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# FDI Spillover Effects on the Productivity of the Indian Pharmaceutical Industry: Panel Data Evidence

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## Abstract

The study empirically examines the horizontal spillover effects of foreign direct investment (FDI) on the productivity of Indian pharmaceutical firms. Robust least squares and the Generalized Method of Moments estimators are applied for the firm-level panel data of Indian pharmaceutical companies whose shares were traded on the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE). The information was collected from the Centre for Monitoring Indian Economy (CMIE) Prowess database from 2015 to 2019. Based on the regularity in data availability, the sample firms are limited to 112 companies, 100 of which are domestic firms and 12 international firms. Firms with more than 10 percent foreign equity are classified as FDI firms, while those with less than that are classified as domestic firms. Estimation results show that foreign ownership does not contribute to the productivity of domestic firms. Due to increased competition, the Indian pharmaceutical companies with foreign equity participation are not more productive than local ones. Moreover, the findings reveal a negative and insignificant horizontal spillover effect from FDI on the productivity of domestic enterprises. The absence of horizontal spillovers may be attributable to foreign enterprises' ability to prevent technological outflow to competitors in the same industry.

**Keywords:** Foreign Direct Investment, Horizontal Spillover, Productivity, Generalized Method of Moments, Pharmaceutical Industry

**JEL Classification Code:** D24, F21, F23, L65

## 1. Introduction

Foreign direct investment (FDI) is a crucial component of a host country's economic development. The spillovers from FDI are the most effective channel for implementing modern technology, which are of two types: inter-industry and intra-industry spillover effects (Liu et al., 2000; Le et al., 2019). Inter-industry (vertical) spillovers emerge due to the linkages between foreign and domestic enterprises, which is frequently a multi-sectorial process. These spillovers occur when local suppliers match a foreign firm's need for greater standards and delivery criteria (Javorcik, 2004). For instance, the product standards and technology are enforced through direct knowledge transfer from abroad affiliates to domestic suppliers within the allied sectors. The presence of multinationals raises the need for intermediate goods, allowing domestic providers to benefit from scale economies (Barrios, 2000; Javorcik, 2004). Intra-industry (horizontal) spillovers are caused by multinational corporations (MNCs) in a particular sector. They can arise through five indirect transmission channels: (i) competitiveness (ii) imitation and demonstration effects (iii) R&D and technology transfer (iv) labor turnover and human capital, and (v) business management (Blomström & Sjöholm, 1999; Gorg & Strobl, 2001).

The local indigenous firms must employ their technology more effectively otherwise, MNE affiliates cause inefficient firms to disappear. Increased competition may be detrimental to domestic enterprises if the marketplace is crowded with foreign firms, which might drive them

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out (Taymaz & Lenger, 2004). Due to their exclusive technology, management, and marketing expertise, MNCs have an advantage in demonstration and imitation effects. Spillover effects arise due to the foreign enterprises' superior knowledge and technological capabilities. For example, technological spillovers can arise when foreign companies' products or manufacturing techniques are imitated or reverse engineered. MNCs are often R&D and capital demanding; therefore, the transfer of production and process technology from MNCs to domestic enterprises could be a possible source of intra-industry (horizontal) spillover. Moreover, the spillover effects may be induced by MNC's R&D activities in the host country. MNCs affiliates have intangible assets viz. management talents, and provide more training to workers than domestic firms. These employees who have been trained within the MNCs may contribute additional effectiveness to domestic firms (Dunning, 1970; Haddad & Harrison, 1993; Aitken & Harrison, 1999). This shows that the existence of foreign firms might benefit the local economy since its knowledge may become available to local enterprises through employee turnover.

Some authors further suggest that horizontal spillovers are much more likely to occur than vertical effects. There exists a debate over the importance of vertical and horizontal spillovers. Over the last decade, horizontal spillovers have become increasingly more important than vertical spillovers (Damijan et al., 2013). Moreover, Laenarts and Merlevede (2011) emphasized that the vertical spillovers are related to inter-industry links at the double-digit industrial level, thereby missing the nuanced and possibly more concrete firm-based vertical association between foreign and domestic firms within an industry. Further, the classification of vertical spillovers is most often based on the industry aggregation used in the input-output (IO) table. The changes in the level of industry aggregation in the IO table might cause a problem in capturing the vertical spillover effects.

Our study attempts to investigate the horizontal spillover effects from FDI on the productivity of domestic pharmaceutical firms. Since the studies related to FDI spillover effects across the Indian pharmaceutical firms are meager, the present study sheds light on whether the presence of foreign affiliates contributes to the productivity of Indian pharmaceutical firms. A balanced panel dataset of pharmaceutical firms from 2015 to 2019 is considered based on the availability of the data. The study sample consists of 112 pharmaceutical firms, including 100 domestic and 12 foreign-affiliated firms. Those firms with 10 percent or more foreign equity are classified as foreign affiliates, whereas 10 percent or less are classified as non-FDI firms. The study assumes special significance given the emergence of developing countries viz. India. The economy is a major recipient of FDI, and predominantly the pharmaceutical and drug manufacturing industries have opened their doors to 100 percent FDI. According to the Department for Promotion of Industry and Internal Trade (DPIIT) Report (2020), the total FDI inflows received from January 2000 – December 2019 were US$ 457.46 billion. Out of this, the amount of FDI equity inflows in the Drugs & Pharmaceuticals Sector from January 2000 to December 2019 is US$ 16.44 billion, which is 3.59 percent of the total FDI equity inflows. The study is crucial for the policymakers to improve the productivity of the domestic sector and effectively steer the FDI policy related to the industry by addressing the vital research question of whether FDI contributes to the productivity of domestic pharmaceutical firms through horizontal spillover effects.

The remainder of the paper is structured as follows. In section 2, we present a literature review on FDI spillover effects. Section 3 shows a description of the econometric model and data. Section 4 discusses the econometric results. The final section contains the conclusion.

## 2. Literature Review

Globerman (1979) examined the spillover effects of FDI in Canadian manufacturing industries. The author evidenced that labor productivity differences across Canadian-owned plants are positive. Using the sample of 468 Chinese manufacturing firms, Kinoshita (1998) revealed that the technical spillovers from FDI have a significant positive effect on domestic firms' productivity growth. Using cointegration and dynamic OLS techniques, Lee and Brahmasrene (2018) investigated the FDI spillover effects on the efficiency of the bank industry in China for the period from January 2002 to October 2013. The results revealed that FDI inflows in the banking sector are positively related to productivity and performance and short-term loans in China. Using firm-level panel data on Czech manufacturing firms, Kinoshita (2000) investigated the impact of the research and development and technology diffusion from FDI on productivity growth. The study found no evidence of technology spillovers to local firms from having a foreign joint venture partner. Using firm-level panel data of Lithuania, Smarzynska (2002) established a positive correlation between the change in the foreign equity share and firm productivity growth, but no evidence of horizontal spillover. Using a panel of more than 10,000 Chinese indigenous and foreign-invested manufacturing firms, Wei and Liu (2006) found positive intra- and inter-industry productivity spillovers from foreign presence to indigenous Chinese firms within regions.

For a panel of Italian manufacturing firms, Reganati and Sica (2007) investigated the productivity technology spillover effects from FDI using pooled OLS model. The study revealed spillover effects happen from foreign firms to local firms through horizontal rather than vertical channels. Tian (2007) investigated the technology spillover effects for

a sample of 11324 Chinese manufacturing firms and found that foreign enterprise generates a positive technical spillover effect on domestic firms. Piyaareekul (2008) analyzed the spillover effects of FDI from the entry of multinational enterprises and the regional economic integration in the ASEAN countries. The study showed that FDI inflows lead to total factor productivity growth in Indonesia, Malaysia, Philippines, Singapore, and Thailand. Using the OLS technique, Dimelis and Papaioannou (2010) examined whether spillover effects from FDI on the productivity growth of 2589 manufacturing firms operating in Greece. The results established a positive and significant spillover effect on productivity growth.

Uttama and Peridy (2010) examined the productivity technology spillover effects of FDI inflows on ASEAN countries. The Toda-Yamamoto causality test results revealed that the entry of multinational firms augments the productivity technology spillover effects through both backward and forward linkages. Javorcik and Spatareanu (2011) examined the vertical spillovers from FDI for a sample size of 59535 manufacturing firms operating in Greece. By employing a Cobb-Douglas production function, the study evidenced the vertical spillovers from FDI. Cristina and Levieuge (2013) investigated the technological spillovers from FDI using an unbalanced panel dataset of Romanian firms and found that vertical spillovers are significant while horizontal ones are insignificant. For a sample of 1000 Ethiopian manufacturing firms, Getachew (2013) indicated that domestic firms benefit in terms of total factor productivity and labor productivity in the presence of foreign affiliates. Sönmez and Pamukcu (2013) assessed the horizontal technology spillovers on the growth of domestic firms in the Turkish manufacturing industry using the Cobb-Douglas production function. The study found horizontal spillover effects in the presence of foreign ownership.

Salim and Bloch (2014) evaluated the spillover effects on the technical efficiency of the Indonesian pharmaceutical sector using unbalanced panel data of 210 firms. The results from data envelopment analysis showed that FDI has a significant negative impact on technical efficiency but generates positive spillovers to domestic suppliers. For a sample of 4000 Vietnamese manufacturing firms, Newman et al. (2015) found that the spillovers are more likely through vertical channels than horizontal spillovers. Erdal and Göçer (2015) investigated the effects of FDI on research and development and innovation for a sample of ten developing countries, viz. China, South Korea, India, Iran, Pakistan, Malaysia, Singapore, Thailand, Saudi Arabia, and Turkey. The panel causality and cointegration approach demonstrated a positive technology spillover from FDI on the research and development. Dunne and Masiyandima (2016) investigated the impact of FDI technology spillovers on domestic firms belonging to African countries in the SADC region and found positive productivity technology spillover effects within firms. Furthermore, it is confirmed that seven countries exhibit positive intra-industry spillovers while two countries experience negative effects. Using the French firm-level panel data, Ben Hassine et al. (2017) found a positive FDI spillover effect on the firms' performance. Moralles & Moreno (2020) showed that Brazilian firms suffer from negative productivity spillovers. Besides, the author observed that local firms could accumulate positive spillover if they have high absorptive capacity. Huynh et al. (2021) investigated the productivity spillover through horizontal, backward, and forward spillover channels for Vietnamese firms. The findings indicate positive spillover from FDI through backward and forward channels but not from the horizontal channels. Hoang et al. (2021) examined the determinants of spillover effects of FDI on technology innovation of Vietnamese enterprises using a logistic regression model. The authors found that FDI had positive spillover effects on the technology innovation of Vietnamese enterprises.

Kathuria et al. (1996) examined the impact of the FDI spillover effect on the productivity of domestic firms belonging to Indian manufacturing firms and found that the positive spillovers effect is positive in the low-tech sectors. Kathuria (2001) used the panel data for 368 medium and large-sized Indian manufacturing firms and indicated positive spillovers from the presence of foreign-owned firms. Feinber and Majumdar (2001) examined whether knowledge spillovers from MNCs' local R&D activities benefit domestic firms in the Indian pharmaceutical industry and found significant R&D spillovers. Bergman (2006) examined the spillover effect observed from FDI in the Indian pharmaceutical industry. Using the Ordinary Least Square Method, the study indicated the positive spillover from FDI in the pharmaceutical industry. Using the ordinary least square method, Sasidharan (2006) examined the spillover effects of FDI for a sample of 4900 Indian manufacturing firms and found a significant positive vertical spillover, while the horizontal spillover was statistically insignificant.

Joseph (2007) examined whether domestic firms improve their productivity and competitiveness through horizontal spillovers. The sample firms include eight industries: food processing, textiles, chemicals, nonmetallic minerals, metal and metal products, machine and machine tools, electrical and electronics, and transportation. Using the panel data technique, the study found that the presence of foreign firms improved the performance of domestic firms. Using the Ordinary Least Square Method, Sarkar and Lai (2009) showed that FDI has significantly increased the firm's output. Pant and Mondal (2010) used a sample of 1168 firms that belongs to five industries viz. Power and Fuel

(37 firms), Chemical Industry (505 firms), Industrial Machinery (231 firms), Electrical Equipment (176 firms), and Transport Equipment (219 firms) and indicated that the technology transfer is more likely to be achieved by the presence of foreign firms rather than by the simple purchase of foreign technology. Using a sample of 1840 firms, Kathuria (2010) found that the domestic firms are more productive in the post-liberalization period than in the pre-reform period. Pattnayak and Thangavelu (2011) examined the effect of technology spillovers due to the incidence of foreign firms in the Indian pharmaceutical industry. Using the OLS and fixed effect models, the authors found a positive technology spillover from research and development activities of foreign firms. Behera et al. (2012) analyzed the technology spillover effects of FDI in Indian manufacturing industries across the different selected regions such as Baddi, Noida, Gurgaon, Bhiwadi, and Thane, Ankleshwar, Kolkata, Chennai, Hyderabad, and Bangalore. Using the panel data technique, the study found significant variation in the technological spillover from FDI across the regions. Fujimori and Sato (2015) evaluated the vertical and horizontal spillover effects of FDI on the manufacturing industry, and the results suggested that the spillover from FDI tends to be stronger from the downstream (vertical) sector than intra-industry (horizontal). Using the unbalanced panel data of 21 manufacturing firms, Malik (2015) confirmed technology spillovers via backward linkages from foreign firms. Furthermore, the author confirmed that firms in high-tech industries benefit more from technology spillovers than the low-tech industry.

Using the simultaneous equation model, Behera (2015) found that local firms benefit from horizontal and vertical FDI adopting foreign technologies. Ghosh and Roy (2016) applied the Logit model and suggested that there has been a rise in domestic research and development intensity of firms across high-tech and medium-high tech industry groups. Arora and Lohani (2017) investigated whether the FDI leads to total factor productivity growth in the drugs and pharmaceutical industry by applying the stochastic frontier approach. The study found Intra-industry spillover from the presence of foreign equity in drugs and the pharmaceutical industry, which leads to an increase in the level of production. Using the generalized least squares method, Pradeep et al. (2017) indicated that foreign presence has a significant positive spillover effect on Indian manufacturing firms' productivity compared to alternative spillovers from R&D and export initiatives. Sur and Nandy (2018) examined the technical efficiency spillover from FDI in the Indian automobile industry. Using stochastic frontier analysis, the study showed that the spillover effect is prominent through the demonstration effect from foreign to domestic firms. Recently, Jangili et al. (2021) assessed the knowledge spillovers from foreign originalities in the Indian pharmaceutical industry during 2000–01 to 2019–20, and the study has been divided into four sub-periods of five years each. The study evidenced that FDI does not have any impact on the output of domestic firms in the first two sub-periods. Positive knowledge spillovers are evidenced in the last two sub-periods, enhancing the productivity of domestic firms.

## 3. Methodology

Robust least squares and Generalised method of moments (GMM) estimators were used to examine the FDI spillover effect on the productivity of the domestic firms. When the error term is unrelated to the input selections, OLS is inefficient. Hence, the robust and GMM models are consistent and efficient in this scenario. The GMM approach mitigates unobserved heterogeneity and endogeneity issues by providing consistent and efficient estimates (Arellano & Bond, 1991). The following specification of the model is used to evaluate whether the foreign affiliates are more productive than the domestic firms.

$$\begin{aligned} LO_{it} = {} & \propto + \delta_1 LO_{i(t-1)} + \delta_2 LL_{(i,t)} + \delta_3 LC_{it} + \delta_4 M_{it} \\ & + \delta_5 \, LSIZE_{it} + \delta_6 ADV_{it} + \delta_7 LAGE_{it} \\ & + \delta_8 R\&D_{it} + \delta_9 TI_{it} + \delta_{10} \, OWNERSHIP_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

Equation 2 is estimated to examine the impact of the FDI spillover effect on the productivity of domestic pharmaceutical firms.

$$\begin{aligned} LO_{it} = {} & \propto + \delta_1 LO_{i(t-1)} + \delta_2 LL_{(i,t)} + \delta_3 LC_{it} + \delta_4 M_{it} \\ & + \delta_5 \, LSIZE_{it} + \delta_6 ADV_{it} + \delta_7 LAGE_{it} \\ & + \delta_8 R\&D_{it} + \delta_9 TI_{it} + \delta_{10} SPILLOVER_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

In the above specifications, ten factors were considered to affect the productivity of pharmaceutical firms. Prefix L on a variable name shows the natural logarithm, and $\boldsymbol{\varepsilon}_{it}$ stands for the error term. The dependent variable in the former specification is related to the pharmaceutical firms' total productivity that includes the foreign and domestic firms, and the dependent variable for the latter is confined to the domestic firms. The description of the variables is shown in Table 1.

The analysis is based on firm-level panel data of Indian pharmaceutical companies whose shares were traded on the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE). The information was collected from the Centre for Monitoring Indian Economy (CMIE) Prowess database from 2015 to 2019. Based on the regularity in data availability, the sample firms are limited to 112 companies, 100 of which are domestic firms and 12 international firms.

**Table 1:** Description of the Variables

| Variables | Symbol | Description | Expected Sign |
|---|---|---|---|
| Output | LO | Output produced by the Indian & foreign pharma firms is measured in terms of rupees in millions (Kathuria, 2010; Bergman, 2006; Sasidharan, 2006; Dimelis & Papaioannou, 2010) | – |
| Labour | LL | Salaries + Wages + Bonus + Ex-gratia + Provident fund + Gratuities paid (Bergman, 2006; Sasidharan, 2006; Sur & Nandy, 2018) | + |
| Capital | LC | Gross Fixed Assets (Kathuria et al., 1996; Bergman, 2006; Pant, 2010; Behera, 2015; Newman et al., 2015) | + |
| Materials | M | Raw material consumed + Opening stock of work-in-progress + Semi-finished goods (Smarzynska, 2002; Bergman, 2006; Pattnayak & Thangavelu, 2011; Behera, 2015) | + |
| Size | LSIZE | Revenue is generated by Indian & foreign pharmaceutical firms (Sasidharan, 2006; Reganati & Sica, 2007; Pradeep et al., 2017) | + |
| R&D intensity | R&D | Total R&D expenditure of the firm divided by total sales of the firm (percent) (Bergman, 2006; Sasidharan, 2006; Kathuria, 2010; Hassine et al., 2017) | + |
| Technology Import Intensity | TI | Import of capital goods+ royalties' technology know-how of the firm divided by total sales of the firm (Bergman, 2006; Sasidharan, 2006; Jangili et al., 2021) | + |
| Age | LAGE | Year of Financial Report–Year of Founding of Company (Bergman, 2006; Behera, 2015; Sur & Nandy, 2018) | + |
| Advertisement | ADV | Advertisement expenses of the firm (Newman et al., 2015; Bergman, 2006; Huynh et al., 2021) | + |
| Ownership | OWNERSHIP | Firms having 10 percent or more foreign equity are classified as Foreign affiliates (FDI firms), whereas 10 percent or less foreign equity are classified as non-FDI firms.<br>For FDI firms, OWN = 1, If not OWN = 0. | + |
| Horizontal Spillover | SPILLOVER | It is measured in terms of output produced by the FDI firms to the total output of the Pharmaceutical Industry (Sasidharan, 2006; Kathuria, 2010; Cristina & Levieuge, 2013; Bergman, 2016; Huynh et al., 2021) | +/– |

Prefix L on a variable name shows the natural logarithm.

Firms with more than 10 percent foreign equity are classified as FDI firms, while those with less than that are classified as domestic firms. The list of selected pharmaceutical firms for the study is presented in Appendix 1.

## 4. Results and Discussion

Table 2 presents the performance indicators of domestic and foreign pharmaceutical firms. Non-FDI enterprises' average output has risen from Rs.8149 million in 2015 to Rs.10370 million in 2019, whereas FDI firms' average output has risen from Rs.16352 million in 2015 to Rs.18488 million in 2019. This shows that FDI firms were more productive than domestically owned firms. Domestic enterprises' average sales have climbed from Rs.8588 million in 2015 to Rs.10882 million in 2019, while international firms' average sales have doubled. The higher average output and sales imply that FDI firms primarily focus on consumer markets and take advantage of the Indian economy's market size. We also see that the intensity of technology imports by FDI firms is higher than that of domestic firms. This demonstrates that FDI firms spend more on royalty payments for technology imported from overseas networks than their domestic rivals (Aggarwal & Kapoor, 2018). Furthermore, overseas affiliates spend far more time on R&D than their local counterparts, rather than focusing on production (Stiebale & Reize, 2011; Anwar & Sun, 2014; Siedschlag & Zhang, 2015). It is worth noting that the average export intensity of domestic enterprises is higher than that of international firms. The recent weakening of the Indian rupee may have increased the

**Table 2:** Performance of Domestic and Foreign Pharmaceutical Firms

| Indicators | Domestic Firms | | Foreign Firms | |
|---|---|---|---|---|
| | 2015 | 2019 | 2015 | 2019 |
| Output (Rs. Million) | 8149 | 10370 | 16352 | 18488 |
| Sales (Rs. Million) | 8588 | 10882 | 18974 | 22321 |
| R&D Intensity (percent) | 2.26 | 3.57 | 3.25 | 4.04 |
| Technology Imports Intensity (percent) | 1.12 | 3.29 | 1.75 | 11.83 |
| Export Intensity (percent) | 37.76 | 44.19 | 22.74 | 34.27 |

Source: Authors computation based on the Prowess database, Centre for Monitoring Indian Economy.

**Table 3:** Correlation Matrix

| Variables | LO | LL | LC | M | LSIZE | ADV | AGE | R&D | TI |
|---|---|---|---|---|---|---|---|---|---|
| LO | 1.0000 | | | | | | | | |
| LL | 0.9189 | 1.0000 | | | | | | | |
| LC | 0.8806 | 0.4056 | 1.0000 | | | | | | |
| M | 0.4209 | 0.3861 | 0.3876 | 1.0000 | | | | | |
| LSIZE | 0.9976 | 0.4223 | 0.4760 | 0.4167 | 1.0000 | | | | |
| ADV | 0.2487 | 0.2968 | 0.1872 | 0.0143 | 0.2685 | 1.0000 | | | |
| AGE | 0.2974 | 0.3542 | 0.2373 | 0.0888 | 0.3053 | 0.4402 | 1.0000 | | |
| R&D | 0.5247 | 0.5428 | 0.5001 | 0.3192 | 0.5233 | 0.0111 | 0.0613 | 1.0000 | |
| TI | 0.3519 | 0.3663 | 0.3307 | 0.5246 | 0.3512 | 0.0288 | 0.0550 | 0.4516 | 1.0000 |

incentive for domestic enterprises to export. Furthermore, if the presence of foreign enterprises is relatively high, indigenous firms are more inclined to export.

Before using robust least squares and the Generalised Method of Moment approaches, it is important to look at the multicollinearity issue among the firm's characteristics, including labor, capital, materials, firm size, advertisement, age, R&D, and technology import intensity. Table 3 shows that there is no strong link between the firm-characteristic determinants. As a result, the study can move forward with its estimations because there is no evidence of multicollinearity.

The empirical results of the robust least squares and GMM estimators are shown in Table 4, with the output of FDI and Non-FDI enterprises as the dependent component. The model was estimated to evaluate whether the enterprises with foreign equity participation, as represented by the ownership variable, are more productive than local firms. Control variables including factor inputs (labor, capital, and materials), firm size, advertisement, R&D, and technology import intensity are found to have a statistically significant effect on productivity across local and FDI pharmaceutical enterprises. Most notably, the ownership variable is positive but statistically insignificant, implying that foreign ownership does not contribute to the productivity of domestic firms. Due to increased competition, the Indian pharmaceutical companies with foreign equity participation are not more productive than local ones.

We used the robust least squares and GMM estimators to see if overseas affiliates increase domestic company productivity through horizontal spillover effects, and the results are shown in Table 5. According to the findings, control variables, including factor inputs (labor, capital, and materials), firm size, and technology import intensity, are found to have a statistically significant effect on productivity across domestic pharmaceutical enterprises. The horizontal spillover variable is negative and insignificant statistically. The nonexistence of horizontal spillover is consistent with current research that has found negative or insignificant findings (Aitken & Harrison, 1999; Javorcik, 2004; Kathuria, 2001). The absence of horizontal spillovers may be attributable to foreign enterprises' ability to prevent technological outflow to competitors in the same industry. The R&D is statistically

**Table 4:** Production Function Estimates with the Foreign Ownership

| Parameters | Robust Least Squares Method | GMM Method |
|---|---|---|
| $LO_{t-1}$ | –0.003573** (0.001592) | –0.010097 (0.010195) |
| LL | –0.022831* (0.005073) | –0.034994* (0.010380) |
| LC | 0.020445* (0.003448) | 0.036778* (0.009816) |
| M | 9.68E–07 (9.90E–07) | 2.44E–06** (1.23E–06) |
| LSIZE | 0.998965* (0.004319) | 0.988659* (0.010023) |
| ADV | –0.000173* (2.73E–05) | –0.000291* (6.89E–05) |
| LAGE | –0.010559 (0.009241) | 0.012104 (0.022115) |
| R&D | –1.04E–06 (2.27E–06) | 7.00E–06** (3.13E–06) |
| TI | –1.31E–05 (1.40E–05) | –2.14E–05 (1.76E–05) |
| OWNERSHIP | 0.005136 (0.011781) | 0.007375 (0.020177) |
| C | 0.030659 (0.034588) | – |
| J-test (*p*-value) | – | 0.24 (0.8674) |
| BP test (*p*-value) | | 0.42 (0.6415) |
| DW statistic | – | 1.80 |
| No. of firms | 112 | 112 |
| Instrument rank | – | 10 |

Standard errors in parentheses. *$p < 0.1$; **$p < 0.05$. Durbin-Watson's (DW) statistics are close to 2 indicating the absence of serial correlation in errors. Breusch Pagan (BP) tests the null of homoscedasticity. Hansen's J tests over-identifying restrictions in GMM estimations.

**Table 5:** Production Function Estimates with the Spillover Effect

| Parameters | Robust Least Squares Method | GMM Method |
|---|---|---|
| LO (–1) | –0.003590** (0.001651) | 0.006890 (0.020489) |
| LL | –0.021078* (0.005233) | –0.036209* (0.012700) |
| LC | 0.016793* (0.003620) | 0.033725** (0.013106) |
| M | 1.42E–06 (1.07E–06) | 4.14E–06* (1.55E–06) |
| LSIZE | 1.001875* (0.004474) | 0.996991* (0.011919) |
| ADV | –6.39E–05 (5.72E–05) | –2.15E–06 (4.56E–05) |
| LAGE | –0.002123 (0.009721) | 0.013932 (0.019675) |
| R&D | –2.69E–06 (2.39E–06) | 1.42E–06 (5.08E–06) |
| TI | –1.26E–05 (1.43E–05) | –3.18E–05*** (1.97E–05) |
| SPILLOVER | –0.638666 (0.499594) | –0.913101 (0.755631) |
| C | 0.114484 (0.104307) | – |
| J-test (*p*-value) | – | 0.25 (0.8670) |
| BP test (*p*-value) | | 0.41 (0.6413) |
| DW statistic | – | 1.90 |
| No. of firms | 100 | 100 |
| Instrument rank | – | 10 |

Standard errors in parentheses. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Durbin-Watson's (DW) statistics are close to 2 indicating the absence of serial correlation in errors. Breusch Pagan (BP) tests the null of homoscedasticity. Hansen's J tests over-identifying restrictions in GMM estimations.

insignificant, meaning that foreign firms may buy domestic enterprises with a greater R&D intensity than international firms with an advanced R&D intensity. Furthermore, native firms have limited absorption capacity and cannot internalize technical spillovers caused by foreign firms' presence.

According to the specification tests, the estimation models are well defined in terms of endogeneity and instrument validity. The null hypothesis of the over-identifying constraints is valid in both specifications, according to the Sargan and Hansen J tests (*p*-value). The D-W statistics show that the residuals have no serial association. Furthermore, there is no evidence of heteroscedasticity in the BP test data.

## 5. Conclusion

It is often assumed that FDI increases domestic enterprises' output through spillover effects. Our study attempts to investigate the horizontal spillover effects from FDI on the productivity of the Indian domestic pharmaceutical firms. Robust least squares and the Generalised Method of Moments estimators are applied for the balanced panel dataset of 112 Pharmaceutical firms. The study shows that foreign ownership does not significantly contribute to the productivity of domestic firms. A negative and insignificant horizontal spillover effect from FDI is observed. Although the Indian economy authorized 100 percent foreign investment in the pharmaceuticals industry through the automatic route of the FDI Scheme, positive spillovers from MNEs to local enterprises were not evident due to domestic firms' poor performance in upgrading firm-specific capabilities.

The study has significant implications. Foreign enterprises are likely to offer much-needed experience and capabilities to their pharmaceutical industry structure with specific qualities. Reducing the technology gap between foreign and domestic firms through R&D activities is significant. This would contribute to the firm's absorptive capacity to internalize spillovers. Rather than implementing measures to attract FDI inflows, the Indian economy should provide more fiscal or non-fiscal incentives to the domestic pharmaceutical companies to actively promote their R&D activities.

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## Appendix 1: List of selected Pharmaceutical Firms

| S.No. | Company Name | FDI/Non-FDI Firms | Incorporation Year | Age |
|---|---|---|---|---|
| 1 | Abbott India Ltd. | FDI Firm | 1944 | 71 |
| 2 | Biocon Ltd. | FDI Firm | 1978 | 37 |
| 3 | Cipla Ltd. | FDI Firm | 1935 | 80 |
| 4 | GlaxoSmithKline Pharmaceuticals Ltd. | FDI Firm | 1924 | 91 |
| 5 | Gujarat Themis Biosyn Ltd. | FDI Firm | 1981 | 34 |
| 6 | Kerala Ayurveda Ltd. | FDI Firm | 1992 | 23 |
| 7 | Pfizer Ltd. | FDI Firm | 1950 | 65 |
| 8 | Sanofi India Ltd. | FDI Firm | 1956 | 59 |
| 9 | Vista Pharmaceuticals Ltd. | FDI Firm | 1991 | 24 |
| 10 | Wanbury Ltd. | FDI Firm | 1988 | 27 |
| 11 | Wintac Ltd. | FDI Firm | 1990 | 25 |
| 12 | Zenotech Laboratories Ltd. | FDI Firm | 1989 | 26 |
| 13 | Aarti Drugs Ltd. | Non-FDI Firms | 1984 | 31 |
| 14 | Ajanta Pharma Ltd. | Non-FDI Firms | 1979 | 36 |
| 15 | Albert David Ltd. | Non-FDI Firms | 1938 | 77 |
| 16 | Alembic Pharmaceuticals Ltd. | Non-FDI Firms | 2010 | 5 |
| 17 | Alpa Laboratories Ltd. | Non-FDI Firms | 1988 | 27 |
| 18 | Amrutanjan Health Care Ltd. | Non-FDI Firms | 1936 | 79 |
| 19 | Anuh Pharma Ltd. | Non-FDI Firms | 1960 | 55 |
| 20 | Auro Laboratories Ltd. | Non-FDI Firms | 1989 | 26 |
| 21 | Aurobindo Pharma Ltd. | Non-FDI Firms | 1986 | 29 |
| 22 | B D H Industries Ltd. | Non-FDI Firms | 1990 | 25 |
| 23 | Bafna Pharmaceuticals Ltd. | Non-FDI Firms | 1995 | 20 |
| 24 | Bal Pharma Ltd. | Non-FDI Firms | 1987 | 28 |
| 25 | Beryl Drugs Ltd. | Non-FDI Firms | 1993 | 22 |
| 26 | Bharat Immunologicals & Biologicals Corpn. Ltd. | Non-FDI Firms | 1989 | 26 |
| 27 | Bliss G V S Pharma Ltd. | Non-FDI Firms | 1984 | 31 |
| 28 | Brooks Laboratories Ltd. | Non-FDI Firms | 2002 | 13 |
| 29 | Cadila Healthcare Ltd. | Non-FDI Firms | 1995 | 20 |
| 30 | Colinz Laboratories Ltd. | Non-FDI Firms | 1986 | 29 |
| 31 | Concord Drugs Ltd. | Non-FDI Firms | 1995 | 20 |
| 32 | Coral Laboratories Ltd. | Non-FDI Firms | 1997 | 18 |
| 33 | Denis Chem Lab Ltd. | Non-FDI Firms | 1980 | 35 |
| 34 | Desh Rakshak Aushdhalaya Ltd. | Non-FDI Firms | 1981 | 34 |
| 35 | Divi's Laboratories Ltd. | Non-FDI Firms | 1990 | 25 |
| 36 | Dr. Reddy's Laboratories Ltd. | Non-FDI Firms | 1984 | 31 |

| S.No. | Company Name | FDI/Non-FDI Firms | Incorporation Year | Age |
|---|---|---|---|---|
| 37 | Everest Organics Ltd. | Non-FDI Firms | 1993 | 22 |
| 38 | F D C Ltd. | Non-FDI Firms | 1940 | 75 |
| 39 | Fermenta Biotech Ltd. | Non-FDI Firms | 1951 | 64 |
| 40 | Gennex Laboratories Ltd. | Non-FDI Firms | 1990 | 25 |
| 41 | Glenmark Pharmaceuticals Ltd. | Non-FDI Firms | 1977 | 38 |
| 42 | Godavari Drugs Ltd. | Non-FDI Firms | 1987 | 28 |
| 43 | Granules India Ltd. | Non-FDI Firms | 1991 | 24 |
| 44 | Gufic Biosciences Ltd. | Non-FDI Firms | 1984 | 31 |
| 45 | Hester Biosciences Ltd. | Non-FDI Firms | 1987 | 28 |
| 46 | Hikal Ltd. | Non-FDI Firms | 1988 | 27 |
| 47 | I O L Chemicals & Pharmaceuticals Ltd. | Non-FDI Firms | 1986 | 29 |
| 48 | Indoco Remedies Ltd. | Non-FDI Firms | 1947 | 68 |
| 49 | Ind-Swift Laboratories Ltd. | Non-FDI Firms | 1995 | 20 |
| 50 | Ind-Swift Ltd. | Non-FDI Firms | 1986 | 29 |
| 51 | Ipca Laboratories Ltd. | Non-FDI Firms | 1949 | 66 |
| 52 | Ishita Drugs & Inds. Ltd. | Non-FDI Firms | 1992 | 23 |
| 53 | J B Chemicals & Pharmaceuticals Ltd. | Non-FDI Firms | 1976 | 39 |
| 54 | Jagsonpal Pharmaceuticals Ltd. | Non-FDI Firms | 1978 | 37 |
| 55 | Jenburkt Pharmaceuticals Ltd. | Non-FDI Firms | 1985 | 30 |
| 56 | Kanoria Chemicals & Inds. Ltd. | Non-FDI Firms | 1960 | 55 |
| 57 | Kilitch Drugs (India) Ltd. | Non-FDI Firms | 1992 | 23 |
| 58 | Kimia Biosciences Ltd. | Non-FDI Firms | 1993 | 22 |
| 59 | Kopran Ltd. | Non-FDI Firms | 1958 | 57 |
| 60 | Krebs Biochemicals & Inds. Ltd. | Non-FDI Firms | 1991 | 24 |
| 61 | Lactose (India) Ltd. | Non-FDI Firms | 1991 | 24 |
| 62 | Lincoln Pharmaceuticals Ltd. | Non-FDI Firms | 1995 | 20 |
| 63 | Lupin Ltd. | Non-FDI Firms | 1983 | 32 |
| 64 | Lyka Labs Ltd. | Non-FDI Firms | 1976 | 39 |
| 65 | Makers Laboratories Ltd. | Non-FDI Firms | 1984 | 31 |
| 66 | Mangalam Drugs & Organics Ltd. | Non-FDI Firms | 1972 | 43 |
| 67 | Marksans Pharma Ltd. | Non-FDI Firms | 1992 | 23 |
| 68 | Medicamen Biotech Ltd. | Non-FDI Firms | 1993 | 22 |
| 69 | Medicaps Ltd. | Non-FDI Firms | 1983 | 32 |
| 70 | Mercury Laboratories Ltd. | Non-FDI Firms | 1982 | 33 |
| 71 | Mesco Pharmaceuticals Ltd. | Non-FDI Firms | 1993 | 22 |
| 72 | Morepen Laboratories Ltd. | Non-FDI Firms | 1984 | 31 |
| 73 | N G L Fine-Chem Ltd. | Non-FDI Firms | 1981 | 34 |
| 74 | Natco Pharma Ltd. | Non-FDI Firms | 1981 | 34 |
| 75 | Natural Capsules Ltd. | Non-FDI Firms | 1993 | 22 |

| S.No. | Company Name | FDI/Non-FDI Firms | Incorporation Year | Age |
|---|---|---|---|---|
| 76 | Nectar Lifesciences Ltd. | Non-FDI Firms | 1995 | 20 |
| 77 | Neuland Laboratories Ltd. | Non-FDI Firms | 1984 | 31 |
| 78 | Norris Medicines Ltd. | Non-FDI Firms | 1990 | 25 |
| 79 | Nutraplus India Ltd. | Non-FDI Firms | 1990 | 25 |
| 80 | Orchid Pharma Ltd. | Non-FDI Firms | 1992 | 23 |
| 81 | Ortin Laboratories Ltd. | Non-FDI Firms | 1986 | 29 |
| 82 | Panacea Biotec Ltd. | Non-FDI Firms | 1984 | 31 |
| 83 | Panchsheel Organics Ltd. | Non-FDI Firms | 1989 | 26 |
| 84 | Parenteral Drugs (India) Ltd. | Non-FDI Firms | 1983 | 32 |
| 85 | Parnax Lab Ltd. | Non-FDI Firms | 1982 | 33 |
| 86 | Phaarmasia Ltd. | Non-FDI Firms | 1981 | 34 |
| 87 | Piramal Phytocare Ltd. [Merged] | Non-FDI Firms | 2001 | 14 |
| 88 | R P G Life Sciences Ltd. | Non-FDI Firms | 2007 | 8 |
| 89 | Resonance Specialties Ltd. | Non-FDI Firms | 1989 | 26 |
| 90 | Roopa Industries Ltd. | Non-FDI Firms | 1985 | 30 |
| 91 | S M S Pharmaceuticals Ltd. | Non-FDI Firms | 1987 | 28 |
| 92 | S S Organics Ltd. | Non-FDI Firms | 1990 | 25 |
| 93 | Samrat Pharmachem Ltd. | Non-FDI Firms | 1992 | 23 |
| 94 | Sanjivani Paranteral Ltd. | Non-FDI Firms | 1994 | 21 |
| 95 | Sequent Scientific Ltd. | Non-FDI Firms | 1985 | 30 |
| 96 | Shilpa Medicare Ltd. | Non-FDI Firms | 1987 | 28 |
| 97 | Source Natural Foods & Herbal Supplements Ltd. | Non-FDI Firms | 1995 | 20 |
| 98 | Strides Pharma Science Ltd. | Non-FDI Firms | 1990 | 25 |
| 99 | Sun Pharmaceutical Inds. Ltd. | Non-FDI Firms | 1993 | 22 |
| 100 | Sunil Healthcare Ltd. | Non-FDI Firms | 1974 | 41 |
| 101 | Suven Life Sciences Ltd. | Non-FDI Firms | 1989 | 26 |
| 102 | Syncom Formulations (India) Ltd. | Non-FDI Firms | 1988 | 27 |
| 103 | Syncom Healthcare Ltd. | Non-FDI Firms | 2002 | 13 |
| 104 | Torrent Pharmaceuticals Ltd. | Non-FDI Firms | 1972 | 43 |
| 105 | Triochem Products Ltd. | Non-FDI Firms | 1972 | 43 |
| 106 | Tyche Industries Ltd. | Non-FDI Firms | 1998 | 17 |
| 107 | Unichem Laboratories Ltd. | Non-FDI Firms | 1962 | 53 |
| 108 | Unjha Formulations Ltd. | Non-FDI Firms | 1994 | 21 |
| 109 | Venus Remedies Ltd. | Non-FDI Firms | 1989 | 26 |
| 110 | Vikram Thermo (India) Ltd. | Non-FDI Firms | 1994 | 21 |
| 111 | Wockhardt Ltd. | Non-FDI Firms | 1999 | 16 |
| 112 | Zenith Health Care Ltd. | Non-FDI Firms | 1994 | 21 |