (2003). *World Investment* Report—FDI policies fo development: National and International Perspectives. New York and Geneva, United Nations.

UNCTAD (2005). *World Investment Report*—Transnational corporations and internationalization of R&D. New York and Geneva, United Nations.

UNCTAD (2005), *Transnational Corporations and the Internationalization of R&D,* World Investment Report, New York and Geneva, United Nations.

World Bank (2005). *World Development Indicators on CD-ROM*. Washigton, DC: The World Bank.