



Foreign Direct Investment and R&D: Substitutes or Complements—A Case of Indian Manufacturing after 1991 Reforms

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Summary. — The entry of foreign firms in India since the reforms forces domestic firms to undertake R&D activities or import technology so as to compete with them. This study examines the relationship between FDI and R&D of the domestic firms in the post-liberalization regime. The study uses unbalanced panel data for 1,843 Indian manufacturing firms operating during the period 1994–2005 and corrects for the self-selection problem by using a Heckman-two step procedure. The analysis involving full sample does not give a clear picture of the impact of FDI on the innovation strategies of domestic firms. Interesting results emerge, when analysis is carried out according to different sub-samples—based on foreign-ownership and technology intensity of the industry. FDI and R&D are found to be complements when sample is divided on the bases of equity ownership. FDI inflow induces foreign-owned firms in high tech industries and firms in minority ownership to invest in R&D.
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Key words — FDI, R&D, complementarities, substitution, India

1. INTRODUCTION

Technological advancement is considered as one of the vital factors in achieving a high level of economic growth. The endogenous growth models consider generation of new knowledge through investment in research and development (R&D) as the major source of technical progress and, hence, growth (Romer, 1990). In the case of newly industrialized countries, technology was found to be an important catalyst in fostering their spectacular growth (Nelson & Pack, 1999). The role of technology has become more important in the present scenario as the world is moving toward knowledge economy and the only way countries can sustain growth is by aggressively promoting technological efforts of their domestic firms. Developing countries, such as India, have been striving hard to promote technological advancement through indigenous R&D efforts as well as through technology imports (Basant, 1997).¹

Of late, many countries have acknowledged foreign direct investment (FDI) as a main channel of technology transfer. It is based on the realization that FDI brings superior technology that is previously unavailable in the host country. The role of FDI in the host country cannot be viewed solely from the angle of technology provider. Recent attempts of studying the benefits from FDI have looked at the impact on domestic firms' productivity, technology transfer, exporting behavior *etc.*² The presence of foreign firms can also create positive externalities in the form of spillover effects to the domestic firms (Kathuria, 2000).³ It is increasingly recognized that foreign firms can significantly contribute, directly or indirectly, to innovative activities in the host country (Lall, 1993). For instance, foreign firms may undertake R&D activity in order to adapt to the host economy conditions or to meet the competition from domestic firms (Kathuria, 2008). Similarly, in

the case of domestic firms, the presence of foreign firms may force them to invest in innovative activities so as to enhance their technological capability (Helfat, 2000). Investment in R&D also enables the domestic firms to assimilate the technological spillover effects from the foreign firms (Kathuria, 2001, 2002). However, there is some amount of skepticism about the technological efforts of foreign firms in the host country (Globerman and Meredith (1984), Fan & Hu, 2007). Since foreign firms have access to parent firms' technology, there is little incentive for them to undertake new technological efforts (Kathuria, 2008). Studies have found that foreign firms undertake little or no research activities in the host country (see, for example, Beers, 2004). Moreover, R&D being an uncertain activity with gestational lag, in order to compete with foreign firms, local firms may procure technology from outside, rather than investing in R&D. Therefore, the pertinent question is whether the entry of the foreign firm enhances or diminishes the innovativeness of the domestic firms.

Despite growing importance of the FDI and the impact on the indigenous technological efforts, studies exploring the issue using detailed firm level data are scarce. Using a rich firm level data for Indian manufacturing industries for the period

*The authors acknowledge the support provided by UNIDO to participate in the First Annual Conference of the Sanjaya Lall Programme for Technology and Management for Development (SLPTMD) "Confronting the Challenge of Technology for Development: Experiences from the BRICS", University of Oxford, May 29–30, 2008. The authors wish to express their gratitude to Adamos Adamou and John T. Scott for the useful discussions and Dr. C. Veeramani for comments on an earlier draft. The authors would like to thank the conference participants and the two anonymous referees for very useful comments. The usual disclaimers nevertheless apply. Final revision accepted: May 20, 2010.

1994–2005, this study investigates the effects of FDI on indigenous R&D efforts.

An important contribution of this paper is the correction of self-selection bias arising from R&D activities. We have a reason to believe that results of most of the earlier studies using firm-level data are biased, as they have carried out analysis for only R&D performing firms. The R&D activities of the firms depend on the prevailing market structure. Therefore, firms can decide to do R&D depending on the market structure or, in other words, self-select in doing R&D. Analyzing only those firms that invest in R&D would imply that we are selecting a category of firms. In India or Japan or elsewhere, the way R&D data are reported can also result in self-selection bias. According to the Indian Company Act, firms need to report R&D expenses in their balance sheet provided the expenses are at least 1% of their sales turnover. For adaptive R&D or shop floor modifications, R&D expenditure of firms is often <1%; hence, these firms do not report it.⁴ This implies that the results of the previous studies (Kathuria & Das, 2005; Kumar & Aggarwal, 2005) based on only those firms which report R&D are biased. Therefore, use of Ordinary Least Squares (OLS) will yield estimates that would be biased and inconsistent. In this study, we correct for the problem of self-selection bias by applying Heckman's two-step procedure.⁵

Until 1991, India followed a restrictive policy on foreign capital (Rao, Murthy, & Ranganathan, 1999). The reforms undertaken during the early nineties have led to large inflows of FDI into the Indian economy.⁶ FDI is now allowed in almost all the sectors except those reserved for small scale industries or strategic reasons. As a result, competition in the domestic market has increased considerably. In order to thwart competition from foreign firms, domestic firms need either to invest in indigenous R&D or obtain new technology through imports. Since liberalization has also made import of technology cheaper and easier, firms can prefer technology imports instead of spending on R&D (Kathuria, 2008). The investment in R&D is, however, essential to compete with the global players as well as to adapt the imported technology. Against this backdrop, the purpose of this study is to explore the nature of the relationship between FDI and R&D in the post-liberalization era.

Section 2 provides a brief literature review. Section 3 elaborates the hypothesis and model used to gauge the impact of FDI on R&D behavior. In Section 4, data sources and summary statistics of the key variables are given. Section 5 discusses the empirical results. Section 6 presents the conclusions.

2. LITERATURE REVIEW

The existing studies on effects of FDI have looked at a variety of issues such as FDI and productivity/technology spillover, exporting behavior, R&D investment, competitiveness *etc.* In this study, since our focus is on FDI and R&D, we confine literature survey to those studies looking into the effect of FDI/technology imports on R&D.

Theoretical and empirical arguments are made in favor and against complementarity of FDI and R&D. Those who argue in favor of complementarity are of the opinion that MNCs will have to undertake adaptive R&D to suit the local conditions (Nelson, 2004; Tomiura, 2003). According to Annique and Cuervo-Cazurra (2008), there are three distinct channels of accessing technological and scientific instruments of other countries, which result in a subsidiary of a foreign MNE spending less in R&D in the host country: (a) through its

access to the parent firm located in a country with a well-developed technological infrastructure; (b) through its access to other MNE subsidiaries located in countries with highly developed technological capabilities; or (c) through its access to knowledge developed within the network of subsidiaries. On the other hand, investments in R&D being subjected to financial constraints, which a subsidiary of a foreign MNE may not face because the parent has better access to capital markets than domestic firms, hence may spend more on R&D (Annique, 2008).

Irrespective of whether foreign firms spend on R&D or not, the enhanced competition due to the entry of foreign firms has a direct bearing on the R&D efforts of the domestic firms (Caves, 1974). In order to face competition from MNCs, domestic firms may acquire technology either by sourcing it from outside/externally or undertaking own R&D. Domestic firms may not devote resources for R&D in the fear of lower profitability, gestation lag, and the risk associated with own research efforts (Veugelers & van den Houte, 1990). Therefore, firms consider technology import from abroad as a favorable option. However, technology import may still necessitate R&D to adapt the technology to local conditions. Similarly, absorption of spillovers may require spending on R&D by domestic firms (Feinberg & Majumdar, 2001; Kathuria, 2002).

Empirical studies have found both complementary, as well as substitution effect, between the technology imports, FDI, and R&D (see, for example, Pack & Saggi, 1997 and the literature summarized in Table 1). A large number of studies carried out for Brazil, China, Germany, India, Japan, *etc.* have found a complementary relationship between technology imports and R&D. See, for instance, Katrak (1985), Siddharthan (1992), Deolalikar and Evenson (1989), Kumar and Aggarwal (2005) for India, Odagiri (1983) for Japan, Braga and Wilmore (1991) for Brazil, Bertschek (1995) for Germany, Zhao (1995) and Hu, Jefferson, and Jinchang (2005) for China among others. The substitution effect of technology imports on domestic R&D has been obtained by Kumar (1987), Basant and Fikkert (1996), Kathuria and Das (2005) for India, Veugelers and van den Houte (1990) for Belgium, Lee (1996) for the Republic of Korea, Chuang and Lin (1999) for Taiwan Province of China, and Fan and Hu (2007) for China, among others. However, some studies, such as Kumar and Saqib (1996) and Katrak (1997), find neither substitution nor complementary effects in the technology imports-R&D relationship.

From the literature cited in Table 1 two gaps clearly emerge: (a) barring two (Lee, 1996; and Chuang & Lin, 1999), none of the studies correct for selection bias, and (b) most of the studies in the Indian context are for the period when the economy was not liberalized. The present study fills these obvious gaps in the literature.

3. MODEL

In any industry, not all firms undertake R&D. Firms self-select into R&D due either to the prevailing market structure or expected net gains from R&D. Therefore, using an OLS method to estimate R&D intensity of only those firms undertaking R&D can lead to selection bias. Moreover, due to uncertainty involved in R&D outcome and existence of sunk costs in establishment of R&D labs and equipment, only a few firms decide to spend on R&D. Therefore, the whole process can be visualized in two stages: the decision to undertake R&D, as stage 1 (i.e., selection stage) and how much resources need to be spent on undertaking R&D, as stage 2 (i.e., outcome

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