Local R&D and Technology Transfers

A Comparative Analysis of Foreign and Local Firms in Indian Industries

Aggarwal, Aradhna

58 2016 April

Local R&D and technology transfers: A Comparative Analysis of foreign and local firms in Indian Industries

Aradhna Aggarwal

Editor of the Copenhagen Discussion Papers:
Associate Professor Michael Jakobsen

Asia Research Centre
Copenhagen Business School
Porcelænshaven 24
DK-2000 Frederiksberg
Denmark

Tel.: (+45) 3815 3396
Email: mj.int@cbs.dk
www.cbs.dk/arc

Local R&D and technology transfers: A Comparative Analysis of foreign and local firms in Indian Industries

Aradhna Aggarwal[1]
Professor
Asia Research Centre
Department of International Economics and Management
Copenhagen Business School
Mobile: +45 9145 5565
Email: aa.int@cbs.dk

Abstract

This study examines how inter-firm heterogeneities in technology modes and intensities are linked to ownership of firms in India, using a panel dataset of 2000 odd Bombay Stock Exchange listed firms for the period from 2003 to 2014 drawn from the PROWESS database of CMIE. For the analysis, foreign ownership is categorised according to the control exercisable by them as defined under the Companies' Act of India. A comparative analysis of domestic and different categories of foreign firms was conducted at two time periods: the global boom period of 2004-2008 and post crisis period of 2008-2014. The propensity score matching (PSM) analysis reveals that the majority owned foreign companies spend less on R&D and more on technology transfers than their local counterparts. Overall, threshold equity holding and global conditions matter. A panel data regression analysis on matched sample confirms the findings and validates the PSM findings. A horizontal cluster analysis on 3-digit industry level data shows that foreign firms cluster in high technology industries.

JEL classification: G21; G32; K22; L25

Key words: *Foreign firms, Majority owned foreign subsidiaries, minority owned subsidiaries, domestic firms, performance*

[1] *I sincerely thank Shweta Jain for her support and assistance in preparing this paper.*

1. Introduction

Rapid advances in new technologies reinforced by the process of globalization have exposed firms in developing countries to intense technological competition both in the domestic and export markets. Conscious efforts towards building technological capabilities are increasingly becoming vital for them to survive. But, building these capabilities is costly, cumulative and evolutionary; it takes time and is uncertain (Lall, 1992). Since MNEs are a major source of cutting edge technology and innovation, developing countries' governments encourage them to set up local production facilities in the hope that the latter would bring new technologies and help build technological capabilities of the local firms through labour turn overs, imitation, competition and demonstration. While there are direct channels of international technology transfers for local firms (for instance, licensing arrangements and imports of capital goods), FDI is expected to be instrumental in transferring the latest technologies to these countries. There is almost consensus in the literature that the latest and proprietary technologies are transferred through internalization (Dunning, 1993). More than 80% of royalty payments for international technology transfers were made by affiliates to their parent companies (UNCTAD, 1997 and 2005). Thus the presence of MNEs itself is assumed to entail technology transfers to local firms though spillover effects, even if they do not indulge in R&D in the host countries. But, there is also a possibility that MNEs directly undertake R&D activities in the host countries to adapt technologies to suit to local conditions and/or seek new assets to increase group capabilities as a strategic decision (Kuemmerle, 1999; Narula, 2004; Pearce, 1999). These R&D active MNE subsidiaries may provide better access

to foreign knowledge, and enable host countries to integrate more advantageously into global innovation networks (Cantwell and Piscitello 2000, Carlsson 2006). Embeddedness of MNEs into the local R&D networks may thus ensure more profound knowledge spillover to local firms. As a result there is growing competition among countries for high value adding R&D active FDI in recent years. Even while most R&D and patenting activities are largely concentrated in the MNEs' home countries, and in a few developed host countries, there is evidence of relocation of R&D activities by them to developing countries (Dachs et al, 2014; Hall, 2010; Lundan and Dunning,2009; OECD, 2008a). It is against this background that this paper analyses whether MNEs are significantly different from their local counterparts in terms of their technology intensities and forms of technology activities in a developing economy with a special reference to India. We identify three main forms of technological activities: (i) local R&D efforts, (ii) licensing arrangements with foreign (parents for MNE affiliates) firms for technology acquisitions, and (iii) imports of technologies embodied in capital goods. The objective is to investigate whether MNEs undertake larger R&D spending than their local counterparts or they are more likely to acquire technologies from their own global networks through licensing and imports of capital goods. As noted above, the choice of technological spending by them may have different implications for the host developing countries.

The analysis is based on the propensity score matching method followed by regression techniques, using the panel data for the period of 2003-04 to 2013-14. The data was partitioned into two periods: the boom period of 2003-04 to

2007-08, and the global crisis period of 2008-09 to 2013-14. For each period we conducted a separate analysis to investigate the impact of global conditions on the choices of foreign and local firms and validate our results. Evidence suggests that global relocation of R&D activities has suffered during the global crisis of the post 2008 (Dachs and Zahradnik, 2014; Kinkel and Som, 2012)

The distribution of corporate R&D spending is highly skewed across industries. A few high-tech sectors account for the overwhelming share of R&D activity (Hirscheya et al. 2010). It has also been observed that R&D spending in high tech sectors is more effective in closing productivity gaps than that in other sectors (Ortega-Argilés et al, 2009). Thus, the analysis of differential technological behaviour of foreign and local firms is meaningful only if MNEs predominate in R&D intensive sectors. It is likely that MNEs do not even target these sectors. Rather, they concentrate in resource or labour intensive industries seeking access to cheap resources. For our analysis therefore we shall begin by identifying the sectoral distribution of MNEs by technological intensity in India using the cluster analysis.

Economic reforms introduced in 1991 marked a transition of the Indian economy from an import substituting to an outward oriented regime. Since then the government of India has carried out massive economic reforms to promote the integration of the Indian economy with the rest of the world (Aggarwal and Kumar, 2012). One of the most important dimensions of these reforms is the lowering of barriers for foreign direct investment. The FDI regime had been fairly restrictive in India between the late 1960s and the early 1990s when ‘technological

self-reliance' was adopted as one of the key objectives of the growth strategy. Numerous restrictions were imposed to attract FDI only in core technology intensive industries where little technological progress had been made in the country. These included, restrictions on the ownership control, entry and growth of foreign companies including, setting up of joint ventures with domestic partners, local content clauses, export obligations, promotion of local R and D and so on. In the open regime of the post 1991 however, the government has directed its policy towards investment liberalization, promotion and facilitation, and has been increasingly amending the investment laws and guidelines to facilitate inflows of FDI. Since 2005, the country has opened nearly all economic sectors for FDI as a step towards FDI-induced growth strategy. The present analysis therefore is expected to have important policy implications for other countries that have adopted a similar path of growth.

There have been several studies analyzing the R&D behavior of firms. Most studies include a variable representing foreign ownership as one of the explanatory variables. However, the focus has essentially been on the relationship between local R&D and technology imports (Kumar and Siddharthan, 1997; Sasidharan and Kathuria, 2011 for literature surveys). To the best of my knowledge, there is no systematic analysis of the differential technological behavior of local and foreign firms in the Indian context. Further, while the International Business literature has evolved both, theoretically and empirically to better test and explain the differential behavior of foreign and local firms, most studies for developing countries in particular those in South Asia are still embedded in the classical frameworks and remain beset by the lack of good

quality data and weak methodology. It is therefore important to revisit the comparative analysis of technological behavior of firms by ownership.

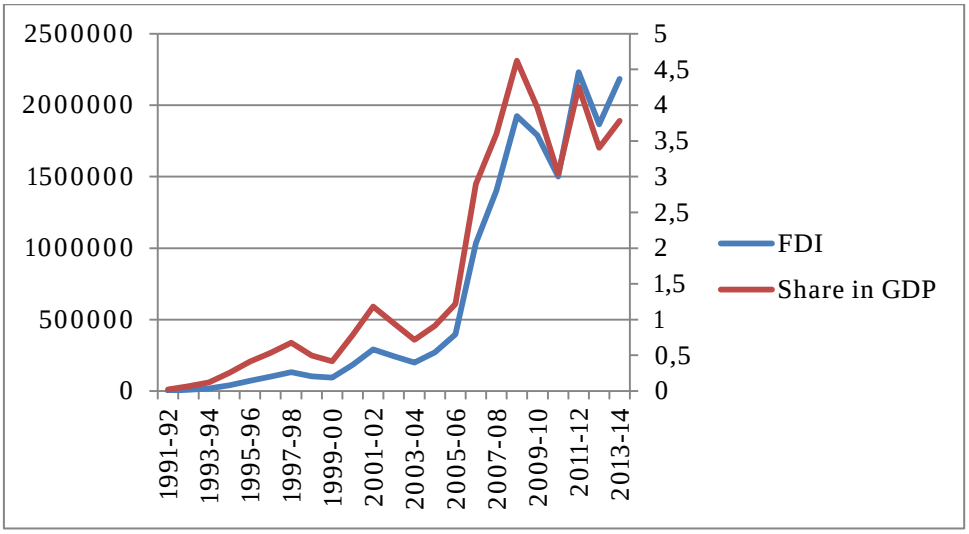
Methodologically, a key problem in evaluating the differential behavior of the local and foreign firms is that the investment decision of foreign firms is not independent from factors determining performance indicators. Better performance of foreign affiliates may for instance simply reflect the fact that they are attracted to high technology industries (Bellak, 2004; Girma et al. 2001;Globerman et al. 1994, p. 144; Howenstine and Zeile 1992, p. 53;). Selection bias can thus be a major problem in such studies. There are recent studies (Damijan et al., 2003; Javorcick and Spatareanu, 2008; Hake,2009) that explicitly address the question of selection bias. However, there is none for India. Furthermore, most existing studies are concerned with foreign ownership; the strategic importance of ownership holding is largely ignored. Finally, the firm-ownership data available from secondary sources which form the basis of most studies in particularly for India is subject to several limitations and that there is a lack of transparency in the identification of foreign firms. The present study contributes to the existing literature by addressing these gaps in the exiting literature.

The rest of the study is organized into 6 sections. Section 2 discusses the changing role of FDI in the Indian economy and establishes the need for the present analysis. Section 3 describes the theoretical underpinnings of the analysis. Sections 4 and 5 provide methodological and data related details while Section 6 presents empirical results. Finally, Section 7 concludes the findings.

2. FDI in India

Empirical evidence suggests that there has been a tremendous increase in inward FDI in India during the post reform period particularly after 2005. In absolute terms, the FDI inflows grew from roughly $129 million in 1991-92 to over $46 billion in 2011-12. It declined somewhat in later years though. Figure 1 shows that, over the 25-year period, growth in FDI inflows has been relatively steady[2]. It accelerated in 2006-07 due to relaxation in FDI norms in construction and real estate, and continued to grow since then. Not only that, the IFDI inflows as percent of GDP also grew steadily. The ratio improved from less than 2% to over 4.5 in 2009-10, but declined thereafter to touch 3.8% in 2013-14.

Figure 1: IFDI flows and the ratio with GDP in India: 1991-92 to 2013-14



Source: RBI Monthly bulletins, various issues

Correspondingly, the stock of FDI also increased astronomically from a mere

[2] *FDI statistics compiled by the RBI in the Balance of Payments prior to 2000 included only equity capital. In 2000-01, following the IMF's definition, it incorporated equity capital, reinvested earnings (retained earnings of FDI companies) and 'other direct investment capital' (intracompany loans or intra-company debt transactions) also.*

$1984 million in 1992 to US $226,748 million in 2013 (UNCTAD website on FDI statistics). According to the RBI Census survey, the total foreign liabilities in FDI was $1230 in 1992 which rose sharply to US 233,678 million in March 2013 and further to US $264,672 as on March 31, 2015 (RBI, 2015). Nearly half of the total FDI stock at market prices was in the manufacturing sector. Information and communication services (15.5 per cent) and financial and insurance activities (13.6 per cent) were other major activities attracting FDI.

Globally, India has become one of the most attractive destinations of FDI improving its position vis-à-vis other countries. In 2005-06 it was the 4th largest recipient of FDI in the world. After the global crisis of 2008, it slipped out of the club of top 10 FDI recipients to enter again in 2014[3]. In South Asia, it accounts for more than 90% of the total IFDI.

It must also be noted that there been a proliferation of wholly or majority owned foreign companies in the county in the post reform period. The foreign share in total equity of foreign companies was high at 70.1 per cent as at end 2013 which further increase to 72% as at the end of 2014 (RBI, 2014,2015). In manufacturing it was as high as 85% (RBI, 2015). This is significant because prior to 1991-92, foreign equity share was restricted to 40% in most sectors.

It will therefore be interesting to analyse how the removal of restrictions on MNEs and conducive environment have affected their technological activity within the country.

[3] *However, it is the only BRIC country that could not cross $50 billion.*

3. Theoretical discussion

Technological activities: MNEs vs local firms

The MNE is not a compact, rationally conceived organization with a uniform goal, but a differentiated network of relatively autonomous subsidiaries which have to face heterogeneous national contexts (Ghoshal and Bartlett, 1990, Hedlund 1986; and Perlmutter 1969). These networks comprise not only of MNE units but also its relationships with external customers, suppliers and authorities. International business literature identifies three levels of networks:

- Intra-organisational networks that refer to the relationship between headquarters and subsidiaries, and to the relationship that subsidiaries have with each other
- Inter-organisational networks that refer to relationship with other organisations in joint ventures, strategic alliances and licensing agreements,
- Local networks with customers, suppliers and authorities,

The earlier IB literature adopts essentially a top-down approach and expects majority owned firms to be more 'intra-organizational network' embedded. This literature, comprising of the industrial organisation (Caves 1996; Hymer 1976) and transaction cost theories (Dunning 1993; Hennart, 1982; Williamson, 1975), argues that the existence of MNEs hinges on the relative monopolistic advantages that they enjoy against the rival local firms. They derive their competitive advantages from the assets that they have generated in their home countries. Activities such as R&D, generating firm-specific assets are mostly

being carried out at the headquarters. They are expected to transfer their technologies from the home to host countries to generate monopolistic advantages. They are thus more likely to depend upon imports of technologies from their internal networks and are less likely to engage in R&D activities in the host country than their local counterparts.

The Resource Based View (RBV) turns the focus from the firm (MNE) to the subsidiary (Barney, 1991; Peng 2001; Rugman et al., 2011). It conceptualizes a MNE subsidiary as ‘a semi-autonomous entity with its own entrepreneurial potential (Andersson et al., 2007; Birkinshaw et al. 2005, p. 227; Bouquet and Birkinshaw, 2008; Do¨rrenba¨ cher and Geppert, 2011; Forsgren et al., 2005; Rugman et al., 2011). Thus, subsidiary growth is driven by its own distinctive capabilities developed through the entrepreneurial efforts of subsidiary management. According to the power and internal politics approach, a subsidiary is competing internally as part of the MNE network with other subsidiaries for the allocation of MNE’s scarce resources (for instance, new investment, positive attention from MNE top management team), and externally with host country competitors (Andersson et al, 2001). Therefore, it becomes inevitable for a subsidiary to develop its own strategies that can enhance its competitive position, both internally and externally for intra-organizational negotiations (Do¨rrenba¨cher and Gammelgaard, 2006; Peng & Wang, 2000). In this framework, subsidiaries are likely to have a considerable R&D spending and out-compete the local firms in terms of R&D spending. Their technological embeddedness in local networks may have a positive impact on technology transfers to the host country.

The network approach on the other hand postulates that the subsidiaries' enhance their competitiveness through cooperative efforts (Bartlett and Ghoshal, 1986). Their behavior is contingent on the host country and subsidiary specific factors, and strategic considerations of setting them up. Their relations with external customers and suppliers (business embeddedness) and the collaborative development of new products and processes (technical embeddedness) influence technological competence of the whole company (Andersson et al. 2002). Subsidiaries with high technology spending and competencies are thus designated as contributors or strategic leaders (Bartlett and Ghoshal, 1986, p. 90; Cantwell and Mudambi, 2005). Their role is not just 'home-base exploiting' (Kuemmerle, 1999). Instead, they become home base augmenting by generating new technology (Cantwell and Janne, 1999; Pearce, 1999; Zander, 1999). But an important resource for technological competencies of subsidiaries is the local innovation system which increases the potential skill base of subsidiaries; the better these systems are, the better a subsidiary can contribute to technology generation within the MNE network (Cantwell and Mudambi, 2005; Lundan and Dunning, 2009). Also the strategic intent/ investment motive behind establishing the subsidiary may influence its conduct in the host country economies.

Considering that theoretical arguments are conflicting, we set up two competing hypotheses for the analysis:

- H1: the MNE subsidiaries in India have R&D intensity significantly higher

than that of local firms, and

- H2: the MNE subsidiaries are embedded in the intra organisational networks and exhibit higher spending on royalty payments for technology imports from these networks than their local counterparts

Ownership holding and technological activity

Theoretically, there is almost consensus that the parent that supplies the most critical proprietary resources is more likely to maintain controlling ownership stakes over the affiliates. However, its implication for technology activities of MNE subsidiaries in the host country is ambiguous. While the classical IB theories postulate that the strategic ownership 'control over the resources ensures greater embeddedness of these subsidiaries within the internal networks to minimize leakages of their proprietary technology, the recent literature argues that subsidiaries that are subject to strategic controls are more likely to compete for excellence and commit larger resources to R&D spending. This is because such subsidiaries are more likely to be assessed in regard to long-term objectives of the firm. The institutional approach supports this view and argues that a firm's strategic behaviour is influenced by the surrounding institutional environment (DiMaggio and Powell, 1983; Dunning and Lundan, 2008, Meyer and Rowan 1977; Geppert and Williams, 2006; Peng and Khoury, 2008 ;). When the regulatory environment is weak in the host country or the social and cultural distance between the home and host countries is large, the company lowers its control and commits lower resources. Thus, the lower the control, the lower is the support that subsidiaries receive from their parents for

local initiatives. Once again, given the conflicting arguments, we test two competing hypotheses

- H3: Majority owned subsidiaries with controlling stakes exhibit a greater tendency to embed in local networks and incur larger R&D expenditures than their local counterparts.
- H4: Majority owned subsidiaries with controlling stakes are more likely to depend on imports of technologies from their parents and other internal network actors.

4. Methodology

For empirical analysis, we used a multilevel methodology. In what follows we discuss that briefly.

Identifying foreign firms

In India, a direct investment enterprise is defined, in keeping with the IMF guidelines, as an incorporated or unincorporated enterprise in which a foreign direct investor owns 10 per cent or more of the ordinary shares or voting power (for an incorporated enterprise) or the equivalent (for an unincorporated). There is however recognition that a numerical guideline of 10% does not capture the essence of FDI for economic analysis. This is adopted essentially for the sake of consistency and cross-country comparability of the FDI statistics, and is based on the premise that a share as low as 10 per cent of voting rights or equity

capital allows the investor to 'influence the management' and provides the basis for a FDI relationship. The System of National Accounts (SNA) Framework of the UN with an objective of facilitating economic analysis on the impact of FDI uses "controlling stakes" as the basis for defining FDI for which more than 50% ownership is necessary. OECD (2008b) defines companies with 50% or more stake as FDI subsidiaries (controlled enterprises) while those with 10-50% of the stake, FDI associates (influenced enterprises). In line with this approach, for the present analysis of firm level performance, we considered three categories of foreign companies based on the right of the shareholders as defined in the Indian Companies' Act. The Act defines three threshold levels of shareholding from the perspective of defining "influence" and" control" on the management. These are: 10%, 25% and 50%. Based on this classification and the available data, we identified four types of foreign firms:

- Minority holding (10-25%) with minor influence
- Dominant minority holding (25-50%) with dominant influence
- Majority holding (above 50%) with controlling stake
- Experiential foreign firms which are not predominantly foreign firms during the selected period but do have foreign ownership for a short period.

Investigating the sectoral distribution of MNEs by technology intensity: Cluster analysis

To investigate whether the MNEs target high tech industries in the first place, we clustered the three digit industries by technological orientation and brand value.

There are two different procedures that can be used to cluster data: hierarchical cluster analysis and k-means cluster. Since we did not know the number of clusters in advance, we eliminated the latter and focused on the former. Of the different methods of hierarchical clustering, we used the Wards linkage method. Based on the dendogram and the Calinski and Harabasz (1974) and Duda, Hart and Stork (2001) stopping rules we determined the number of clusters in the sample and then examined the presence of foreign firms by ownership stake in each group.

Assessing the difference in technology intensity and activity between the local and foreign owned firms:

Propensity Score Matching: As stated earlier, MNEs are likely to exhibit higher technology intensities due to a package of competitive advantages that they possess. But these advantages also provide the reasons of their investing in a host country. It is therefore important to control the effect of these variables before analyzing the impact of foreign ownership. The usual approach in correcting the selection bias is by using instrumental variables. Since most variables that affect foreign acquisition also affect technology intensity, this approach is inappropriate in the case of FDI. We have therefore used propensity score matching (PSM) to control for endogeneity.

PSM is a non-parametric estimation method works by creating a comparison group (local firms) with identical distributions of observable characteristics to those in the treatment group (foreign firms). The basic idea is to find, for every

foreign firm, a matching local firm in terms of all relevant observable characteristics X. All observable covariates are controlled simultaneously by matching on a single variable, the propensity score. The mean effect of foreign ownership can then be calculated as the average difference in outcomes between the foreign and matched local firms. More specifically, if P=1 for foreign firms and P =0 for the local firms, then the average treatment effect on treated (ATT) on an outcome variable Y (technology spending) is

$$ATT= E (Y_1-Y_0|P=1),$$

which means,

$$ATT= E (Y_1|P=1)-E (Y_0|P=1)$$

While data on E (Y_1|P=1) i.e. foreign firms are available, estimation of the counterfactual *E* (Y_0|*P*=1) is the expected value of technology spending of the matched local firms. In all, we identified four broad categories of the foreign firms as stated above, and correspondingly constructed four propensity score models using firm and industry specific attributes. In each case, the balancing property is satisfied. Following the standard practice to limit comparisons to a subset of cases lying on the common support of propensity scores, we dropped local firms with propensity scores that were larger/smaller than the maximum/minimum propensity score. Kernel method was used to identify the local firms that match the foreign firms. This is a type of weighted regression of the outcome on the treatment indicator variable, the kernel weights being a decreasing function of the absolute difference in propensity score between the treated and comparison unit (Smith and Todd, 2005). A Gaussian kernel with bandwidth of 0.06 was

used for the analysis. It must however be noted that while matching removes any bias caused by selection on observable variables, it leaves the possibility of bias due to selection on unobservable variables. Thus, perfect matching is not possible.

Generalised least square regression on matched sample: The PSM analysis is supplemented by GLS based regression analysis. The variables representing technological activity are regressed on foreign ownership variables after controlling for the scale of operations, age, technological opportunities and demand conditions prevailing in the industry in which the firm operates, technology acquisition through other sources, capital intensity of production methods, outward orientation, internal flows of resources, and government policy, using the matched sample to control for both, the observed and unobservable attributes and produce a robust estimator.

5. Data

The Sample

We used firm level data from PROWESS. It is a database of the financial performance of over 27,000 listed and unlisted Indian companies from a wide section of manufacturing, utilities, mining and service sectors. The data are collected by the Centre for Monitoring Indian Economy (CMIE) from the balance sheet of companies supplemented by surveys. The database is updated continuously and typically covers the period 1990 on. This data is widely used in

firm level studies of India across the world. Along with financials, the database also provides detailed information on shareholding patterns of these companies. The latter however is subject to critical limitations which are often overlooked: first, this information is provided only for the latest year. Most studies use this data assuming that the foreign shareholding of firms remains the same over the years prior to the latest year. This assumption is not reasonable for listed firms because the shares of most these companies are actively traded in the market. Acquisition of shares of the existing firms in the market has become an important mode of entry for foreign firms in India. Second, the data for shareholding patters is based on convenience sampling which means that it is subject to availability. For the listed firms it is available only for those firms that are actively traded in the market and for unlisted firms it is subject to their permission. Clearly, the studies using this data are subject to selectivity bias. For different periods, the results may vary depending upon the availability of ownership data and firms' ownership stakes in that year. There is evidence that the distributional properties of samples drawn from PROWESS are not consistent over different periods (Chaudhury, 2002). To address this limitation, we procured the month-wise ownership data of 5109 listed firms from 2000-1 to 2013-14. Interestingly, this database is also provided by PROWESS separately but gets largely ignored in the firm level analysis of FDI. We focused on this data as of March 31 of each year. It was matched with the SEBI data to validate it. It was observed that the data pertains only to actively traded firms. Therefore we cleaned this data to compare apples with apples following the two truncation rules. Firstly, we included only those firms for which the information was available for each of the 11 years. The rest were dropped. We were thus left with 2004 firms. Secondly,

we dropped those firms reporting zero or negative netsales. After the cleaning process, our final data set consisted of a balanced panel of 1781 firms belonging to 280 three-digit manufacturing industries based on the National Industrial Classification (NIC) 1998 and spanning 11 years, from 2003 to 2014.

Variables used in the analysis are defined in the Appendix Table A1.

6. Empirical analysis

Sectoral distribution of MNEs by technology intensity

For the analysis, the firm level data was aggregated into 280 three digit level industry data for the period 2003-04 to 2007-08. This exercise was done only for the boom period. The crisis period was excluded from the cluster analysis to avoid any type of bias that might have affected technological efforts of firms asymmetrically across industries. The analysis was conducted using the sectoral, technology and product differentiation variables: R&D spending (RD_INT), royalty payments (ROY_INT), and capital goods imports (CAPIMP_INT), branding intensity (ADINT) and a dummy for manufacturing sector (MFG). All these variables were converted into a binary form and the 'matching dissimilarity matrix' method was used in the clustering procedure.

Based on the standard rules as mentioned above, we identified 5 clusters of industries. All these clusters are well populated. None of them dominates in terms of the number of observations, and none of them represents a mere

residual category. This confirms that each cluster is substantive. Table 1 gives mean values on the variables in the five principal clusters. The main dividing line runs between principally manufacturing and service industries on the one hand, and between industries that score high and low on the technology and product differentiation variables on the other hand. Based on the mean values of the cluster variables we distinguished them into 5 categories as shown in Table 1.

Table 1: Mean Values by clusters

	Manufacturing			**Service**	
Variable	High Tech and high product differentiation	Medium technology and high product differentiation	Low technology and low product differentiation	High Tech and high product differentiation	Medium tech but high product differentiation
No. of industries	83	67	53	25	52
RD_INT	0.65	0.30	0.00	0.39	0.00
ROY_INT	0.35	0.04	0.00	0.10	0.05
CAPIMP_INT	1.79	2.54	1.19	2.32	3.50
ADINT	1.50	2.17	0.91	0.98	3.02

Note: See, Appendix table A1 for the definition of variables

Source: Estimated by the author

Table 2 reports clustering results by ownership of the firms (appendix table A1 for definitions), which is of primary interest to us. It may be seen that the majority owned companies are by far the most advanced ones as over 62% of them during 2009-2014 belonged to the high-tech manufacturing cluster and almost one-fourth of them concentrated in the high-tech services cluster. Only about 15% of them are classified as low-tech either in manufacturing or services. As stated above, the technological or brand superiority of MNEs is the primary reason why they venture into investing abroad in the first place. In India, this

pattern can also be attributed to the legal framework prior to 1991 which sought to channelise the activities of FDI into high technology production by setting higher FDI caps in these sectors. During 2004-08, the distribution of foreign companies was highly skewed in the favour of high tech manufacturing industries. As more policy reforms were introduced, services started becoming more promising in the late 2000s, and the distribution became somewhat diffused (as shown by standard deviations). But the changes in the sample were marginal rather than substantive.

Table 2: Classification of firms by technological orientation of industries

(%)

	2003-04 to 2007-08				
	Majority owned	Dominant__minority	Minority owned	Experiential_FF	Domestic firms
High Tech and high product differentiation mfg	64.6	62.3	62.2	36.7	37.7
Medium technology and high product differentiation mfg	6.3	7.5	2.7	10.0	13.2
Low technology and low product differentiation mfg	1.3	9.4	13.5	0.0	5.5
High Tech and high product differentiation services	19.0	18.9	13.5	46.7	32.2
Medium tech high product differentiation services	8.9	1.9	8.1	6.7	11.4
Total	100	100	100	100	100
Standard deviation	25.7	24.4	24.0	20.4	14.1
	2008-09 to 2013-14				
	Majority owned	Dominant__min	Minority owned	Experiential_FF	Domestic firms
High Tech and high product differentiation mfg	62.4	56.0	50.0	46.2	37.7
Medium technology and high product differentiation mfg	7.3	12.0	9.3	19.2	12.9
Low technology and low product differentiation mfg	0.9	4.0	11.1	7.7	5.4
High Tech and high product differentiation services	22.9	22.0	18.5	26.9	32.0
Medium tech high product differentiation services	6.4	6.0	11.1	0.0	11.9
Total	100	100	100	100	100
Standard deviation	25.1	21.3	17.1	17.9	14.0

There also appears to be substantial restructuring of firms in terms of ownership holding across the first 4 categories in the late 2000s. Within services, the share of experiential firms has declined sharply while that of other foreign firms has increased significantly across both high and low tech categories. In the manufacturing sector, on the contrary, the share of experiential firms has shown an upward movement. This reflects a clear shift of FDI from manufacturing to services. Within manufacturing, there is a visible shift of foreign firms in favour of the medium tech consumer goods. However, they continue to predominate in high tech sectors. A critical question is whether foreign firms are also more R&D active than their local counterparts or they continue to embed in internal knowledge networks.

In the PSM and regression analyses we shall control for the effect of these sectors to control for the sectoral endogeneity. These groups are represented as HTECH_MFG, MTECH_MFG, LTECH_MFG, HTECH_SER, and MTECH_SER in the subsequent analysis.

Propensity score matching

While applying the PSM, we first estimate the predicted probability of receiving foreign investment, given several firm and industry characteristics. As discussed above, we have four treatment groups: majority owned foreign firms, dominant minority owned firms, and minority owned firms and experiential firms. For

pair-wise comparisons, we estimated four propensity score functions corresponding to each group of foreign firms. We have chosen the covariates based on the existing literature (Girma, 2005; Blonigen 2005; Dunning, 1993 for literature surveys), but also considering the available dataset. Variables representing technological activity have been excluded from the model as they are the outcome variables in the analysis. The probit model used for generating propensity scores is as follows

FE= f (SIZE AGE CAP_INT EX_INT IMPR_INT, PCM, HTECH_MFG MTECH_MFG LTECH_MFG HTECH_SER MTECH_SER)

Sectoral dummies pertain to the five broad sectors identified in the cluster analysis to capture the sectoral presence of MNEs. FE represents dummy variables for four groups of foreign firms (Appendix table A1). The probit coefficients of all the variables (available on request) differ noticeably in their statistical significance across models. The estimation of different propensity score functions for different binary combinations of foreign and domestic firms sets the stage for good quality matching. Using kernel density estimation techniques, MNEs were matched with local firms over a common region of the matching variables. We ensured that the distribution of covariates between the two groups is balanced. The condition of common support resulted in discarding some firms. The level of rejections of unmatched local firms varied between 14% and 23%. Considering that the there is a large number of local firms, this does not amount to a significant loss of data and is therefore unlikely to compromise the representativeness of the results. To assess the quality of matching,

appropriate tests were conducted. The results of matching for individual covariates (available on request) show that, there were large differences in the covariates between the foreign and local firms in the original sample. These differences are considerably reduced after kernel matching. In all the cases, the absolute mean bias turns out to be insignificant. Table 3 reports the summary results of matching quality assessment tests. The pseudo-R2 which is obtained by regressing treatment propensity scores on all covariates used in matching, on the matched and unmatched samples, substantially decreased after matching in all the cases. Matching clearly removed a large part of mean and median biases also across the board. Rosenbaum and Rubin (1985) suggest that a standardised difference of > 20 should be considered as "large." Our results show that, post-matching, none of the standardised differences have absolute values larger than 3. Finally, the Likelihood ratio turns insignificant in all the models in the matched samples, confirming the results of the previous two tests.

Table 3: **Kernel matching performance: results of the mean and median absolute bias, pseudo-R2 and LR tests**

	PsR2	LRchi2	p>chi2	Mean Bias	Med Bias
Unmatched	0.102	64.78	0	33.5	24.2
Matched	0.002	0.49	1	2.6	2.2
Unmatched	0.049	23.36	0.005	20.9	15.3
Matched	0	0.06	1	1.3	1.1
Unmatched	0.063	22.71	0.007	23.2	20.2
Matched	0.006	0.65	1	3.3	1.1
Unmatched	0.057	17.05	0.03	19.1	14.1
Matched	0.002	0.14	1	3.2	2.6
Unmatched	0.071	58.26	0.000	28	24.9
Matched	0.001	0.27	1.000	2	1.1
Unmatched	0.026	11.94	0.217	17	10.3
Matched	0	0.03	1.000	0.8	0.6

Unmatched	0.024	11.8	0.225	13.4	11
Matched	0.002	0.35	1.000	0.9	0.4
Unmatched	0.015	3.88	0.867	19	9.6
Matched	0	0.01	1.000	0.7	0.6

The results based on the propensity score matching technique are presented in Table 4 and are discussed below.

Table 4: **Propensity score matching estimates of the average effect of foreign ownership and ownership stakes**

	2004-08					
	Foreign firms	Local firms	Technology spending indicator	ATT	Bootstrapped standard deviation	t-statistics
DFOR50	77	1549	RD_INT	-.131	.079	-1.658*
	77	1549	ROY_INT	.520	.118	4.410***
	77	1549	CAPIMP_INT	-.496	2.342	-.212
DFOR25	53	1336	RD_INT	0.147	0.237	0.619
	53	1336	ROY_INT	0.403	0.181	2.219**
	53	1336	CAPIMP_INT	-0.305	0.424	-0.721
DFOR10	37	1305	RD_INT	-0.168	0.165	-1.1018
	37	1305	ROY_INT	-0.018	0.061	-0.299
	37	1305	CAPIMP_INT	0.615	1.173	0.524
DFOR_EXP	30	1206	RD_INT	-0.276	0.129	-2.132**
	30	1206	ROY_INT	-0.087	.050	-1.1734
	30	1206	CAPIMP_INT	0.520	1.054	0.493
	2009-2014					
DFOR50	109	1499	RD_INT	0.091	0.133	0.685
	109	1499	ROY_INT	0.526	0.111	4.760***
	109	1499	CAPIMP_INT	0.136	0.320	0.426
DFOR25	50	1340	RD_INT	0.604	0.560	1.079
	50	1340	ROY_INT	0.220	0.120	1.830*
	50	1340	CAPIMP_INT	0.291	0.464	0.627
DFOR10	50	1340	RD_INT	-.005	0.184	-0.027
	50	1340	ROY_INT	0.031	0.046	0.672
	50	1340	CAPIMP_INT	-0.135	0.351	-0.384
DFOR_EXP	26	1209	RD_INT	2.703	2.836	0.953
	26	1209	ROY_INT	0.112	0.115	0.974
	26	1209	CAPIMP_INT	0.034	0.569	0.059

R&D activity: It may be seen that there are statistically significant differences in the average R&D intensity between local and foreign firms, in particular majority owned and experiential foreign firms during the pre-2008 period. However, contrary to our hypothesis 1, this difference is negative. These results appear to

be in line with the existing studies though. In a 1991 period study on the R&D behavior of manufacturing firms in India, Kumar and Aggarwal (2005) used the firm level data for 1992-93 to 1998-99. Their findings reveal that MNEs have increased their R&D expenditures faster than their local counterparts in response to the process of liberalization. However, after controlling for the effects of other firm specific characteristics, their average R&D intensity still turned out to be less than that of local firms. The study was revisited by Sasidharan and Kathuria (2013) who find that the average R&D intensity of foreign firms has been significantly lower than that of the local firms for the period 1994-2005.

However, our study shows that in the post 2008 period, the R&D intensity of foreign firms increased faster across all groups closing the gap between them and their local counterparts. It could partly be due to second generation reforms in the FDI regime in India that were initiated in the post 2005 period. But more importantly, it could be due to worldwide economic crisis which might have affected companies' offshoring strategies for R&D significantly by creating credit crunch in the developed world. This might have forced them to search for highly qualified personnel at low cost for their innovative activities for cost reduction. Recent studies do not confirm this explanation. A recent study by Kinkel and Som (2012) finds that German firms have actually reduced R&D relocation activities in the post crisis period. They argue that the companies seem to be more reluctant to new approaches with subjectively higher associated risks and to experimental learning of more advanced offshoring activities and modes. Their finding is confirmed by Dachs and Zahradnik (2014). They find that "in

most countries, R&D of foreign firms was more severely affected by the crisis than R&D of domestic firms". Their argument is that multinationals may have reduced R&D relocation to lower coordination costs of dispersed R&D, or because of their political commitments to their home countries. But they do find exceptions in France, the UK and Poland which show a rising trends in R&D relocation activities. Our study shows that India has also succeeded in attracting R&D oriented FDI during this period mainly due to the availability of highly skilled manpower at low cost. There has been an increase in R&D activities by all groups of MNEs in the post crisis period. But, this did not result into significantly higher R&D spending by them when compared with that of local firms.

Royalty payment intensity: Technology acquisitions through licensing arrangements show interesting results. During the first period, majority and dominant majority owned firms were found to be spending significantly more on royalty payments than their local counterparts. Evidently, secured and controlling stakes positively influence MNEs' royalty payments to their parents. This confirms the classical view of greater embeddedness of majority owned firms in internal networks to protect the spillover of their proprietary technologies. This also translates into a slow process of R&D relocation by them. During the post crisis period, royalty payments showed an upward trend by and large for both local and foreign firms but foreign firms in all categories except the 'dominant minority group' increased it faster widening the gap with local firms. Despite getting slow, the dominant minority foreign firms maintained a significant gap with the local firms. Clearly, the technological activities of foreign firms particularly those with controlling stakes increased substantially in the post crisis

period. The results confirm our hypotheses 2 and 4.

Capital goods imports: Expenditures on capital goods imports have been higher than that on the acquisition of disembodied technologies. Evidently, this has been a significant mode of technology transfer for firms for both the local and foreign owned, in the Indian context. The difference in the average spending on this mode of technology acquisition is not significantly different between the foreign and local firms in either period.

Regression Analysis

There has been a vast literature on the determinants of inter-firm differences in R&D intensity. This literature examines enterprise level R&D effort within a broad framework that associates it with several firm- and industry-specific attributes (See Kumar and Aggarwal, 2005; Sasidharan and Kathuria, 2013; see also, Cohen, 1995; Kumar and Siddharthan, 1997 for literature surveys). Adapting this broad framework to the present context, we estimated the following models for R&D (RD_INT) and international transfer of disembodied technologies (ROY_INT).

RD_INT = *f(*SIZE AGE CAPINT TECHEM ROY_INT EX_INT PCM DFOR50 DFOR25 DFOR10 DFOR_EX HITECH-MFG MEDTECH-MFG LTECH-MFG HITECH-SER MTECH-SER TAX)…..(1)

ROY_INT= *f(*SIZE AGE CAPINT RDS TECHDISEM EX PCM DFOR50 DFOR25

DFOR10 DFOR_EX HTECH-MFG MTECH-MFG LTECH-MFG HTECH-SER MTECH-SER TAX)…..(2)

It must however be noted that the two modes of technology activity namely R&D and technology acquisition may not be alternative to each other. Technology imports by firms are likely to influence their R&D efforts but the intensity of technology imports may itself depend on R&D efforts. There is thus an issue to simultaneity between 1 and 2. Further, with respect to most explanatory variables in (1) and (2), there could be a problem of two-way causality. To address these issues we assume that both, technology choice and intensity are strategic decisions and have a long term orientation. They are not spontaneously determined by the firms on the basis of their current performances. Rather these strategic decisions are influenced by their past, current and planned behavior and performances. Therefore, the performance and behavioural explanatory variables: CAPINT ROY_INT TECHEM EX_INT PCM in model 1 and CAPINT RDS TECHEM EX_INT PCM in model 2 are converted into moving average of three years: lagged year, current year and lead year. TAX is a lagged variable. Inclusion of lagged and lead variables has addressed the issue of causality and simultaneity, and has allowed us to estimate the two models separately to explore the impact of foreign ownership on them.

A panel data approach is employed to control for the unobserved firm and time specific characteristics. Using the propensity scores, the firms that are off the common support are dropped to include only those in the common support region and are matched. A fixed effect specification of the model would be an

ideal choice but is ruled out, as it does not return estimates of the main variables which are dummy variables. The only feasible way to estimate the model, therefore, is to use the random effect-specification. While estimating the model, we also took into account the year dummies to capture fixed effects of intertemporal shifts and corrected the estimates for heteroscedasticity for ensuring robustness of the estimates. The regression analysis is thus expected to produce doubly robust results.

The GLS estimates of model are presented in Table 5. It may be seen that the regression results confirm the PSM based results. Firms with ownership stakes higher than the threshold of 25% are more likely to import technologies than their local counterparts.

Table 5: GLS estimates of R&D and technology transfers: 2004-2008 and 2009-2014 on matched sample

	2004-08		**2009-14**	
	RD_INT	ROY_INT	RD_INT	ROY_INT
VARIABLES	Model 1	Model 5	Model 9	Model 13
SIZE	-0.0149	0.0272*	0.0489	0.0314**
	(-0.741)	(1.716)	(1.430)	(2.113)
SIZE2	0.00480	-0.000495	-0.00402	-0.00198
	(1.512)	(-0.307)	(-0.925)	(-1.508)
AGE	-0.00381**	7.14e-05	-0.00428**	0.000673
	(-2.082)	(0.0387)	(-2.057)	(0.489)
ROY_INT#	-0.00330		-0.0911	
	(-0.770)		(-1.112)	
RDS #		-0.000169		-0.00667
		(-0.452)		(-1.177)
CAPINT #	-4.93e-06	4.01e-06*	-5.58e-07	1.15e-07
	(-0.672)	(1.722)	(-0.759)	(0.340)
CAPIMP#	0.00831	-0.000104	0.000207	2.30e-05
	(0.845)	(-0.234)	(0.935)	(0.210)
EXINT #	0.0198***	0.000595	0.0169***	-0.000569
	(2.638)	(0.617)	(3.018)	(-0.886)

IMPR_INT#	-0.00911***	-0.000325	0.00111	0.00123*
	(-2.648)	(-0.636)	(0.422)	(1.700)
PCM#	-2.89e-06	5.48e-07	1.42e-05	1.84e-07
	(-1.276)	(0.419)	(1.261)	(0.298)
MTECH_SER	-0.0332	-0.0791	-0.109*	0.0292*
	(-0.655)	(-0.726)	(-1.769)	(1.688)
HTECH_SER	0.179	0.110	0.133	0.208***
	(1.290)	(0.679)	(0.947)	(2.823)
HTECH_MFG	0.448***	-0.0469	0.454***	0.0961***
	(5.014)	(-0.342)	(4.708)	(4.815)
MTECH_MFG	-0.0311	-0.125	-0.159***	0.0130
	(-0.754)	(-1.047)	(-2.805)	(0.874)
DFOR50	-0.296***	0.450***	0.0565	0.520***
	(-3.517)	(3.948)	(0.401)	(4.883)
DFOR25	-0.109	0.482**	-0.0490	0.242*
	(-0.908)	(2.228)	(-0.420)	(1.771)
DFOR10	-0.268***	0.00817	-0.0835	0.0377
	(-3.321)	(0.180)	(-0.720)	(0.894)
DFOR_EXP	-0.189*	-0.0735	0.583	0.186
	(-1.761)	(-1.192)	(0.721)	(1.067)
TAX##	-8.71e-07	-9.07e-07	-1.16e-06	2.11e-06
	(-0.265)	(-1.006)	(-0.518)	(1.168)
Constant	0.122	-0.0659	0.204**	-0.175***
	(1.037)	(-0.716)	(2.113)	(-3.033)
Year dummies	YES	YES	YES	YES
Observations	4,800	4,800	5,229	5,229
Number of code	1,690	1,690	1,615	1,615

Note: # represents Three years; moving average; ## represent lagged variable

*** Significant at 1%; **: significant at 5%*: significant at 10%

DFOR50 and DFOR25 turn out to be significant in all specifications for ROY_INT both the periods. Our results thus indicate that the majority owned and dominant minority owned firms spend a considerable more amount of money on R&D performed abroad (in their parent companies) than the local firms. On the other hand, the DFOR50 and DFOR25 exhibit ambiguous results in the RD_INT specifications. As a matter of fact, R&D spending of foreign firms across all categories is less than that of local firms during the first period. It was only during the crisis that these firms increased R&D relocation to India. But the change has been marginal. On an average, foreign firms are not technologically embedded in India. They are more likely to depend on their parent labs.

Among the control variables, it is interesting to note that the R&D and royalty intensities are affected differently by the strategic explanatory variables. High tech sectors in both manufacturing and services attract significant technology transfers; but those in manufacturing alone induce significantly higher R&D intensities. Thus promoting manufacturing is more likely to accelerate R&D efforts in Indian industries. Further, exporting is significantly associated with local R&D efforts; its relationship with technology imports turns out to be insignificant. Younger but large sized firms are more likely to undertake R&D; relatively smaller firms exhibit a greater tendency to import technologies. Finally, global conditions seem to affect R&D and technology transfers differently. However, the relationship between them is not found to be significant in any case. Thus technology transfers may not positively influence local R&D efforts. It is important to identify the triggers for the latter to augment technological capabilities of firms.

7. Conclusion

The majority owned and dominant minority owned firms are considered as conduits of technology transfers but evidently, their local R&D efforts are not significantly different from those of their local counterparts in the Indian context. The activities of technology generation are still concentrated in the home countries of MNEs located in India. A mere presence of MNEs as has been hypothesized in the literature may not be sufficient to generate knowledge spillover effects. The role of FDI in technology diffusion in this case depends on

the strengths and weaknesses of the local innovation systems and firms' competitiveness. In general, MNEs' R&D efforts, by cultivating closer ties to host companies and research institutes are an important source of technology spillovers. But their decision to relocate R&D to a host country itself depends in part on the strengths and weaknesses of the local R&D infrastructure.

This has an important policy implication for the government of India to improve local R&D infrastructure. It can alone play a vital role for promoting technological efforts by foreign subsidiaries and augment host country R&D base in general. Thus, much depends on the local absorptive capacity. MNEs relocate production and R&D to exploit the host country's comparative advantages to augment their own competitiveness. The host developing countries must therefore strengthen their own capabilities to exploit the benefits generated from their presence.

References

Anderson A, Park J and Jack S (2007) Entrepreneurial social capital: Conceptualizing social capital in new high-tech firms. International Small Business Journal 25(3): 245–272.

Anderson, U., Mats Forsgren and Ulf Holm 2002. The strategic impact of external networks: Subsidiary performance and competence development in the MNE, Management Journal Strat. Mgmt. J., 23: 979–996 (2002)

Andersson U, M Forsgren, T Pedersen (2001) Subsidiary performance in multinational corporations: the importance of technology embeddedness International Business Review 10 (1), 3-23

Bartlett, C. A. and Ghoshal, S. (1986). 'Tap your subsidiaries for global reach'. Harvard Business Review, 64, 87–94

Barney, J 1991, 'Firm resources and sustained competitive advantage', Journal of Management, 17(1), pp. 99-121, viewed 12 November 2010

Bellak , C. (2004). "*Foreign Firms Differ and Why Does it Matter?*" Journal of Economic Surveys Volume 18(4), 483–514.

Birkinshaw Julian, Neil Hood, Stephen Young 2005. Subsidiary entrepreneurship, internal and external competitive forces, and subsidiary performance International Business Review 14 (2005) 227–248.

Bouquet, C. and Birkinshaw, J. (2008). 'Weight versus voice: how foreign subsidiaries gain attention from corporate headquarters'. Academy of Management Journal, 51, 577–601.

Blonigen, B. 2005. "A Review of the Empirical Literature on FDI Determinants," Atlantic Economic Journal, International Atlantic Economic Society, vol. 33(4), pages 383-403, December.

Calinski, T. and J. Harabasz (1974). "A Dendrite Method for Cluster Analysis," Communications in Statistics – Theory and Methods, 3 (1), 1-27.

John Cantwell & Lucia Piscitello, 2015. "New Competence Creation in Multinational Company Subunits: The Role of International Knowledge," The World Economy, Wiley Blackwell, vol. 38(2),

pages 231-254, 02

Cantwell, J., & Mudambi, R. 2005 MNE competence-creating subsidiary mandates. Strategic Management Journal, 26 (12): 1109-1128.

Cantwell, John & Janne, Odile, 1999. "Technological globalisation and innovative centres: the role of corporate technological leadership and locational hierarchy1," Research Policy, Elsevier, vol. 28(2-3), pages 119-144, March.

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

Caves RE. 1996. Multinational Enterprise and Economic Analysis. Cambridge University Press: New York

Chang S.J., Jaiho Chung & Jon Jungbien Moon (2013) When do foreign subsidiaries outperform local firms? *Journal of International Business Studies* (2013) 44, 853–860

Chaudhury, M. (2002) Potential Selectivity Bias in Data Econo0mic and Political weekly, 37 (8), 758-766

Cohen, W. (1995) Empirical studies of innovative activity. In Stoneman, P. (Ed.) Handbook of the Economics of Innovation and Technological Change. Oxford: Blackwell

Dachs B. and G. Zahradnik , 2014 R&D internationalisation during the Global Crisis http://www.voxeu.org/article/rd-internationalisation-during-global-crisis

Dachs, B, R Stehrer, and G Zahradnik (2014), The Internationalisation of Business R&D, Edward Elgar.

Damijan, J. P., Knell, M., Majcen B. and Rojec M. (2003). “Technology Transfer through FDI in Top-10 Transition Countries: How Important are Direct Effects, Horizontal and Vertical Spillovers?,” William Davidson Institute Working Papers Series 549, William Davidson Institute.

DiMaggio, Paul J., and Walter W. Powell. 1983. “The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields,” American Sociological Review 48:147-60.

Duda, R. O., P. E. Hart, and D. G. Stork Pattern Classification (2nd edition), (John Wiley & Sons, New York, NY, 2001)

Lundan, Sarianna M.; Dunning, John (2009): 'The internationalization of corporate R&D: A review of the evidence and some policy implications', Review of Policy Research, 26(1-2):1-21, 2009

Dunning, J. H. (1993). Multinational Enterprises and the Global Economy. Wokingham: Addison-Wesley

Dunning, J. H., and S. M. Lundan 2008. Multinational enterprises and the global economy. Edward Elgar Publishing.

Dörrenbächer, C., & Gammelgaard, J. 2006. Subsidiary role development: The effect of micro political headquarters–subsidiary negotiations on the product, market and value-added scope of foreign-owned subsidiaries. Journal of International Management. 12(3): 266-283.

Dörrenbächer, C./Geppert, M. (2011): Politics and power in the multinational corporation: The role of interests, identities, and institution. Cambridge University Press: Cambridge (New paperback ed. In 2012)

Forsgren M., Holm, U., & Johanson. J. 2005. Managing the embedded multinational.: A business network view. Edward Elgar: Cheltenham.

Geppert, M./Williams, K. (2006): Global, national and local practices in multinational corporations: Towards a socio-political framework, International Journal of Human Resource Management, 17/1: 49-69.

Hedlund, G. 1986. The Hypermodern MNE – A Hierarchy? Human Resource Management, 25 (1): 9-35.

Ghoshal, Sumantra and Christopher A. Bartlett (1990), "The Multinational Corporation as an Interorganizational Network," Academy of Management Review, 15(4), 603-625.

Girma, Sourafel (2005), "Absorptive Capacity and Productivity Spillovers from FDI: A Threshold Regression Analysis", Oxford Bulletin of Economics and Statistics, Vol.

Girma, S., Greenaway, D. and Wakelin, K. (2001), “Who Benefits from Foreign Direct Investment in the UK?,” Scottish Journal of Political Economy, vol. 48(2), pp. 119-133.

Globerman, S. Ries, J. C. and Vertinsky, I., 1994. The Economic Performance of Foreign Affiliates in Canada. Canadian Journal of Economics, XXVII, No. 1, pp. 143-155.

Hake Mariya, 2009. Firm Growth and Ownership Change in CEE Countries . WIFO discussion paper

Hall BA 2010; The Internationalisation of R&D Maastricht UNU-Merit working paper series 2010-049

Hennart, J. F. 1982. A theory of multinational enterprise. Ann Arbor: University of Michigan Press.

Hirscheya M. , Hilla Skibab and M. Babajide Wintoki The Size, Concentration and Evolution of Corporate R&D Spending is U.S. Firms from 1976 to 2010: Evidence and Implications

Howenstine, N. G., and W. J. Zeile (1992). Foreign Direct Investment in the United States: Establishment Data for 1987. Survey of Current Business 72 (10): 44–78.

Hymer, S. H. 1976/1960. International operations of national firms-A study of direct foreign investment. Cambridge, MA: MIT Press.

Javorcik, Beata Smarzynska & Spatareanu, Mariana, 2008. To share or not to share: Does local participation matter for spillovers from foreign direct investment?. Journal of Development Economics, Elsevier, vol. 85(1- 2), pp. 194-217.

Kinkel, S. and O. Som (2012). Changing patterns of R&D relocation activities in the course of the global economic crisis. Technical report, DRUID summer conference, June 2012.

Kuemmerle, W. 1999. The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation. Journal of International Business Studies 30 (1): 1-24.

Kumar N. and Aggarwal A (2005) Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing_ Research Policy 34 (2005) 441–460

Kumar, N., Siddharthan, N.S., 1997. Technology, Market Structure and Internationalization: Issues and Policies for Developing Countries. Routledge and UNU Press, London and New York.

Lall, S. (1992),"Technological Capabilities and Industrialization", World Development, 20(2), pp.165 -86.

Lundan, Sarianna M.; Dunning, John (2009): 'The MNE as a creator, fashioner and respondent to institutional change' in Simon Collinson & Glenn Morgan (eds.) Images of the Multinational Firm, pp. 93-115, Oxford: Wiley, 2009.

Meyer J.W. and B. Rowan (1977) "Institutional organizations: formal structure as myth and ceremony," American Journal of Sociology, 83 (1977), 340-63.

Mudambi, R., & Pedersen, T. 2007. Agency theory and resource dependency theory: Complementary explanations for subsidiary power in multinational corporations. In: Pedersen, T. & Volberda, H. (eds.) Bridging IB theories, constructs, and methods across cultures and social sciences, Palgave-Macmillan, Basingstoke, 2007.

Narula, R., 2004, 'Understanding Absorptive Capacities in an Innovation Systems Context: Consequences for Economic and Employment Growth', MERIT Research Memorandum 2004-003.

Nerlove, M., and S. J. Press. 1973. "Univariate and Multivariate Log-Linear in Logistics Models Rand Corporation papers-R 1306-EDA/NIH Santa Monica calif

OECD (2008), "The Internationalisation of Business R&D: Evidence, Impacts and Implications", Paris.

OECD, 2008. OECD Benchmark Definition of Foreign Direct Investment - 4th Edition

Ortega-Argilés, R.; M. Piva; L. Potters and M. Vivarelli (2010) Is corporate R&D investment in high-tech sectors more effective? Some guidelines for European Research Policy. Contemporary Economic Policy, 28(3), July, 353-365

Steffen Kinkel Fraunhofer and Oliver Som Fraunhofer Changing patterns of R&D relocation activities in the course of the global economic crisis

Pearce, R. (1999) “Decentralised R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational enterprises (MNEs)”, Research Policy, 28, 157-178.

Peng, M. W. 2002. Towards an institution-based view of business strategy. Asia Pacific Journal of Management, 19(2), 251- 268.

Peng, M. W., C. Hill, and D. Wang (2000). Schumpeterian dynamics versus Williamsonian considerations: A test of export intermediary performance. Journal of Management Studies, 37 (2): 167-184.

Peng, M.W. (2001). “*The Resource-based View and International Business*.”Journal of Management Vol. 27(6): 803-829.

Peng, M.W., and T.A. Khoury. 2008. “Unbundling the Institution-Based View of International Business Strategy.” In Oxford Handbook of International Business, ed. A. Rugman. Oxford, UK: Oxford University Press

Perlmutter, H.V. (1969). The Tortuous Evolution of Multinational Enterprises. Columbia Journal of World Business, 1, 9-18

Peteraf, Margaret A. 1993. The cornerstones of competitive advantage: a resource-based view. Strategic management journal 14.3: 179-191.

RBI (2014) Annual Census on Foreign Liabilities and Assets of Indian Companies 2012-13 Feb 14, 2014 https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/ACH170214F.pdf

RBI, 2014 Census on Foreign Liabilities and Assets of Indian Companies 2013-14 – Data Release Jan 16, 2015

Rosenbaum PR, Rubin DB. 1983. The central role of the propensity score in observational studies for causal effects. Biometrika 70: 41–55.

Rugman A,M. Alain Verbeke · Quyen T. K. Nguyen, 2011 Fifty Years of International Business Theory and Beyond Management International Review (2011) 51:755–786

Sasidharan, Subash & Kathuria, Vinish, 2011. "Foreign Direct Investment and R&D: Substitutes or Complements--A Case of Indian Manufacturing after 1991 Reforms," World Development,

Elsevier, vol. 39(7), pages 1226-1239, July.

Smith JA, Todd PE. 2005. Does matching overcome LaLonde's critique of non-experimental estimators? Journal of Econometrics 125(1–2): 305–353.

Hirschey, M., Skiba, H., & Wintoki, M. B. (2012). The size, concentration and evolution of corporate R&D spending in US firms from 1976 to 2010: Evidence and implications. Journal of Corporate Finance, 18(3), 496-518.

UNCTAD (2015) World Investment Report, 2015 United Nations,

UNCTAD, 1997 World Investment Report, UNCTAD New York United Nation

UNCTAD 2005 World Investment Report UNCTAD, New York United Nation

Williamson, O.E., 1975. Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economics of Internal Organization. Free Press: New York.

Zander, I. (1999) How do you mean „global"? An empirical investigation of innovation networks in the multinational corporation, Research Policy, 28, pp. 195-213.

Appendix A1

Foreign ownership: This analysis identifies the following 5 groups of firms for the analysis

- DFOR10: firms that had predominantly been minority holders (10-25%). Predominantly means that in more than two third of the period.
- DFOR25: Firms that had been dominant minority holders (25-50%)
- DFOR50: Firms that had been majority holders (above 50%)
- DFOR_EXP: The remaining firms that had been under 25% or more foreign ownership stake in at least one of the years but less than 66% of the period.
- Dom: Purely local firms

Modes and intensities of technological activities:

- RD_INT: total R&D expenditure of ith firm as a proportion of its sales
- ROY_INT (Acquisition of disembodied technologies) : Royalties and technical fee paid abroad by *i*th firm as a proportion of its sales
- CAPIMP_INT (Acquisition of embodied technologies) : Imports of capital goods by *i*th firm as a proportion of its sales

Firm specific variables

- SIZE: net sales (transformed into logarithms)
- SIZE2: Square of SIZE
- AGE : The current year net of the year of incorporation
- ADINT: (Branding intensity): Spending on advertisement and sales promotion as % of net sales
- EX_INT: Exports of goods and services as % of net sales
- CAPINT: Net fixed assets as % of net sales
- IMPR_INT: Imports of raw materials and components as % of net sales
- PCM: profits before tax as % of net sales
- Tax: Profits before tax as a proportion of profit after tax.

Sector specific

- MFG= 1 if the industry belongs to manufacturing; =0 if it is in the service sector

- HTECH_MFG: High Tech and high product differentiation manufacturing industry =1
- MTECH_MFG Medium technology and high product differentiation manufacturing industry=1
- LTECH_MFG: Low technology and low product differentiation manufacturing industry=1
- HTECH_SER: High Tech and high product differentiation service industries
- MTECH_SER :Medium tech high product differentiation services

COPENHAGEN DISCUSSION PAPERS

2005:

2005-1 May: Can–Seng Ooi - Orientalists Imaginations and Touristification of Museums: Experiences from Singapore

2005-2 June: Verner Worm, Xiaojun Xu, and Jai B. P. Sinha - Moderating Effects of Culture in Transfer of Knowledge: A Case of Danish Multinationals and their Subsidiaries in P. R. China and India

2005-3 June: Peter Wad - Global Challenges and Local Responses: Trade Unions in the Korean and Malaysian Auto Industries

2005-4 November: Lenore Lyons - Making Citizen Babies for Papa: Feminist Responses to Reproductive Policy in Singapore

2006:

2006-5 April: Juliette Koning - On Being "Chinese Overseas": the Case of Chinese Indonesian Entrepreneurs

2006-6 April: Mads Holst Jensen - Serve the People! Corporate Social Responsibility (CSR) in China

2006-7 April: Edmund Terence Gomez - Malaysian Investments in China: Transnationalism and the 'Chineseness' of Enterprise Development

2006-8 April: Kate Hannan - China's Trade Relations with the US and the EU WTO Membership, Free Markets (?), Agricultural Subsidies and Clothing, Textile and Footwear Quotas

2006-9 May: Can- Seng Ooi - Tales From Two Countries: The Place Branding of Denmark and Singapore

2006-10 May: Gordon C. K. Cheung - Identity: In Searching the Meaning of Chineseness in Greater China

2006-11 May: Heidi Dahles - 'Chineseness' as a Competitive Disadvantage, Singapore Chinese business strategies after failing in China

2006-12 June: Émile Kok- Kheng Yeoh - Development Policy, Demographic Diversity and Interregional Disparities in China

2006-13 June: Johannes Dragsbaek Schmidt - China's "soft power" re-emergence in Southeast Asia

2006-14 September: Michael Jacobsen - Beyond Chinese Capitalism: Re-Conceptualising Notions of Chinese-ness in a Southeast Asian Business cum Societal Context

2006-15 October: Ng Beoy Kui - The Economic Rise of China: Its Threats and Opportunities from the Perspective of Southeast Asia

2007:

2007-16 February: Michael Jacobsen - Navigating between Disaggregating Nation States and Entrenching Processes of Globalisation: Reconceptualising the Chinese Diaspora in Southeast Asia

2007-17 April: Émile Kok-Kheng Yeoh, Shuat-Mei Ooi - China-ASEAN Free Trade Area: Implications for Sino-Malaysian Economic Relations

2007-18 May: John Ravenhill, Yang Jiang - China's Move to Preferential Trading: An Extension of Chinese Network Power?

2007-19 May: Peter J. Peverelli - Port of Rotterdam in Chinese Eyes

2007-20 June: Chengxin Pan - What is Chinese about Chinese Business? Implications for U.S. Responses to China's Rise

2007-21 September: Charles S. Costello III - The Irony of the Crane: Labour Issues in the Construction Industry in the New China

2007-22 October: Evelyn Devadason - Malaysia-China Network Trade: A Note on Product Upgrading

2007-23 October: LooSee Beh - Administrative Reform: Issues of Ethics and Governance in Malaysia and China

2007-24 November: Zhao Hong - China- U.S. Oil Rivalry in Africa

2008:

2008-25 January: Émile Kok-Kheng Yeoh - Ethnoregional Disparities, Fiscal Decentralization and Political Transition: The case of China

2008-26 February: Ng Beoy Kui - The Economic Emergence of China: Strategic Policy Implications for Southeast Asia

2008-27 September: Verner Worm - Chinese Personality: Center in a Network

2009:

2009-28 July: Xin Li, Verner Worm - Building China's soft power for a peaceful rise

2009-29 July: Xin Li, Kjeld Erik Brødsgaard, Michael Jacobsen - Redefining Beijing Consensus: Ten general principles

2009-30 August: Michael Jacobsen - Frozen Identities. Inter-Ethnic Relations and Economic Development in Penang, Malaysia

2010:

2010-31 January: David Shambaugh – Reforming China's Diplomacy

2010-32 March: Koen Rutten - Social Welfare in China: The role of equity in the transition from egalitarianism to capitalism

2010-33 March: Khoo Cheok Sin - The Success Stories of Malaysian SMEs in Promoting and Penetrating Global Markets through Business Competitiveness Strategies

2010-34 October: Rasmus Gjedssø and Steffen Møller – The Soft Power of American Missionary Universities in China and of their Legacies: Yenching University, St. John's University and Yale in China

2010-35 November: Michael Jacobsen - Interdependency versus Notions of Decoupling in a Globalising World: Assessing the Impact of Global Economics on Industrial Developments and Inter-Ethnic Relations in Penang, Malaysia

2010-36 November: Kjeld Erik Brødsgaard – Chinese-Danish Relations: The Collapse of a special Relationship

2011:

2011-37 April: Masatoshi Fujiwara – Innovation by Defining Failures under Environmental and Competitive Pressures: A Case Study of the Laundry Detergent Market in Japan

2011-38 November: Kjeld Erik Brødsgaard - Western Transitology and Chinese Reality: Some Preliminary Thoughts

2012:

2012-39 December: Kjeld Erik Brødsgaard - Murder, Sex, Corruption: Will China Continue to Hold Together?

2013:

2013-40 January: Sudipta Bhattacharyya, Mathew Abraham and Anthony P. D'Costa - Political Economy of Agrarian Crisis and Slow Industrialization in India

2013-41 February: Yangfeng Cao, Kai Zhang and Wenhao Luo - What are the Sources of Leader Charisma? An Inductive Study from China

2013-42 April: Yangfeng Cao, Peter Ping Li, Peter Skat-Rørdam - Entrepreneurial Aspiration and Flexibility of Small and Medium-Sized Firms: How Headquarters Facilitate Business Model Innovation at the Subsidiary Level

2013-43 October: Zhiqian YU, Ning ZHU, Yuan ZHENG - Efficiency of Public Educational Expenditure in China

2013-44: November: Yangfeng Cao - Initiative-taking, Improvisational Capability, and Business Model Innovation in Emerging Markets

2014:

2014-45 January: Michael Jakobsen - International Business Studies and the Imperative of Context. Exploring the 'Black Whole' in Institutional Theory

2014-46 February: Xin Li - The hidden secrets of the Yin-Yang symbol

2015:

2015-47 March: Aradhna Aggarwal and Takahiro Sato – Identifying High Growth Firms in India: An Alternative Approach

2015-48 May: Michael Jakobsen - Exploring Key External and Internal Factors Affecting State Performance in Southeast Asia

2015-49 May: Xin Li, Peihong Xie and Verner Worm - Solutions to Organizational Paradox: A Philosophical Perspective

2015-50 June: Ari Kokko - Imbalances between the European Union and China

2015-51 August: Chin Yee Whah - Changes of Ownership and Identities of Malaysian Banks: Ethnicity, State and Globalization

2015-52 November: Abdul Rahman Embong - State, Development and Inequality in Selected ASEAN Countries: Internal and External Pressures and State Responses

2015-53 November: Verner Worm, Xin Li, Michael Jakobsen and Peihong Xie - Culture studies in the field of international business research: A tale of two paradigms

2016:

2016-54 April: Vinish Kathuria - Does Environmental Governance matter for FDI? – Testing for Pollution Haven Hypothesis for Indian States

2016-55 April: Shruti Sharma - Does Plant Size Matter? Differential Effects of FDI on Wages and Employment in Indian Manufacturing

2016-56 April: Amar Anwar and Mazhar Mughal - Foreign Financial Flows and Terrorism – A Case Study of Pakistan

2016-57 April: Maitri Ghosh and Saikat Sinha Roy - FDI, Firm Heterogeneity and Exports An analysis of Indian Manufacturing

2016-58 April: Aradhna Aggarwal - Local R&D and technology transfers: A Comparative Analysis of foreign and local firms in Indian Industries