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Firm Heterogeneity and Choice of Ownership Structure: An Empirical Analysis of German FDI in India

by

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Abstract

We contribute to the literature on the heterogeneity of multinational enterprises (MNEs) and the relevance of firm characteristics for analyzing the determinants of outward foreign direct investment (FDI). The focus is on the role of firm-level heterogeneity when MNEs decide on the share of ownership in foreign affiliates. We combine two firm-specific datasets on German MNEs with varying equity stakes in Indian affiliates. The impact of firm characteristics on ownership shares is assessed in the context of OLS and fractional logit models, controlling for industry and location characteristics. We show that the effect of several characteristics differs between the establishment of new affiliates by German MNEs and their engagement in already existing Indian firms. Most notably, the productivity of the German parents matters only for ownership shares in new affiliates.

JEL classification: F23, L25

Keywords: multinational enterprises, firm characteristics, Indian locations, German FDI; ownership share

Outline

Non-Technical Summary

This paper contributes to the recent literature on the heterogeneity of multinational enterprises (MNEs) by analyzing the relevance of firm-specific characteristics when MNEs decide on the share of ownership in foreign affiliates. We combine two largely unnoticed datasets on German MNEs with varying equity stakes in Indian affiliates. The impact of firm characteristics on ownership shares is assessed in the context of OLS and Fractional logit models, controlling for industry and location characteristics.

The analysis shows that several factors are clearly correlated with higher ownership shares. For instance, larger parent companies prefer higher equity shares. The formation of a new firm in India, i.e., an arguably more technology intensive engagement than a joint venture with an already existing firm, generally implies a higher ownership share by the German parent. The correlation between the productivity of the parent firm and its ownership share, though positive, remains statistically insignificant – in contrast to what could be expected.

A distinct novelty of the present paper helps disentangle the links between the parent's productivity and its ownership share. The data allows examining whether there are differences in the determinants of the ownership share between the establishment of new affiliates by German MNEs and their engagement in already existing Indian firms. Indeed, the effect of several firm characteristics (and also industry characteristics) differs between these two subsamples of affiliates. Most notably, the productivity of the German parents matters only for ownership shares in new affiliates. It appears that the productivity of the parent is relevant for operating at the technological frontier and further upgrading the level of technology for the setup of a new firm employing relatively sophisticated technology. By contrast, the productivity of the parent does not play a role when German companies invest in existing firms with less than sophisticated technology.

In terms of policy implications our work points to a major aspect of heterogeneity that needs to be taken into account by governments attracting foreign direct investment to boost their growth performance. There is an important distinction in terms of productivity and, by implication technology between newly set up firms and existing firms which attract some capital inflow from abroad. Host-country governments aiming at greenfield FDI by productive MNEs may be well advised to relax foreign ownership restrictions, as India has done since the early 1990s, in order to get better access to foreign technology.

1. Introduction

There is a vast literature on the determinants of foreign direct investment (FDI), and yet our understanding of what drives FDI has remained seriously deficient. The bulk of the existing literature focuses on one particular set of possible FDI determinants, i.e., host-country characteristics that (may) help attract FDI. The other side of the coin, the characteristics of the firms undertaking FDI and the industries to which these firms belong, have been largely ignored until recently.[1]

This paper is meant to help narrow the still wide gap between purely macroeconomic studies on FDI determinants and the nascent literature on the heterogeneity of multinational enterprises (MNEs). We study a firm's choice of what level of ownership to choose when setting up a foreign affiliate. This is an important question for a number of reasons. First, a parent may be more likely to transfer state-of-the-art technology to a wholly owned affiliate than to a joint venture in order to prevent the leakage of technology to the foreign partner (Desai, Foley and Hines 2004; Ramacharandran 1993). In turn, given these differences in the levels of technology, it has been shown that there are important differences in spillovers from majority and minority owned foreign affiliates of multinationals to the local economy (Javorcik and Spatareanu 2008; Blomström and Sjöholm 1999). Hence, the decision on the ownership share may ultimately have profound implications for the relationship between inward FDI and growth in the host economy.

We focus in particular on firm characteristics as main determinant of the choice of ownership share in order to link our paper to the recent literature on firm level heterogeneity in the FDI decision (Helpman, Melitz and Yeaple 2004). To this end we combine two firm-specific datasets on German companies being engaged in India as foreign direct investors. Germany belongs to the most important home countries of FDI,[2] and India may be second only to China when it comes to concerns about offshoring in the home countries of MNEs. The bilateral FDI context is clearly relevant for both Germany and India:

- Germany plays an important role in India's efforts to attract FDI and, thereby, promote the process of economic catching up. In the 1990s, Germany ranked first among European direct investors in India.[3]

[1] Kravis and Lipsey (1982: 203) provide a notable exception: "Even in a single industry within a single parent country, firms with different characteristics will have very different propensities to produce abroad or to produce in particular countries."

[2] It is only the United States and the United Kingdom whose outward FDI stocks clearly exceeded Germany's outward FDI stocks in 2006 (UNCTAD 2007).

[3] Since 2000 Germany has been surpassed by the Netherlands and the United Kingdom (Kundu 2005; IGCC 2007).

- India's share in German FDI stocks is still relatively small; India hosted just three percent of stocks held in all developing countries in 2006, compared to 13 percent for China (Deutsche Bundesbank 2008). But German firms employed more than 120.000 workers in India, accounting for almost eight percent of German firms' employment in all developing countries.[4]

The structure of the paper is as follows. Section 2 provides a short overview of the relevant literature. Next we describe the firm-specific data used here, and provide some stylized facts on German firms' FDI and technical collaboration in India (Section 3). We employ OLS and fractional logit models to assess the impact of firm, industry and location characteristics and present the estimation results in Section 4. The effect of several characteristics differs between the establishment of new affiliates by German MNEs and their engagement in already existing Indian firms. Most notably, the productivity of the parent companies matters only for ownership shares in new affiliates.

2. Previous literature

The bulk of the existing literature on FDI determinants uses aggregate data to assess the importance of location factors at the macro level for host countries' attractiveness to FDI. The major objective of cross-country and country-specific studies alike has often been to identify policy instruments that might be effective in attracting FDI to specific locations (Amiti and Javorcik 2008).[5] The recent survey by Blonigen (2005: 4) stresses that most of these studies "either ignore … micro-level factors or assume they are controlled for through an average industry- or country-level fixed effect." Analyses on FDI determinants using aggregate data also fail to capture that FDI comes in various forms (e.g., wholly foreign owned affiliates or joint ventures with foreign minority stakes), and takes place in specific industries with varying characteristics (e.g., related to factor intensities).

However, it is by now widely accepted that firm heterogeneity plays an important role in the decision to invest abroad, as established by Helpman, Melitz and Yeaple (2004). Still, a substantial part of the recent empirical literature using firm-specific data has still in common with studies on aggregate FDI that the analysis is restricted to host-country characteristics as

[4] Employment by German firms in India was only slightly less than that in China before 2002; in more recent years, smaller German investors (affiliates with balance sheets of less than € 3 million) are no longer covered in the FDI statistics of Deutsche Bundesbank. As a matter of fact, the source on which the subsequent analysis draws (IGCC 2003) reports a considerably higher number of employees in India (about 154.000 in all firms with German equity participation) than Deutsche Bundesbank (2008). The engagement in India was particularly strong in Germany's traditional industrial strongholds such as machinery (see also Section 3).

[5] Apart from the United States as an advanced host country of FDI (e.g., Bobonis and Shatz 2007), China has received particular attention with respect to the factors underlying regional attractiveness to FDI (e.g., Cheng and Kwan 2000; Amiti and Javorcik 2008).

possible determinants of FDI. For instance, Head and Mayer (2004) use firm-specific Japanese data to assess some 450 location decisions at the regional level of EU countries. The focus is on the spatial distribution of demand as a pull factor of FDI, rather than firm characteristics that may push FDI. Buch et al. (2005) draw on firm-level FDI data for German companies to assess the relative role of host-country and firm characteristics. They account for heterogeneity mainly by including "a full set of firm-specific fixed effects" (page 84), finding that heterogeneity matters considerably for FDI-related internationalization patterns. However, the database of the Deutsche Bundesbank offers little information to control for factors that are specific to the German parent firm.[6] Javorcik and Spatareanu (2005) explicitly control for firm size and the number of foreign subsidiaries in their Tobit model on labor market regulations as determinants of FDI flows across 19 European countries. But the degree of firm heterogeneity is reduced considerably by limiting the analysis to the largest European companies.

Another group of studies provides a fuller account of firm-specific characteristics. Nachum and Wymbs (2002) cover various aspects of firm heterogeneity, but their analysis is narrowly confined to clustering of financial and professional service MNEs through mergers and acquisitions (M&As) in London and New York. Geishecker, Görg and Taglioni (2008) characterize MNEs from twelve European home countries. They find strong links between the status of a firm and firm characteristics including productivity, size and profits. More productive and larger firms are shown to own more affiliates and to be more strongly engaged in distant locations. The interaction of location and firm characteristics remains, however, open to question.

More closely related to our work, several studies analyze the determinants of the ownership structure of FDI projects by employing dichotomous choice models on wholly owned subsidiaries versus joint ventures. Gomes-Casseres (1989) shows for some 1500 subsidiaries of about 180 US-based MNEs that this binomial choice depends on the nature of each subsidiary's business, in combination with industry and host-country characteristics.[7] The probability for a joint venture is lower, for instance, when the US parent is more experienced in the specific industry and more familiar with the host country, when the

[6] Furthermore, the database of the Deutsche Bundesbank may underreport substantially FDI by smaller German firms. As noted before, reporting requirements have been relaxed since 2002, with FDI projects of less than € 3 million no longer being covered.

[7] Gatignon and Anderson (1988) draw on the same database, the Harvard Multinational Enterprise Project covering the entry modes of US-based MNEs in 1960-1975. In contrast to Gomes-Casseres (1989), these authors consider the continuum of foreign ownership (5-100 percent equity). They find, inter alia, that MNEs with more experience abroad opt for wholly owned subsidiaries; R&D intensity positively affects the first-stage decision to aim at full ownership, while varying degrees of JV partnership are viewed as equivalent in the second stage once full ownership is ruled out.

subsidiary is integrated into intra-MNE trade, and when the subsidiary operates in an R&D intensive industry that is part of the parent company's core business. Likewise, Blomström and Zejan (1991) find that Swedish MNEs with less diversified product lines and more foreign experience opt against minority ownership.[8] Javorcik (2000) focuses on intra-industry differences in R&D and marketing efforts to assess the choice between wholly owned subsidiaries and joint ventures in Eastern European transition countries. She finds that leading parent companies in terms of technology and marketing prefer wholly owned subsidiaries, though not in low-tech industries.

Asiedu and Esfahani (2001) go beyond the dichotomy between wholly owned subsidiaries and joint ventures and treat the foreign equity share as a continuous variable. Note however that joint ventures account for only 14 percent of their sample of about 2400 subsidiaries of US-based MNEs. Asiedu and Esfahani (2001) complement firm characteristics by industry- and host country-related determinants of foreign equity shares, as we will do in the following. Firm characteristics include proxies of the parent firms' assets and more widely used variables such as firm size, production diversity and international experience. Most firm characteristics impact significantly on the equity share, with the notable exception of firm size.

Two particularly interesting papers for our work are by Raff, Ryan and Stähler (2007, 2008). These papers relate directly to the recent work on firm heterogeneity and examine the links between firm characteristics (notably the productivity) of Japanese MNEs and their internationalization strategies. Raff, Ryan and Stähler (2007) analyze a sequence of internationalization decisions: Controlling for industry and country characteristics, it turns out that more productive Japanese firms are more likely to choose (i) FDI rather than exporting, (ii) greenfield FDI rather than M&As, and (iii) fully owned affiliates rather than joint ventures. Raff, Ryan and Stähler (2008) build a theoretical model which shows, inter alia, that firm productivity is positively correlated with the choice of ownership share in a foreign affiliate. They find empirical support for this proposition again using Japanese firm-level data and controlling for some host-country characteristics. Obvious questions remain, including whether these findings are specific to Japanese MNEs undertaking horizontal FDI,[9] or carry over to vertical FDI and to MNEs based elsewhere, and whether the findings would be robust to a fuller treatment of location and industry characteristics.

[8] Blomström and Zejan (1991) address the dichotomy between minority and majority ownership, rather than that of wholly owned subsidiaries versus joint ventures.

[9] Note that Raff, Ryan and Stähler (2007) deliberately focus on horizontal Japanese FDI and restrict their MNE sample accordingly. Likewise, the analysis of Raff, Ryan and Stähler (2008) is restricted to 22 OECD host countries where FDI is most likely to be horizontal.

In summary, it is widely established that the heterogeneity of firms plays an important role for both the decision to undertake FDI (Helpman, Melitz and Yeaple 2004) and the choice of ownership share (Raff, Ryan and Stähler 2008). Yet, there continues to be a shortage of empirical studies combining location characteristics, industry characteristics and firm characteristics and, thus, providing a balanced picture on major pull and push factors of FDI in general, and the ownership structure of FDI projects in particular.

3. Data and stylized facts

We combine two firm-specific datasets to assess the determinants of German company decisions on engaging in India. The first source, the Indo-German Chamber of Commerce (IGCC 2003), provides detailed information on almost 800 so-called financial and technical collaborations of German firms with Indian partners. The second source, the online databank of Hoppenstedt, a commercial data provider, contains company profiles of German companies with more than 20 employees or annual sales of more than one million €, including most of the parent firms with engagements in India.

The directory compiled by the Indo-German Chamber of Commerce covers subsidiaries of German firms in India, joint ventures with Indian firms and other collaborations involving the production of goods and services.[10] The snapshot provided by this source relates to the situation as of 2003. The dataset includes joint ventures that do not fall under the usual FDI heading, i.e., involving a minimum of 10 percent of foreign equity participation. Purely technical collaboration (license) agreements without any financial engagement of the German firm are also included.

It is in several respects that IGCC (2003) provides a particularly rich database. Information related to the type and intensity of the German firms' engagement include: the type of collaboration (financial or purely technical), the year when the collaboration started as well as the founding year of the Indian partner firm,[11] the capital stock of the German subsidiary or Indo-German joint venture, the German share in paid up capital, annual sales, and employment.[12] In addition, it is clearly identified where exactly in India the German subsidiary or Indo-German joint venture is located. This renders it possible to account for

[10] The directory excludes collaborations not involving any production such as agency agreements with Indian partners for the promotion of sales on behalf of German companies as well as representative and liaison offices set up by German firms in India.

[11] As detailed below, both years coincide if the German engagement results in a new firm that did not exist before.

[12] It should be noted, however, that some data are missing for various cases; this especially applies to annual sales.

regional characteristics at the level of Indian states and districts when assessing the determinants of the German firms' engagement.

It is important to note that the unit of observation in IGCC (2003) is the subsidiary, joint venture or purely technical collaboration, rather than the German parent or partner company.[13] Some German companies are actually involved in several projects, either FDI or technical collaboration; prominent examples include major German companies and conglomerates such as Daimler AG, Osram GmbH, Epcos AG, Allianz SE, and Siemens AG.

In order to obtain more information on the German firms being engaged in India, we use Hoppenstedt's company profiles to obtain information on the German parent relating to: (major and minor) line(s) of business with NACE industry code(s) (version 1.1), location, year of foundation, annual sales, number of employees, and number of (domestic and foreign) affiliates. We principally draw on the online database of Hoppenstedt (http://www.hoppenstedt-hochschuldatenbank.de). For many companies, however, employment and sales figures are available online only for most recent years. In order to appropriately match the parent firm data with the information on their engagement in India we refer to earlier hardcopies of Hoppenstedt (2004a; 2004b) for data on employment and sales in, preferably, 2002 (or the closest year available).[14]

Apart from stand-alone companies, Hoppenstedt presents employees and sales for (i) specific firms belonging to a company group or conglomerate ("Konzern") and (ii) the company group as a whole. We use company group data whenever applicable. Option (ii) is preferred since the decision to engage in India is highly likely to be taken at a higher company level. Moreover, option (i) would involve a downward bias for company size when minor segments of the conglomerate such as holdings provide the legal roof of foreign affiliates, while accounting for a small fraction of the conglomerate's employment and sales.

The firm-specific datasets are complemented by two sets of variables. First, we consider some important characteristics of the industry in Germany to which the parent firm belongs.[15] Characteristics such as R&D and skill intensity are supposed to be relevant *per se*

[13] The same applies to the data used by Marin, Lorentowicz and Raubold (2003) as well as Raff, Ryan and Stähler (2007).

[14] While the matching is improved by drawing on Hoppenstedt (2004a; 2004b), this comes at the cost of losing some observations on German parent firms. The reason is that employment and sales thresholds are somewhat higher (35 employees or annual sales of more than € 3.5 million), compared to the online database.

[15] Most industry characteristics can be calculated at the 4-digit NACE level. An important exception is R&D intensity which is reported only at the 2-digit level (Statistisches Bundesamt 2002a). Note that the German *Warenverzeichnis* (WZ 2003) corresponds with NACE revision 1.1.

for the decision on the ownership share (e.g., Javorcik, 2000).[16] Second, we consider some FDI determinants that are widely supposed to reflect the host economy's attraction to FDI and which may also be relevant for a firm's choice of ownership share in the foreign affiliate. We include the availability of skills (proxied by the ratio of student enrollment in higher education to population) as well as the cost of labor at the Indian state level. Appendix A presents exact definitions of all variables.

Indo-German financial collaboration (FDI for short) and technical collaboration is concentrated in two major respects: (i) in a limited number of India's states, and (ii) in some manufacturing industries.[17] The regional distribution is concentrated on the urbanized states in the south-west of India and around Delhi.[18] The distribution across states depends to some extent on whether one refers to headquarters or the factory location of the firms in India with German participation. Many headquarters are located in Delhi, Mumbai or Bangalore, while factories are located in other states. The factory location is of principal interest, notably in the manufacturing sector, when assessing the distribution of production activities (Head and Mayer 2004: 971). In various cases, however, there is no separate entry of factory location in the IGCC database (294 financial and technical collaborations). We then assume production to take place at the location of headquarters. We also use the headquarter location in cases for which the database lists several factory locations (43 financial and technical collaborations).

Applying this combination of factory/ headquarter location, the top-5 Indian states (Maharashtra, Tamil Nadu, Delhi, Karnataka and Gujarat) attracted 74 percent of the number of FDI projects. The concentration of FDI-related employment is still stronger, with more than 82 percent of employees working in the top-5 states. Maharashtra alone accounts for about half of total paid up capital and employment, while its share in the number of collaborations is considerably smaller.[19] This difference can be attributed to some large FDI projects in manufacturing industries such as the production of motor vehicles and chemicals, notably the engagement of Daimler AG (formerly DaimlerChrysler AG) in two FDI

[16] Ideally, one would of course refer to R&D intensity and skill intensity at the firm level. However, these data are generally not available; see Marin, Lorentowicz and Raubold (2003) for related survey data on German FDI projects in Eastern Europe.

[17] Detailed tables providing more information on the stylized facts summarized in the subsequent paragraphs are available in Appendix B.

[18] Twelve states mainly located in the eastern and northern hinterland did not take part in any (financial or technical) collaboration with German companies: Sikkim, Assam, Arunchal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya (all in the east), Jammu & Kashmir, Andaman & Nicobar Islands, Chhattisgarh.

[19] By contrast, Delhi hosts more than 13 percent of all headquarters of German subsidiaries and Indo-German JVs, while its share in FDI-related capital and employment is considerably smaller. This gap is at least partly due to the relatively small size of headquarter operations.

projects.[20] The regional concentration of German FDI is in line with that of approved FDI from all source countries in 2001-2005 (Nunnenkamp and Stracke 2008).

Turning to the distribution across sectors and industries, the German engagement in the services sector remained marginal until 2003. The focus of German FDI in India was clearly on the manufacturing sector, which accounted for 78-92 percent of total FDI depending on the FDI measure applied. The German engagement is also concentrated within manufacturing. Mechanical engineering, chemicals, and metal products figure most prominently in terms of the number of FDI projects. However, the industry ranking changes considerably when taking account of the size of FDI projects. As noted before, a few exceptionally large projects in the production of motor vehicles affect the distribution of German FDI in India, notably when calculating shares in terms of FDI-related employment.[21]

The prominence of some large FDI projects is also evident from the characteristics of the IGCC data shown in Table 1. All the same, three quarters of German FDI projects involve subsidiaries or joint ventures with less than Rs. 60 million of paid up capital in 2003 (slightly more than € one million at exchange rates of 2003); the median of employment is slightly below 50 workers. Large and small FDI projects have in common that the median of the German equity share typically is in the range of 50-60 percent. While minority shares of up to 25 percent are clearly the exception (54 out of 550 observations), almost a third of all FDI projects are wholly German owned subsidiaries. Another similarity is that financial collaboration typically started in the mid-1990s, i.e., after FDI regulations were relaxed in the course of India's economic reform program of 1991 (CUTS 2003). Larger FDI projects in terms of paid up capital are by far more capital intensive than smaller projects. At the same time, the ratio of turnover to employees for the first decile exceeds the corresponding ratio for the last decile by a factor of seven (calculated for the median of turnover and employment in the respective decile).

[20] The cases of DaimlerChrysler India Pvt. Ltd. and Tata Engineering & Locomotive Co. Ltd. accounted for more than 40 percent of FDI-related capital and employment in Maharashtra.
[21] Tata Engineering & Locomotive Co. Ltd., an Indian partner of Daimler AG, employed 38.000 workers in Pune.

Table 1: Sample characteristics: Median of FDI-related variables

	Paid up capital		German equity share		Employment		Annual turnover		Year of coll.	Memorandum	
	Rs. mill	(#obs)	%	(#obs)	number	(#obs)	Rs. mill.	(#obs)		cap/ empl.	turnover/ empl.
FDI (financial coll.), all cases (610)	12.8	(476)	51	(550)	48	(483)	81.9	(359)	1996	0.27	1.71
FDI deciles (capital in descending order)											
1st (47)	400		52.7		338.5	(44)	1875.1	(38)	1995	1.18	5.54
2nd (47)	116		51	(44)	125	(46)	487.2	(30)	1996	0.93	3.90
3rd (47)	60		54.5	(46)	122	(45)	290.8	(38)	1994	0.49	2.38
4th (47)	30		50.5	(42)	100	(43)	92	(33)	1996	0.30	0.92
5th (47)	20		51		50	(43)	108.4	(37)	1996	0.40	2.17
6th (47)	10		60	(46)	32.5	(42)	60	(30)	1996	0.31	1.85
7th (47)	5.6		50		35.5	(44)	38.3	(36)	1994	0.16	1.08
8th (47)	3		50	(46)	31	(45)	24.1	(38)	1995	0.10	0.78
9th (47)	2		51		19.5	(40)	13.4	(35)	1995	0.10	0.69
10th (53)	0.6		51	(51)	12	(50)	9.5	(34)	1995	0.05	0.79
technical collaboration, all (147)	20	(108)	---	---	150	(119)	120	(107)	1998	0.13	0.80

Number of observations given in parentheses only when less than total in first column.

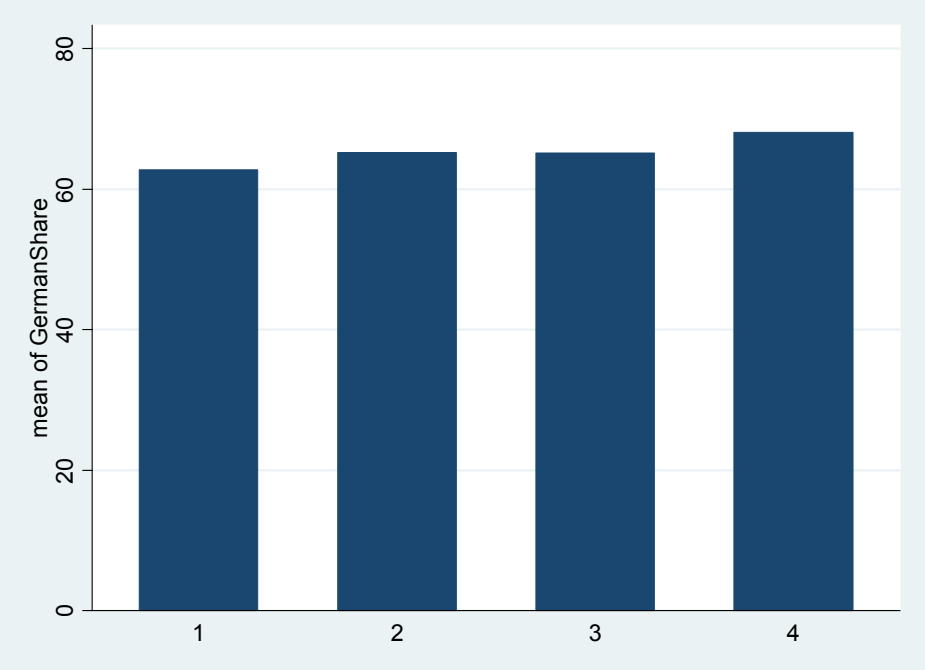
Source: IGCC (2003).

In order to connect our work with the recent theoretical and empirical work on firm heterogeneity in FDI, we focus on productivity as a firm characteristic to see how this is related to the ownership share. In what follows, we concentrate on cases of financial collaboration only (i.e., where the ownership share is strictly greater than zero). Raff, Ryan and Stähler (2008) present a theoretical model and evidence which shows that more productive firms tend to choose higher ownership shares. In order to check whether this is borne out in our data, we present as a first step a diagram plotting the average German ownership share for four productivity quartiles.[22] As can be seen, there is weak evidence that firms with higher productivity have higher ownership shares, but the difference across groups is only marginal. Of course, we are not able to exploit the various dimensions in our data in

[22] We find some strong outliers in terms of labor productivity in our data. In order to mitigate their influence we drop observations with labor productivity higher than 2.5 to avoid a bias because of holdings with low employment and very high turnover.

this graph, confounding firm, state and industry variables. In order to get a more complete picture of this issue, we now turn to a more formal modeling of the choice of ownership share.

Figure 1: Ownership share and productivity quartile



4 Methodology and results

In order to test the relationship between firm, industry, state characteristics and the ownership share we postulate the following empirical model:

$$gsi_i = \beta_1\, size_i + \beta_2\, productivity_i + \beta_3\, X_i + \beta_4\, X_j + \beta_5\, X_s + e_i \qquad (1)$$

where *gsi* is the ownership share in firm *i*; size (measured in terms of employment) and productivity (measured as labor productivity) are also at the firm level and there are three vectors of control variables at the firm *i*, industry *j* and sector *s* level. Given that we include the latter two categories of controls we also allow the error term *e* to be clustered around the industry-state dimension. Note that we focus here also on financial cases, excluding purely technical cases (with zero ownership share) from the analysis.[23]

Note that we interpret statistically significant coefficients as indicating correlations rather than causality. To do the latter we would have to make sure that there is no correlation between the variable and the error term, i.e., take account of possible endogeneity. Given the

[23] We do, however, include these in the sample in a robustness check below.

cross-section nature of our data it is difficult to come up with convincing instruments that would allow us to do this. Instead, we lag firm size and productivity in equation (1) to at least mitigate problems of endogeneity (see Appendix A for details).

Table 2 presents the results of estimations of equation (1) using simple OLS. Column (1) includes only the two main firm level variables, size and labor productivity. Note that there is a positive correlation between size and ownership share – larger parents tend to be associated with higher participation in the foreign subsidiary. By contrast, labor productivity is not statistically significantly related to ownership share, although the coefficient is positive as expected by Raff, Ryan and Stähler. (2008). This result is robust to inclusion of other variables, as can be seen in the remaining columns in the table.[24] In columns (2) to (4) we successively add more firm, industry and state variables into the equation.

The first firm level variable is a dummy indicating whether the Indian affiliate is a new firm or whether it is a German participation in an already existing Indian firm. A new firm is defined as one where the age of the Indian affiliate equals the age of collaboration, so that we can conclude that the investment was a new setup of a subsidiary. This may be an important variable to include as new firms may be expected to be generally more technology intensive. Indeed, Chakraborty and Nunnenkamp (2008) find, based on surveys of the Reserve Bank of India, that so-called FDI companies from various home countries have transferred more sophisticated technologies as well as undertaken more local R&D in India since the country's reform program in 1991. Previous studies have shown that foreign investors may prefer higher ownership shares the more technology intensive the project is in order to prevent leakage of the technology to the foreign partner (e.g., Gomes-Casseres 1989). As the consistently positive and statistically significant coefficients on this variable indicate, the formation of a new firm in India generally implies a higher ownership share by the German parent, in line with this hypothesis.

In line with earlier work we also add a variable capturing the number of industries in which a parent firm is operating to proxy the level of diversification of the parent. Previous papers hypothesize that more diversified parents are less likely to engage in full ownership, although the empirical evidence in support of this hypothesis is weak (e.g., Javorcik 2000; Meyer 1998). This variable is, also, consistently statistically insignificant in our estimation.

Another firm level determinant relates to firms' experience of investing abroad. For example, Geishecker, Görg and Taglioni (2008) show that European multinationals on

[24] Note that the pair-wise correlation in the sample between log employment size and log labor productivity is only 0.029 and is not statistically significant. Hence, multicollinearity is not a likely explanation for the statistically insignificant result on labor productivity.

average have more than one foreign affiliate, and that there is a positive correlation between the number of foreign affiliates and the productivity of a multinational. In other words, highly productive firms tend to invest more abroad. Arguably, the level of experience abroad may also have implications for the choice of ownership. Firms with no experience may have to cooperate with foreign partners who know about the foreign environment. By contrast, firms with large experience abroad may not have to rely on foreign partners but are familiar with overseas operations and can therefore choose to go on their own. This implies that we would expect a positive correlation between the number of foreign affiliates a firm has, and its choice of ownership share (see also Gatignon and Anderson 1988; Blomström and Zejan 1991). Inclusion of this variable, however, yields statistically insignificant coefficients.

Given that our dependent variable is measured in 2003, there is concern that firms established before that date increase or decrease their ownership share over time. To control for this we include the year of establishment of the collaboration. The coefficients on this variable are negative, although not always statistically significant. Finally, given that India liberalized its regulations towards foreign direct investment from 1991 onwards (CUTS 2003; FICCI 2005), a lower ownership share by firms established before 1991 may not reflect economic optimization but only the effect of the regulation. To control for this we include a dummy which is equal to one from 1991 onwards. This variable, as expected, returns consistently positive and statistically significant coefficients.

Column (3) adds two variables to the equation which control for characteristics of the German industry. These are the average wage in the industry as well as the R&D intensity of production. This, therefore, allows checking whether the fact that a parent operates in a high wage (skill) or high technology industry has any implications for its choice of ownership share. Previous literature finds that firms in R&D and skill intensive industries tend to prefer full to shared ownership in order to assure product quality and prevent leakage of knowledge (e.g., Javorcik 2000; Gomes-Casseres 1989).[25] However, the coefficients turn out to be statistically insignificant in our case. This may reflect that the choice of ownership share is not only due to industry characteristics but, more importantly, driven by attributes of the firm (see also Javorcik 2000).

A distinct novelty of our paper is that we have information on the regional location of the investment and, accordingly, we add two variables proxying characteristics of the Indian host state to the estimation in column (4). The percentage of student enrollment in higher

[25] However, these studies generally proxy industry characteristics using data for the host country, while we use information on the home country industry. Arguably, the characteristics of the home country industry are a better indicator of the technology level used in the industry than the host country.

education, a measure of skills at the state level, returns a positive and statistically significant sign. Firms choose higher ownership shares in states with high levels of human capital. We also find that the level of labor costs in a state is negatively correlated with the ownership share – firms locating in low wage states tend to go for higher capital shares in the foreign affiliates. This is in line with previous findings by Asiedu and Esfahani (2001) who argue that higher wages tend to go along with lower foreign equity shares.

One point to criticize in the estimations thus far is that the dependent variable is the log of the ownership share, where the share ranges from 2.5 to 100 percent. Hence, we have a variable that is bounded in this interval. Ignoring this form of the distribution of the variable and using simple OLS to estimate the model may lead to biased results. In order to deal with this more appropriately we use the absolute level of the ownership share, appropriately scaled between 0.025 and 1, and employ for estimation the quasi-likelihood method developed by Papke and Wooldridge (1996).[26] This fractional logit model allows dealing with a fractional response variable in the interval [0,1] taking account of its bounded nature and the possibility of observing values at the boundaries of the interval.[27] It is reassuring to note, however, that this different estimator does not change the results qualitatively in any significant way.

Another potential criticism is that we in effect treat the liberalization of FDI regulations pursued by India as a "big bang" which is captured by a dummy equal to one from 1991 on and thereafter. While this is the contention of some experts,[28] others would argue that there have been gradual changes since 1991 (e.g., CUTS 2003). These may not be reflected adequately in the simple dummy variable included in the model thus far. In order to allow for more gradual effects over time, we therefore include annual dummy variables from 1991 onwards, with the base category being years before 1991. We do not report the coefficients on these 12 dummies (1991 to 2003) in Table 2 to save space, but we note that they are jointly statistically significant (as indicated by the Wald tests reported in the table) and mostly positive and individually significant also. The results of this estimation are reported in column (7), which are very similar to those of the fractional logit in column (6). The only difference is

[26] A tobit model is in this context not appropriate as it assumes a truncated distribution, i.e., part of the distribution is not observable due to censoring. In the case here, the variable is bounded between 0 and 1 by definition, which is a different issue.

[27] Note that, while industry dummies in columns (1) to (4) are defined at three digit NACE level, estimation of the fractional logit model did not achieve convergence with three digit dummies. We therefore estimated this model with two digit NACE level dummies, reported in columns (5) and (6). To check whether this may introduce a problem into our analysis we also re-estimated the equation reported in column (4) using two digit dummies. The results are very close to the results using three digit dummies. We are therefore confident that using two digit dummies does not lead to any biased results.

[28] For instance, Balasubramanyam and Mahambare (2003: 46) argue: "The 1991 reforms marked a major break from the earlier dirigiste regime with its regulation of the spheres of foreign affiliate participation and its modes of operation."

the coefficient on new firms, which is now statistically insignificant. This may indicate that "new firm" captures to some extent time or regulatory effects. Of course, given the nature of our data we cannot comment on causality, but merely establish correlations. Hence, a possible alternative explanation is based on reverse causation. Rather than new and higher-tech projects resulting in higher German equity shares, the deregulation of ownership restrictions provides better incentives to transfer up-to-date technologies.

Table 2: Baseline estimation results

	(1) OLSs	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) Fractional logit	(7) Fractional logit
ln(size)	0.066	0.055	0.055	0.052	0.048	0.155	0.161
	(0.025)***	(0.026)**	(0.026)**	(0.026)**	(0.018)***	(0.045)***	(0.042)***
ln(productivity)	0.112	0.103	0.103	0.125	0.008	0.169	0.191
	(0.115)	(0.107)	(0.107)	(0.104)	(0.072)	(0.145)	(0.158)
Firm controls							
age		-0.005	-0.005	-0.006	-0.006	-0.021	-0.019
		(0.007)	(0.007)	(0.007)	(0.006)	(0.010)**	(0.008)**
diversification		0.027	0.027	0.022	0.017	0.024	0.054
		(0.018)	(0.018)	(0.017)	(0.016)	(0.035)	(0.037)
dummy liberalization		0.445	0.445	0.425	0.373	0.713	
		(0.142)***	(0.142)***	(0.145)***	(0.122)***	(0.231)***	
new firm		0.187	0.186	0.192	0.223	0.554	0.270
		(0.076)**	(0.075)**	(0.078)**	(0.096)**	(0.230)**	(0.252)
# affiliates		0.011	0.011	0.013	0.008	0.015	0.010
		(0.008)	(0.008)	(0.009)	(0.008)	(0.018)	(0.016)
Industry controls							
ln(wageind)			-0.028	-0.022	0.095	0.333	0.215
			(0.171)	(0.177)	(0.114)	(0.248)	(0.264)
ln(R&D)			0.187	0.129	-0.106	-0.253	-0.139
			(0.128)	(0.133)	(0.101)	(0.194)	(0.208)
State controls							
ln(skill)				0.274	0.298	0.951	0.800
				(0.107)**	(0.091)***	(0.219)***	(0.266)***
ln(wagestat)				-0.292	-0.340	-0.964	-0.963
				(0.214)	(0.216)	(0.461)**	(0.496)*
Observations	282	282	282	282	282	282	282
Wald test (p-value)							0.00
R-squared	0.24	0.42	0.42	0.44	0.33		

Heteroskedasticity consistent standard errors in parentheses, clustered at state-industry level
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include industry dummies. In column (1) to (4) these are defined at 3-digit NACE level, in columns (5) to (7) at 2-digit NACE level
Column (7) also includes a set of time dummies starting in 1991; Wald test for joint significance of time dummies

Thus far we have assumed that the effect of the independent variables on the ownership share is homogenous across different types of firms. We now relax this

assumption. Specifically, we examine whether there are differences in the determinants of the ownership share between affiliates that are newly established firms, and those where the German ownership participation is in an Indian firm that existed already before and continued to operate under the same name. Newly established affiliates in this context include completely new and fully owned greenfield investments as well as new joint ventures with Indian partners that lead to the setup of a legally independent new firm. Why would we expect differences between such new and old affiliates? As shown above, the setup of new firms is generally associated with higher ownership shares. It is reasonable to assume that this reflects the use of more sophisticated technology in these types of affiliates compared to the setup of ownership links with already established Indian firms. Under this assumption it may also be expected that other variables impact differently on the ownership share choice of the two types of firms.

Here we are particularly concerned with productivity. This variable, thus far, has, contrary to expectations, not been an important determinant of the ownership share. We argue and empirically check whether this is due to pooling these two types of firms. It may be the case that for the German investor's engagement in "old firms" with less than sophisticated technology the productivity of the parent does not play a role. By contrast, for the setup of new firms, associated with high technology, the productivity of the parent may be relevant for operating at the technological frontier and further upgrading the level of technology. Hence, we may expect that productivity matters as a determinant of the ownership share of new firms – with parents with higher productivity (thus higher technology) preferring, ceteris paribus, higher ownership shares.

We examine these hypotheses in Table 3, where we split the sample into "new" and "old" firms and estimate the fully specified model as discussed above separately for the two samples. The results are in columns (1) and (2). As expected, there are indeed differences in the coefficients for these two types of firms. For new firms we find that productivity levels of the parent are positively correlated with the ownership share, while this is not the case for German capital participation in old firms. This is in line with our reasoning above. The same goes for the proxy of the level of diversification of the parent, which is positively correlated only for new firms.[29] Assuming that diversification is also a proxy for the level of technology this result fits in with our discussion above.

[29] By contrast, Meyer (1998) and Javorcik (2000) find either a statistically insignificant or negative correlation with the probability of choosing a wholly owned affiliate. One possible explanation is that the research question is different. The previous literature has a probit model on joint vs. wholly owned affiliates, while we model the share of ownership as a dependent variable.

A further difference with the results reported in Table 2 is that R&D intensity in a sector is now statistically significant and positively correlated with the firms' choice of ownership share. This is in line with much of the previous literature which shows that firms in technology intensive sectors are more likely to opt for full ownership in order to protect their proprietary assets.[30]

Table 3: Distinguishing new and old firms

	(1) logit newfirm	(2) logit oldfirm	(3) logit newfirm	(4) logit oldfirm	(5) logit newfirm	(6) logit oldfirm
ln(size)	0.343	0.081	0.314	0.045	0.381	0.011
	(0.077)***	(0.062)	(0.091)***	(0.044)	(0.092)***	(0.054)
ln(productivity)	0.830	0.054	0.935	0.068	0.726	-0.103
	(0.292)***	(0.182)	(0.286)***	(0.213)	(0.277)***	(0.268)
Firm controls						
age	-0.043	-0.013	-0.034	-0.015	-0.050	0.031
	(0.018)**	(0.013)	(0.018)*	(0.010)	(0.020)**	(0.009)***
diversification	0.168	0.030	0.155	0.069	0.191	0.045
	(0.085)**	(0.056)	(0.083)*	(0.053)	(0.087)**	(0.045)
# affiliates	-0.022	0.025	-0.021	0.039	-0.041	0.076
	(0.033)	(0.025)	(0.029)	(0.020)	(0.032)	(0.025)***
dummy liberalization	0.655	0.646				
	(0.442)	(0.276)**				
Industry controls						
ln(wageind)	0.063	0.294	0.383	0.071	0.346	0.206
	(0.358)	(0.338)	(0.417)	(0.350)	(0.309)	(0.350)
ln(R&D)	3.722	5.640	3.588	5.979	3.193	3.051
	(0.414)***	(0.346)***	(0.376)***	(0.410)***	(0.387)***	(0.314)***
State controls						
ln(skill)	0.443	0.861	0.424	0.626	0.994	0.486
	(0.359)	(0.337)**	(0.339)	(0.353)*	(0.414)**	(0.395)
ln(wagestat)	0.233	-1.330	0.215	-1.395	0.680	-0.238
	(0.769)	(0.847)	(0.698)	(0.765)*	(0.666)	(0.743)
Observations	109	173	109	173	115	220

Heteroskedasticity consistent standard errors in parentheses, clustered at state-industry level
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include two digit industry dummies.
Columns (3) to (6) also include a set of time dummies starting in 1991; Wald test for joint significance of time dummies
Column (5) and (6) include technical cases, with gsi = 0

As a robustness check, columns (3) and (4) present estimations which use annual dummies from 1991 onwards to allow for gradual changes in the regulatory environment. This does not change our results in any important way. Columns (5) and (6) add another robustness check. Recall that the sample used for the estimations includes German capital participations in Indian affiliates – i.e., the capital participation is always larger than zero. In

[30] Note that this result also indicates that inappropriate pooling of new and old firms, which assumes homogenous effects of all covariates and a common variance-covariance matrix, leads to misleading results on the importance of sector level R&D intensity.

our data, however, we also have information on another type of international cooperation, namely, technical collaboration. In these so-called “technical cases”, there is no transfer of capital (i.e., a zero ownership share of the German partner) but there is a transfer of technology. In the last step of our analysis we add these technical cases to our sample. In effect we, hence, add a number of observations with zero ownership share. Reassuringly, our results on the relationship between productivity and foreign ownership share are robust to this change in the sample.

5 Summary and conclusion

This paper contributes to the recent literature on the heterogeneity of multinational enterprises (MNEs) by analyzing the relevance of firm-specific characteristics when MNEs decide on the share of ownership in foreign affiliates. We combine two largely unnoticed datasets on German MNEs with varying equity stakes in Indian affiliates. The impact of firm characteristics on ownership shares is assessed in the context of OLS and Fractional logit models, controlling for industry and location characteristics. In contrast to most previous studies employing dichotomous choice models on wholly owned subsidiaries versus joint ventures, the data used in the present study allows treating the German MNEs’ equity shares as a continuous variable.

While the data presents a unique and rich source to study the decisions by German MNEs, the bilateral Indo-German setting of the present paper implies also limitations. Further research is required in several respects. First of all, the findings for German FDI do not necessarily apply to companies based elsewhere. Likewise, the motivations underlying FDI in India are bound to differ from those of FDI in smaller developing countries or advanced host countries. Ideally, one might aim at panel analyses covering various host countries and revealing more than just a snapshot of one particular year. However, such data are at present not available.

The findings that emerge in our empirical analysis are somewhat ambiguous for the overall sample of Indo-German collaborations. Several factors are clearly correlated with higher ownership shares. For instance, larger parent companies prefer higher equity shares. The formation of a new firm in India, i.e., an arguably more technology intensive engagement than a joint venture with an already existing firm, generally implies a higher ownership share by the German parent. On the other hand, the correlation between the productivity of the parent firm and its ownership share, though positive, remains statistically insignificant – in contrast to what could be expected.

A distinct novelty of the present paper helps disentangle the links between the parent's productivity and its ownership share. The data allows examining whether there are differences in the determinants of the ownership share between the establishment of new affiliates by German MNEs and their engagement in already existing Indian firms. Indeed, the effect of several firm characteristics (and also industry characteristics) differs between these two subsamples of affiliates. Most notably, the productivity of the German parents matters only for ownership shares in new affiliates. It appears that the productivity of the parent is relevant for operating at the technological frontier and further upgrading the level of technology for the setup of a new firm employing relatively sophisticated technology. By contrast, the productivity of the parent does not play a role when German companies invest in existing firms with less than sophisticated technology.

In terms of policy implications our work points to a major aspect of heterogeneity that needs to be taken into account by governments attracting foreign direct investment to boost their growth performance. There is an important distinction in terms of productivity and, by implication technology between newly set up firms and existing firms which attract some capital inflow from abroad. Host-country governments aiming at greenfield FDI by productive MNEs may be well advised to relax foreign ownership restrictions, as India has done since the early 1990s, in order to get better access to foreign technology.

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Appendix A – Definition and sources of variables

Variable	Definition	Source
German subsidiary or joint venture in India:		
gsi	German share in paid up capital, percent; 2003	IGCC (2003)
age	Year of subsidiary, JV or technical collaboration going into operation	IGCC (2003)
new firm	Dummy variable; equals "one" if the founding year of the Indian partner firm coincides with "age" (as defined above), and "zero" otherwise	IGCC (2003)
dummy liberalization	Dummy variable accounting for the liberalization of Indian FDI regulations since 1991; equals "one" for collaborations established from 1991 onwards, and "zero" otherwise	IGCC (2003).
Characteristics of German parent firm:		
size	Size of the parent company, measured by number of employees; in logs; 2002 or closest year available.	Hoppenstedt (online; 2004a, b)
productivity	Labor productivity, proxied by sales per employee; in logs; 2002 or closest year available.	Hoppenstedt (online; 2004a, b)
# affiliates	Number of foreign affiliates (proxy of parent firm's international experience)	Hoppenstedt (online)
diversification	Number of industries (4-digit NACE codes) in which the parent firm is active (proxy of degree of diversification)	Hoppenstedt (online)
Industry characteristics in Germany:		
wageind	Skill intensity, proxied by gross wage and salary payments per employee; 1000 €; in logs; 2003 (4-digit NACE)	Statistisches Bundesamt (2002a; 2002b)
R&D	R&D intensity, measured by R&D expenses in percent of gross production; in logs; 2003 (2-digit NACE)	Statistisches Bundesamt (2002a)
Location characteristics in Indian states:		
wagestat	Average labor costs per day; sample sector; Rs. in logs; 2000/01	Ministry of Labour and Employment (2004)
skill	Student enrollment in higher than secondary education; share of population; in logs; 1999/2000	Observer Research Foundation (2004)

Appendix B:

German FDI and technical collaboration in India: Distribution across Indian States (percent)

State	# cases, financial and technical collaboration		# cases, financial collaboration	Paid up capital, financial collaboration	Employment, financial collaboration
	HQ location	factory/HQ location[a]	factory/HQ location[a]	factory/HQ location[a]	factory/HQ location[a]
Maharashtra	35.7	32.0	31.8	49.2	53.4
Delhi	13.1	10.2	11.1	4.6	4.5
Tamil Nadu	12.7	12.7	12.3	3.9	5.1
Karnataka	10.4	10.2	10.5	6.4	15.9
Gujarat	6.1	8.6	8.0	7.0	3.7
West Bengal	5.4	5.0	4.9	9.6	1.6
Haryana	4.5	5.4	5.6	5.1	5.1
Uttarranchal	4.0	5.0	5.1	4.3	3.6
Andhra Pradesh	3.6	3.6	3.1	0.8	0.8
Kerala	1.2	1.2	1.3	0.1	0.1
Rajasthan	0.8	0.9	1.0	0.1	0.1
Jharkhand	0.7	1.1	1.0	0.4	0.3
Madhya Pradesh	0.7	0.7	0.7	0.1	0.2
Punjab	0.5	0.8	0.7	1.9	3.0
Bihar	0.3	0.3	0.3	0.0	0.0
Pondicherry	0.3	0.5	0.7	3.4	0.3
Goa	0.1	0.7	0.8	0.8	0.3
Chandigarh	0.1	0.1	0.2	0.0	0.5
Daman & Diu	0	0.5	0.5	0.6	0.6
Himachal Pradesh	0	0.3	0.2	0.1	0.1
Dadra & Nagar Haveli	0	0.1	0	0	0
Orissa	0	0.1	0.2	0.3	0.2
Uttar Pradesh	0	0.1	0.2	1.2	0.7
# observations	757	757	610	476	483
Sum				42524.03[b]	154329[c]

[a] Factory location whenever available for one particular state; HQ when no separate entry of factory location and when several factory locations given (see text for details). [b] Rs. million. [c] Number of employees.

German FDI and technical collaboration in India: Distribution across industries (percent)

Industry	# cases		Paid up capital (fin. coll.)	Employment, (fin. coll.)
	financial collaboration	technical collaboration		
Mining and quarrying	0.2	0.7	0.0	0.0
Manufacturing	78.4	88.2	80.1	92.0
Manufacture of textiles	1.1	0.0	0.3	0.2
Manufacture of chemicals and chemical products	9.6	7.4	14.7	9.7
Manufacture of rubber and plastic products	3.9	5.1	3.0	1.9
Manufacture of basic metals	2.5	3.7	4.8	4.3
Manufacture of fabricated metal products, except machinery and equipment	7.4	5.1	2.2	2.6
Manufacture of machinery and equipment n.e.c.	28.9	38.2	18.3	16.8
Manufacture of electrical machinery and apparatus n.e.c.	5.7	3.7	5.1	5.0
Manufacture of radio, television and communication equipment and apparatus	2.1	2.2	2.8	1.8
Manufacture of medical, precision and optical instruments, watches and clocks	5.7	9.6	1.3	1.5
Manufacture of motor vehicles, trailers and semi-trailers	4.4	4.4	23.9	45.6
Other manufacturing	4.6	3.7	3.9	1.1
Construction	1.4	1.5	0.3	0.5
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	7.1	5.9	4.7	1.2
Transport, storage and communication	2.3	0	3.3	1.1
Financial intermediation	1.6	0	7.6	0.9
Real estate, renting and business activities	8.0	2.9	3.8	3.9
Other services/ utilities	1.1	0.7	0.3	0.3
Total	571	139	42524.03	154329[b]

[a] Rs. million. [b] Number of employees.