MULTINATIONALS, RELATIVE EFFICIENCY AND SPILLOVERS

A Study of Indian Manufacturing under Liberalisation

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RAJESH P

CENTRE FOR DEVELOPMENT STUDIES
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I hereby affirm that the work for the dissertation titled ***"Multinationals, Relative Efficiency and Spillovers: A Study of Indian Manufacturing under Liberalisation"*** being submitted as part of the requirements of the M. Phil Programme in Applied Economics of the Jawaharlal Nehru University, was carried out entirely by myself and has not formed part of any other Programme and not submitted to any other institution/ University for the award of any other Degree or Programme of Study.

30th June, 2000

Rajesh P.

Certified that this study is the bona fide work of Mr. Rajesh P, carried out under our supervision at the Centre for Development Studies.

P. Mohanan Pillai
Associate Fellow

K. J .Joseph
Associate Fellow

Chandan Mukherjee
Director
Centre for Development Studies
Thiruvananthapuram.

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Chapter I

INTRODUCTION

1.1 THE CONTEXT

In the era of ongoing globalisation, multinational enterprises (MNEs) exert significant influence on the economic activities of most developing countries. In tune with the general trend and as part of the structural reforms of the nineties, India also liberalised its policies towards FDI with a view to exploiting the advantages of technology, marketing, and management associated with foreign firms. The result has been an increased presence of MNEs in different sectors of Indian economy generating a renewed interest among the academia and policy makers on the effects, direct and indirect, of MNEs on the growth and development of the Indian economy. In this context, a specific aspect of the current interest is the performance of the MNEs in terms of relative efficiency and their spillover effects in Indian manufacturing.

The literature has devoted a great deal of attention to the performance of foreign firms in terms of their technology choice, export behaviour, profitability and so on. Yet, some other aspects like relative efficiency of foreign firms, spillovers and linkages from them remain under explored, particularly in Indian context. Foreign direct investment (FDI) can generate direct and indirect effects on the host economies. Direct gains from FDI are obtained when it raises the productivity in the host country and the foreign investor does not wholly appropriate this increase. Direct gains accrue to the labour in the form of higher real wages, to consumers in the form of lower prices and to the government in the form of tax revenues. In a sense the extent of direct contribution of FDI to the growth of host economies depends on their efficiency relative to the domestic firms. The analysis of relative efficiency of foreign firms acquires great significance in the context developing countries as these economies are have acute resource scarcity (particularly capital) and need to optimally utilise the available resources. Hence, it is important to know how well resources are utilised by the foreign and domestic firms, and what possibilities exist to improve the efficiency of the industrial economy in the face of such resource constraints. In addition, FDI may exert indirect effects on the host economies. These indirect effects largely relate to external effects or spillovers (Blomstrom and Pesson, 1983). The results of the previous studies have been inconclusive on the relative efficiency of foreign firms and the overall direction and magnitude of spillovers[1].

Against this backdrop, the present study attempts to analyse the relative efficiency of foreign and domestic firms in selected industries of the Indian manufacturing during the post-liberalisation period and the spillover effects of foreign presence on the efficiency of local Indian firms. The study assumes special relevance in the post-liberalisation phase, for, foreign firms are given a level playing ground as compared to the earlier inward-looking regime associated with controls.

This chapter proceeds as follows. Section 1.2 sets out a conceptual framework we use, section 1.3 reviews the major studies on the comparative performance of foreign and local firms and spillovers in Indian industry. Section 1.4 highlights the significance of the study and major objectives. Section 1.5 describes the database and period of the study. Section 1.6 briefly discusses the methodology used in the study. The last section presents the chapter scheme of the study.

1.2 A CONCEPTUAL FRAMEWORK

The relative efficiency of multinationals and the spillovers from them can be analysed within the general framework of the theory of foreign direct investment. Conventional literature on FDI suggest that, given a specific country and industry, firms with higher share of foreign ownership will on average perform better than their domestic counterparts (Caves, 1996). The theories of FDI[2] asserts that foreign subsidiaries share certain unique intangible assets, such as technology and information, marketing and entrepreneurial skills, organisational systems and access to intermediate final goods markets, with their parent MNEs. The ownership of such intangible assets makes the asset bundles of foreign firms different from that of their local counterparts. These ownership advantages of MNEs are expected to result in their better performance compared to local firms.

There are other theoretical explanations as to why MNEs could be expected to behave differently from the domestic firms. First, if the organisation of MNEs is highly centralised at a global

[1] Brief reviews of the empirical studies on the relative productive efficiency of foreign firms and the spillovers from them are given in Chapter IV and V, respectively.

[2] See Kindleberger (1969), Caves (1971, 1974), and Dunning (1988).

level, the parent itself may take some strategic decisions, in the host economy, regarding plant technology, input sources, investment levels, aspects of import and export behaviour, profit repatriation rates, etc. Even if MNEs vary in degree of centralisation, most parents exercise control over the decisions on some critical aspects of subsidiary behaviour. These decisions are often based on the international financial considerations, global profit objectives, tax structure in different countries, and economic conditions internal to the host country. In variance with the above, domestic firms have to consider only local economic factors. Second, foreign firms may perceive risk differently. For example, they may rely more heavily on imports than domestic firms because of quality and reliability of supplies. Finally, information flows are highly imperfect. Foreign subsidiaries are by nature exposed to the 'knowledge base' of the parent, accumulated for the most part in the home market. They are typically less knowledgeable about local conditions. The reverse is true for domestic firms.

The presence of MNEs with the intangible assets may directly or indirectly affect the performance of the domestic firms in the host country. The entry of MNEs may increase competition, which in turn forces inefficient local firms to be more efficient by investing in physical or human capital, or to exit the industry. Some of the intangible assets of MNEs (particularly the technology) may leak out to the domestic firms in the host economy[3]. The increased competition and the leakage of some of the intangible assets of the MNEs may lead to externality or spillovers. Analysis in this study is carried out in a conceptual framework incorporating the above differential characteristics of MNEs as compared to domestic firms.

1.3 REVIEW OF THE LITERATURE

In this section, we provide a concise survey of the important previous studies on the comparative performance of foreign and domestic firms in the Indian manufacturing sector. We also review the available studies on spillovers in Indian manufacturing industry.

Balasubramanian (1973) compares productivity and capital intensity within industries for a sample of 85 Indian firms, of which 28 are local without foreign licensing, 42 local with foreign licensing, and 15 of them foreign. He uses data for the period 1960-'65 collected from the Bombay Stock Exchange.

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[3] The ways in which the spillovers can happen is discussed in fourth chapter.

He finds a diversity of experience across different industries for different measures of productivity and therefore concludes that foreign ownership or licensing as such does not exercise an independent influence. He finds that, within given industries, the first and third groups of firms are less capital intensive than the second, but does not provide any clear evidence on the performance of foreign investors as such. In any case, the smallness of the sample does not permit any general inference about their performance.

Agarwal (1976) has studied the factor proportions in foreign and Indian manufacturing in Indian industry. The study is based on the data for 34 industries - classified at three-digit level of the classification of Indian industries (CII) - in which foreign firms were operating in 1969. He finds that foreign firms are more capital intensive than domestic firms in the large scale-manufacturing sector of India.

Agarwal's findings (1976) are contradicted by Leipzier's (1976) comparison of US owned firms and local Indian firms. Leipzier uses data on Indian firms (as of 1964-65) from the United Nations Industrial Development Organisation's 'Profiles of Manufacturing establishments' and the comparable data for the Indian affiliates of the US MNCs are collected from the US Commerce Department's 'Special Survey'. Using Cobb-Douglas production functions, he finds that US firms import less capital-intensive technology ex ante, but use more fixed capital per man ex post, because they have to pay higher wages.

Lall (1976) compares the profitability of MNCs and other firms, for a sample of 109 firms- 53 in India and 56 in Colombia-with an average operating age (as of 1969) of 15 years in the host economies. Using analysis of variance, he concludes that the declared profit of MNCs and others do not differ significantly from each other.

Lall and Streeten (1977) examine labour and capital productivity and capital intensity of different groups of firms in their aggregate sample of 109 Indian and Colombian firms but fail to find statistically significant differences between MNCs and other firms.

Agarwal (1979) attempts to find out the productivity differences of foreign and domestic firms using the data prepared by the Central Statistical Organisation by disegregating the figures of its 1969 Annual Survey of Industries between foreign and domestic firms on the basis of majority participation in the share capital. According to his study, foreign firms are more productive than the domestic firms in the manufacturing sector of India. The magnitude of differences amounts to 60% for capital productivity and 55% in the case of total productivity.

Subrahmanian and Pillai (1979) compare the export performance of foreign collaborations and local firms under different clusters of foreign control in three Indian industries viz., engineering, dyestuff and pharmaceutical. (Period: 1956-57 to 1973-74). A composite, index combining: (i) the proportion of output that is exported and, (ii) the rate of growth of the share of export in total production, is used to measure the export performance of the firms. The study has found that export intensity did not increase with the higher levels of foreign collaboration. In fact, the study has shown a poorer export performance of foreign controlled firms as compared to the indigenous counter parts.

Kumar (1994) examines the comparative performance of foreign controlled and local enterprises in India in terms of a number of parameters. His analysis is based on the data obtained from the unpublished sources of the Reserve Bank of India for the period 1975-76 to 1980-81. He finds that foreign controlled enterprises have larger scales of operation and profit margin than their local counter parts. Factor proportions do not significantly differ between groups. The R&D intensity and growth rates of foreign firms are found to be lower on account of extraneous influences. The study does not reveal any statistically significant difference in the export performance of foreign firms and their local counterparts in Indian manufacturing.

Subrahmanian and Joseph (1994) analyse the export intensity of foreign controlled and domestic firms in Indian industry, using data collated from the publications of Centre for Monitoring Indian Economy (CMIE) for the period 1990 to 1992. A simple approach of the comparison of export intensity of firms shows that local firms perform better on the export front than the foreign counter parts. Results of their more sophisticated econometric analysis too do not show any relatively greater export intensity of foreign controlled firms.

Subrahmanian et al., (1996) analyse of the export performance of FDI firms using RBI cross-section data for the period 1991-92 to 1993-94. They could not find a better export performance of FDI firms in terms of both actual export performance and export probability.

Joseph (1999) analyses the export performance of foreign firms based on a panel data set from 1989-90 to 1993-94 collected from the publication `Key Financial Data on Large Business Units' published by CMIE. The analysis is based on a probit model on the decision to export and `selection corrected estimates' of export intensity. The probit model shows that foreign collaboration has a positive effect on the decision to export, while foreign ownership has no significant effect on the export decision. The `selection corrected estimates' of export intensity shows that foreign ownership negatively affects export intensity.

Ahuja (1999) compares of Indian and foreign private sector firms operating in India using three indicators: (i) value of output per unit of capital; (ii) value of output per unit of net-worth; and (iii) wages and salaries per unit of sales. The study is based on CMIE data for the year 1996. The study shows that foreign firms are performing better, in terms of the three indicators, than their domestic counterparts.

Basant and Fikkert (1996) provide estimates of the impact on productivity of firms' own R&D expenditures, their technology purchase (TP) expenditures, and foreign and domestic R&D spillovers using panel data for Indian manufacturing firms from the period 1974-75 to 1981-82 and R&D data from 9 countries. The private returns to technology purchases are estimated to be high and statistically significant, while the private returns to the firms' own R&D expenditures are some- what lower and are often insignificant. The study gives evidence of both international and domestic R&D spillovers.

Kathuria (1999) examines foreign investment spillovers in Indian industry using RBI data provided by Institute for Studies in Industrial Development. The study covers a time span of five years from 1984-85 to 1988-89 covering 388 firms belonging to eight different sectors. Ordinary least square method is used for the spillover estimation. Based on the preliminary results, he concludes that there exists spillovers from foreign investment it but mainly occur in low-technology sectors.

It appears from the foregoing review that none of these studies has shown concern with the relative productive (technical) efficiency of multinationals and domestic firms in Indian manufacturing. Further, the few available on the spillovers are restricted to the pre-liberalisation phase. Thus, we have no precise idea of the relative productive efficiency of foreign and local firms and also of the spillover spillover benefits of foreign firms on the local firms in the post-liberalisation period of Indian industry. The present study seeks to fill these gaps in the literature by addressing the following crucial questions. Given a level playing field to both foreign and domestic firms in the liberalised regime, how far the efficiency of foreign firms is different from that of their local counterparts; and to what extent the presence of foreign firms helps the domestic firms in enhancing their efficiency? The present study makes a moderate attempt to address these questions by analysing the relative efficiency of foreign and domestic firms and the spillovers and linkages of foreign firms on the local firms in the Indian manufacturing sector in the post-liberalisation period.

1.4 SIGNIFICANCE OF THE STUDY AND MAJOR OBJECTIVES

The study has special relevance in the present Indian context. After a four-and- half decades of inward-oriented policies, the Indian economy is increasingly opening up its trade and investment since1991. The structural reforms, which India embarked in 1991, basically aim at improving the efficiency of resource use by changing the structure of incentives and institutions based more on market forces than government intervention. Thus, with the introduction of structural reforms gaining efficiency has come to be of primary concern in Indian industrial sector. The opening up of the economy, as part of the structural reforms, to the forces of competition have resulted in a situation in which domestic firms has to increasingly compete with foreign firms to secure and retain for themselves, adequate market share. In such an environment, an inefficient firm would hardly be able to survive. An underlying assumption behind the liberalisation of international trade and investment policies is that the local firms are efficient enough to face competition from its foreign counter parts. This assumption needs to be rigorously tested to understand the relative strengths and weaknesses of foreign and domestic firms.

Again, an analysis of the spillovers and linkage effects of foreign firms on the local firms has added significance in the post-liberalisation period. The liberalisation of FDI policies aims at exploiting its "attendant advantage of technology transfer, marketing expertise, introduction of modern management techniques in the country and export promotion" (New Industrial Policy Statement, 1991). The analysis of spillovers and linkages may, therefore, reveal the impact of the presence of foreign firms on the performance of local firms[4]. Thus, the significance of the present study both from academic and policy angles needs hardly emphasis.

Keeping in mind the above objectives the study seeks to analyse:

- The relative technical efficiency of foreign and domestic firms in Indian manufacturing during the post-liberalisation and the factors influencing the relative efficiency.
- The spillovers and linkages of foreign firms on the local firms.

1.5 DATABASE AND PERIOD OF THE STUDY

For our analysis, we need a data set comprising different variables for foreign and domestic firms operating in India in the post-liberalisation period. Reserve Bank of India (RBI), Centre for Monitoring Indian Economy (CMIE), Bombay Stock Exchange (BSE), Industrial Credit and Investment Corporation of India (ICICI) and Industrial Development bank of India (IDBI) are the major sources of firm-level data in Indian manufacturing[5]. However, the firm level data available in RBI is not available in published form. The CMIE's computerised database *PROWESS* gives extensive information and data on firm-specific variables for about seven thousand firms listed in BSE. The analysis of the present study is mainly based on the firm-level data taken from the CMIE database *PROWESS*.

Vast coverage, extensive information on firm-specific variables and easy access are the major reasons for choosing *PROWESS* database for our study. None-the-less, the database is not free from limitations. The data provided by *PROWESS* on the variables like R&D, foreign equity share holding etc. are collected from the report of the board of directors of the respective companies. It is observed that there have been serious omissions in this respect[6]. These information, however, are mentioned in the background report. Hence, while making use of the *PROWESS* data the user have to go through the background report of each and every firm under consideration, which is provided along with the data base.

We use a balanced-panel data for a time span of five years from 1991-92 to 1997-98. These industries comprise chemicals, non-electrical machinery, electrical machinery, electronics and transport equipment[7]. The selection of industries has been guided by the industry-wise

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[4] In our case the efficiency performance of local firms.
[5] Shanta and Kumar (1999) provide a detailed discussion on the merits and demerits of these data sources.
[6] Examples are given in Shanta and Kumar (1999)
[7] Appendix I provides details of the sample.

concentration of FDI[8]. In our balanced panel data set, all the 127 pairs of firms (254 firms) are observed over the seven years[9].

Data on FDI are collected from different sources such as RBI (Monthly Bulletins), UNCTC (World Investment Report, various issues), Assocham Parliamentary digest (various issues). Price index data were collected from 'The Index Numbers of Wholesale Prices in India' (Government of India, Ministry of Industry). Data from the Input-output Transaction Tables (CSO) is used for constructing material price indices. Data from Annual Survey of Industries (CSO) is used in the calculation of labour input.

The period of study (i.e., 1991-92 to 1997-98), which represents the liberalised regime, is chosen on the basis of the following two considerations. The first is comparability of foreign firms with domestic firms; the performance of foreign and local firms is more comparable in the post-liberalisation period because they are now operating, more or less, in a similar economic environment. The second is data availability; more firms are available in PROWESS in recent years as compared to the pre-liberalisation years.

1.6 METHODOLOGY

In the balanced-panel data, we have constructed `matched pairs' of foreign and local firms - matched in terms of size and product line. Appendix I gives details of the sample selection. The matching of foreign and local firms (competing firms) is considered as a satisfactory approach as it compares like with like. However, such a pairing procedure has the limitation of reducing the sample size.

Dunning defines a multinational or transnational enterprise as "an enterprise that engages in foreign direct investment and owns or controls value adding activities in more than one country" (Dunning, 1993, p.3). In empirical studies, an important criterion for identifying the `multinationality' or `transnationality' of a firm is the share of its foreign equity participation. Definition of foreign control, at least in theory, is problematic. In our study, a firm is considered as foreign controlled, if its foreign share holding is 25 per cent or more. This threshold, arbitrary as it may appear, is consistent with many other studies such as, Cohen (1975), Lall (1976), Lall and Streeten (1983), Newfarmer and Marsh (1981), Chen (1983), Stanfood and Dunning (1983),

[8] See chapter II for details.

Fairchild and Sosin (1986) and Kumar (1994). Clearly, majority foreign shareholding enables foreign control in most circumstances, but less than majority of foreign share holding may often suffice for exercising effective foreign control, especially if residual share holding are dispersed among a large number of small local shareholders. In the absence of better information, and assuming that local shareholding is not very concentrated (foreign shareholding being held by a company), the threshold level chosen for defining foreign control seems a reasonable one. In the subsequent parts of the study, the terms `multinationals', `MNEs', `foreign firms' and `transnationals' will be used synonymously to denote foreign controlled firms. The terms `enterprise', `firm', `corporation' and `company' also tend to be used synonymously, although we recognise that each has a particular legal connotation. Firms with 100 per cent local shareholding are considered as local firms in this study. The matching of these firms, by size (with foreign firms), make them comparable to foreign firms. In the later parts of the study, we shall use the terms `domestic firms' and `local firms' interchangeably. The methods used for analyses are explained in the concerned chapters.

A major limitation of the study arise from the fact that by focusing on only the foreign controlled and pure local firms, the analysis has left those firms with foreign equity shareholding less than 25 per cent. Inclusion of firms with foreign equity share up to 25 per cent could have probably enabled us to draw more incise. We could not include this category due to the inadequate availability comparable firms in the database.

1.7 CHAPTER SCHEME

The present study is organised in five chapters. The scope and methodology of study is introduced in the present chapter. Chapter II reviews the evolution of the Indian government's policy towards FDI in the post-independence period. The chapter also examines the trends and patterns of FDI in Indian economy. It aims to give a background for the next two analytical chapters. Chapter III analyses the technical efficiency of foreign and local firms in selected Indian industries. Chapter IV seeks to answer the question, whether the technical efficiency performance of domestic firms is influenced by the spillovers from the foreign presence. The chapter also examines the linkages generated by foreign and local firms. A summary of findings and concluding remarks are presented in the chapter V.

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[9] Several benefits and defects of using panel data are listed in literature [see Hsiao (1985,1986), Klevmarken(1989), Solon(1989), and Baltagi(1995)].

Chapter II

FOREIGN DIRECT INVESTMENTS IN INDIA: POLICIES, TRENDS AND PATTERNS

2.1 INTRODUCTION

Foreign direct investment (FDI), which serves as the primary vehicle by which the global activities of MNEs are created, is today eagerly sought by the majority of developing countries. There is a growing interest in the developing countries to understand the role of FDI in the process of economic growth[1]. Based on a survey of econometric studies, de Mello (1997) concludes that growth-FDI nexus is sensitive to country specific factors, particularly, FDI policy regimes and host country factor endowments. In the Indian context, as the government have been following a selective approach towards FDI, its role was minimal until the early nineties. However, since the initiation of Structural Adjustment Programme (SAP) in 1991, a much larger role is envisaged for inflows of FDI in India. This chapter analyses the evolution of government policies, trends and patterns of foreign direct investment (FDI) in India, with a special focus on the post-liberalisation scenario. This exercise mainly intends to provide a background for our subsequent analysis.

Foreign direct investment (FDI), is defined as an investment involving long term relationship and reflecting a lasting interest and control of a resident entity in one economy (foreign direct investor or enterprise) in an enterprise resident in an economy other than that of the foreign direct investor (FDI enterprise or affiliate enterprise or foreign affiliate)[2]. Through FDI, the investor exerts a significant degree of influence on the management of enterprises resident in the other country. Although individuals or partnerships may make such investments, most of FDI is undertaken by enterprises, and a larger proportion by multinational enterprises (MNEs). Thus, FDI is an aggregate entity, the sum total of investments made, mainly, by MNEs.

FDI is considered crucial by developing countries for the following reasons. First, FDI is viewed as a means through which the country secures large inflows of non-debt creating capital, and this augments domestic savings. Second, it acts as a vehicle for transferring

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[1] de Mello (1997) provides a detailed survey of literature on the impact of FDI on growth in developing countries.

[2] This general of definition of FDI is given in the various World Development Reports of UNCTAD.

various technological and managerial resources. Such investments are expected to bring with them assets such as advanced technology, modern management and marketing skills, and organisational competence, which tend to spillover into the domestic economy. Finally, FDI is also seen as a channel for promoting exports of manufactures from the host economy.

This chapter is organised as follows. Section II reviews the evolution of India government's policy towards FDI since independence. Section III deals with the analysis of trends and patterns of FDI in India. It includes a sub-section that analyses its trends and patterns in the post liberalisation period. The final section provides, in brief, the conclusions from our analysis.

2.2 GOVERNMENT POLICY ON FDI - AN OVERVIEW

This section provides, first, a brief overview of the evolution of India's policy towards FDI during the post-independence period. Then it discuses the trends and patterns of FDI during the period. Foreign investment policy of host country government, *inter alia,* is considered to be one of the important factors determining the magnitude, pattern, form and impact of foreign direct investment (FDI) on the economy[3]. Core FDI policies consist of rules and regulations governing the entry and operations of foreign investors, the standards of treatment accorded to them, and the functioning of the markets within which they operate (UNCTAD, 1996,1997). Most governments welcome FDI but most also regulate it, to a greater or lesser degree by using its FDI policy framework. This is because not all forms of FDI are considered desirable, or because some industries may be reserved for national investment. The FDI policies are framed to satisfy various objectives- reducing or increasing FDI, influencing its sectoral composition or geographical origin, encouraging specific contributions to the economy and affecting ways in which these contributions are made. Thus by regulating investments, through appropriate policies, governments seek to maximise the net benefits they receive. Complementing core FDI policies are other policies that affect foreign investors ' location decision directly or indirectly, by influencing the effectiveness of FDI policies. These include trade policy and privatisation policy. Policies intentionally designed to influence FDI and its location constitute "inner ring" of the policy framework for FDI. Policies that affect but have not been designed for that purpose

[3] Lall (1978), Aggarwal (1980) and UNCTC (1992) provide discussions on the determinants of FDI.

constitute the "outer ring" of the policy framework (UNCTAD, 1998). The contents of both rings differ from country to country, as well as over time within a country.

The problem of foreign investment in India has been an issue of sufficient concern ever since the days of East India Company. It acquired a different complexion and added significance after Indian Independence, particularly, after the launching of Five-Year Plans. Soon after independence, India adopted a development strategy based on government control and planning, with emphasis on heavy industry and import substitution. This section briefly reviews the evolution of Government's policy towards FDI in India during the post independence period.

The Government of India's policy on FDI has been changing in the post-independence period and four distinct phases can be discerned: the period from Independence to late 1960s, marked by cautious promotion of FDI; the period from late 1960s to 1970s, characterised by a highly restricted regime; the 1980s, a phase of cautious deregulation; the reform period from 1991 onwards, signifying foreign investment environment (see Kumar, 1994, 1995 for a detailed review).

Since there is no separate law governing the policy on FDI, it has, in general been formulated essentially within the ambit of Industrial Policy Statements and Five-Year Plans issued from time to time. The approach of the Government towards FDI was first laid down in the Industrial Policy Resolution, April 1948. It acknowledged the need of foreign capital, technology and knowledge for the rapid industrialisation of the country. The thrust of the policy was to welcome foreign private investment on a selective basis in areas, which would benefit the economy. However, it advocated an effective Indian control over the management of foreign capital to ensure its regulation in the national interest. In the Foreign Investment Policy Statement, (April, 1949), the Government recognised the necessity of foreign capital for supplementing Indian capital. The Government thus encouraged foreign investment on mutually advantageous terms. Foreign investors were assured that there would be no restrictions on remittance of profits and dividends and that fair compensation would be given in case of acquisition. They were also promised 'national treatment'.

The 1956 resolution on industrial policy reflected a tilt towards 'socialistic pattern' with large chunks of heavy industry earmarked for the public sector to the exclusion of private capital, domestic or foreign. Established firms in these areas were, however, left alone. Foreign exchange shortage of 1957-58 necessitated further liberalisation of foreign investment and foreign investors were offered a host of incentives and concessions. Anticipating the continuation of foreign exchange bottleneck and its impact on the Third Five -Year Plan projects, Government in 1961, for the first time, issued the illustrative lists of industries in which foreign investment would be permitted.

Because of the policy towards FDI followed until mid-1960s, the outflow on account of dividends, profits, royalties and technical fees grew shapely and became a significant proportion of the foreign exchange account of the country. This, in the wake of another foreign exchange crisis in late 1960s the government began to tighten the FDI policy regime. The entry of foreign firms was restricted to specific industries.

Three enactment, namely the Monopolies and Restrictive Trade Practices (MRTP) Act, 1969, the Indian Patents Act, 1970, and the Foreign Exchange Regulation Act (FERA), 1973, tipped the scales against foreign capital. The first one created the MRTP Commission, which scrutinised proposals for capacity expansion by all large firms, and approvals were often tied to export commitments (Chandra, 1988). The second one removed many of the monopolistic advantages of the transnational corporations under the old patent law, particularly in chemicals and pharmaceutical. (Bagchi et al., 1984; Mehrotra, 1989). FERA, however, became the most important tool in the hands of the government for regulating foreign firms in later years. As per the Section 29 of the FERA, all branches of foreign companies in India and joint stock companies with non-resident participation in excess of 40 per cent were required to obtain a fresh approval from the Reserve Bank of India (RBI) to carry on business and comply with RBI directions on foreign participation in capital structure, borrowing, foreign exchange payments relating to repatriation of capital etc. Further, a process of *Indianisation* was introduced in the sense that these companies were obliged to dilute their non-resident share holding within two years to the levels prescribed by the Reserve Bank, which was placed generally at 40 per cent, or fold up. However, foreign equity holding up to a maximum of 74 per cent was allowed in a limited number of companies that are engaged in some specific activities. Thus, companies engaged in export activities, manufacturing activities involving sophisticated technology and skills were permitted to retain up to 51 or 74 per cent of foreign equity.

The Industrial Policy Statement 1977 further tightened the regulatory regime by prohibiting foreign collaboration in certain industries, because it was perceived that indigenous technology in these industries is sufficiently developed. These industries included metallurgical industries, miscellaneous mechanical and engineering industries, rubber industries, chemicals (Other than fertilisers), drugs and pharmaceuticals, etc.

In an environment of general discontentment with the earlier regime, government began to initiate liberalised policy measures, in early 1980s, in almost all sectors of the economy including FDI. Thus, India's development strategy took a new direction. Emphasis was placed on growth with competitiveness and the Government initiated deregulation. Licensing was abolished for a number of industries, and was relaxed in others. Firms were permitted to diversify their product-mix and to increase their capacities without prior official approval. The MRTP Act was revised. In foreign trade, tariff rates were reduced, the tariff structure was rationalised, import licensing was relaxed, the import of raw materials, components and capital goods was deregulated; and duty free access to imported inputs for export promotion was permitted. Various exemptions, rebates and incentives were provided to promote export orientation of firms. Policy changes, such as widening of the range of industries eligible for FDI, simplified procedures for the processing of applications, establishment of fast channels for the speedy clearance of FDI, and setting up of duty free zones lowered the entry barriers for FDI.

To promote investments by Non-resident Indians (NRIs) and entities predominantly by NRIs / Overseas Corporate Bodies (OCBs) and to increase the level of FDI in India, the Government granted special incentives for NRI / OCB investment in to India. NRIs / OCBs were allowed to invest freely in Indian companies without the need for a technology transfer. Cent per cent investment was permitted, if the foreign investment was on a non-repatriable basis.

2.2.1 Structural Reforms of 1990s

In response to an unprecedented macro economic crisis, the Government of India simultaneously launched Structural Adjustment Programme (SAP) and a programme of Stabilisation in mid-1991. As part of the SAP a New Industrial Policy (NIP) was announced on July 24,1991 in the Parliament which marked the beginning process of full-scale liberalisation of FDI in Indian industry. The NIP and subsequent policy amendments have liberalised the industrial policy as well as the FDI policy framework in India. The post 1991 developments in FDI policy are discussed below.

Industrial licensing in all industries has been abolished except for 18 strategic or environmentally sensitive industries. FDI is approved under two routes: (I) automatic route; and (ii) Government / Foreign Investment promotion Board (FIPB) route. In 34 high priority industries identified in the Annex III of the Policy, FDI up to 51 per cent is approved automatically by RBI provided the foreign equity is sufficient to cover the cost of the capital goods which are required to be imported for the project. Existing companies engaged in one or more of the 35 specified industries are permitted to raise the foreign equity participation from existing levels to 51 per cent automatically, provided the cost of import of capital goods are covered by foreign equity. Companies which are not exclusively engaged in any one of the 35 specific industries could also raise the foreign participation from existing levels to 51 percent, if the equity is issued to finance an expansion or diversification into any activity covered by the 35 industry listings.

The policies, when they were announced initially imposed a dividend balancing clause, under which any outflow on account of dividend payments to the foreign investor needed to be balanced by the export earnings of items covered under Annexure III over a period of seven years from the commencement of commercial production. However, the clause has subsequently been dropped except in the case of 22 consumer goods industries.

The prevailing policy permits firms to issue equity to foreign investors at a price determined by the shareholders of the company by a special resolution. This is a major departure from the earlier policy, which required equity to be issued at a price equal to the average market price of an equity share of the company in the previous six months in the case of a listed company, and at the net asset value per share in the case of a closed-held company.

Another deviation in the new policy on foreign investment is that FDI proposals do not necessarily have to be accompanied by technology transfer agreements. To attract MNCs in energy sector, 100 per cent foreign investments are permitted for setting up and operating power plants. To provide greater access to the international markets, foreign equity holding up to 51 per cent also is permitted for trading companies primarily engaged in export activities.

All investment proposals that do not conform to the parameters stipulated for automatic approval were required to obtain prior Government approval. A Foreign Investment Promotion Board (FIPB) authorised to provide single window Clarence has been set up in the prime minister's office to invite, negotiate and facilitate investments in India by large international companies. This programme has designed to attract substantial investments, which would provide access to high technology and to world markets.

Since 23 September 1992, the Government constituted an Empowered Committee to deal with FDI proposals recommended by the FIPB in which total investment is up to Rs 300 crore. Proposals involving total investment beyond Rs 300 crore are submitted to the Cabinet Committee on Foreign Investment.

The NRIs and OCBs are given further incentives. They are permitted to invest up to 100 per cent in the equity of 35 specified industries, provided, foreign equity covers the foreign exchange requirements for import of capital goods. Investments by NRIs and OCBs up to 100 per cent were also be permitted in industries requiring compulsory licensing and industries reserved for the small scale sector, provided specified export obligation conditions are satisfied. OCBs are allowed to sell/transfer shares/bcnds/debentures of Indian companies acquired with repatriation benefits through stock exchange under portfolio investment scheme.

The Indian government gives due protection to the foreign investors through signing the Multilateral Investment Guarantee Agency Agreement (MIGA) Protocol. In case of dis-investments, the whole amount could be repatriated, although in instalment and subject to taxes. The use of foreign brand names for goods manufactured by domestic industry have also been liberalised.

Foreign Exchange Regulation Act of 1973 has been amended and restrictions placed on foreign companies by FERA have been lifted. Under this amendment, companies with more than 40 per cent of foreign capital are now permitted to engage in the establishment of branches, purchase of real estate, fund raising, acquisition of companies and employment of expatriate advisers on an equal basis with domestic companies. These companies are now treated on par with fully Indian owned companies.

Foreign investors are now allowed to disinvest equity shares through stock exchange in India. Permission is also granted to the foreign investors for disinvestments of listed equity shares through private placement subject to certain stipulations. Restriction relating to 5 year lock-in period for issue of shares on preferential basis are removed, except in those cases where preferential issue of securities is in favour of promoters.

New sections such as mining, banking, telecommunications, highways, construction and management have been thrown open to private, including foreign owned, companies. Foreign investors are also offered tax incentives, in respect of dividend income, royalty, technical fees and interest.

Recently, a Foreign Investment Implementation Authority (FIIA) has been set up to facilitate speedy implementation of approved FDI projects. A Foreign Investment Promotion Council (FIPC) is also in place to suggest ways and means to promote FDI.

As part of the structural reforms, the international trade policy in India also has been considerably liberalised by measures like reducing tariffs for most types of importable, sharp pruning of negative lists for imports, etc.

Thus, the government's policy towards FDI in India has evolved from Independence to 1990s in four phases with differential degrees of restrictions. These policy swings have reflected the socio-economic-cum- political objectives of the Government.

2.3 TRENDS AND PATTERNS OF FOREIGN DIRECT INVESTMENT IN INDIA

This section analyses the trends and patterns of FDI in India during the four phases of policy changes identified earlier. The analysis has special focus on the aspects like growth of actual FDI inflows, its industry-wise and geographical distribution, country-wise origin, and also its share in GDP and Capital formation in the economy.

Prior to the analysis, a caveat may be made about the data used for analysis. In India, the definition of FDI has been changed in 1992. Direct investment represents acquisition of some amount of control over the management of the company in which the investment is made. Till March 31,1991, FDI was defined to include investment in (i) Indian companies which were subsidiaries of foreign companies, (ii) Indian companies in which 40 per cent or more of foreign equity was held outside India in any one country and (iii) Indian companies in which 25 per cent or more of the equity capital was held by a single investor abroad. In an attempt to adopt IMF guidelines on the subject, effective from March 31,1992, the objective criterion for identifying FDI has been fixed at 10 per cent of ordinary share capital for a single investor. As a result, estimates of FDI relating to 1992 and beyond are not strictly comparable with those of the earlier periods.

Trends in FDI over four decades, from 1955 to 1995, are presented in Table 2.1 and Figure 2.1. Since comparable data are not available from RBI for the period form 1948 to 1955, the period studied starts with the year 1955. The survey data on FDI are not available for the years from 1981 to 1985. Figure 2.1 purports a slowly rising trend in FDI inflows during 1955 and 1980. However, after 1987 the curve shows a sharply rising trend, particularly after 1991. One possible reason for this major spurt in FDI is the effect of partial liberalisation of 1980s and the structural reforms of the 1990s. During the four decades, he highest annual growth in FDI inflows occurred in 1994 (i.e., 47.3%), while the largest decline in inflows happened in 1978 (4.8%).

Table 2.2 provides the annual averages of foreign investment during the four phases of policy changes. The impact of policy changes during phases is clearly reflected in the foreign investment inflows. The deceleration in the compound growth rates of foreign investment from 4.45 to 3.52 clearly indicates the negative impact of the restrictive policy regime on foreign investment. The steady increase in the growth rates during the next two phases show the positive response of the foreign investors to the gradual and full- scale liberalisation measures introduced in India during these two phases[4].

The stock of foreign investment in India in June 1948, according to the first survey of India's assets and liabilities was Rs. 225.8 crore and bulk of this investment was concentrated in manufacturing (27.73), plantations (20.39) and trading (16.86). By 1995, the latest year for which the comparable official estimates are available, the volume of FDI reached at Rs 9416 crore (RBI Bulletin, April 1998). Not only the magnitude, but also sectoral composition and sources have undergone considerable changes over this period.

[4] The change in definition of FDI in India from 1992 may also have a significant influence on the higher values of FDI in the last phase.

Table: 2.1

Trends of FDI in India (1955 - 1995)

(Rs. Crore) End March

Year	FDI	% Growth	Year	FDI	% Growth
1955	392.2	---	1975	973.3	6.2
1956	416.4	6.2	1976	957.1	-1.7
1957	434.2	4.3	1977	920.2	-3.9
1958	437.7	0.8	1978	876.0	-4.8
1959	448.1	2.4	1979	875.4	-0.1
1960	501.7	12.0	1980	933.2	6.6
1961	527.2	5.1	1981	N.A.	N.A.
1962	567.6	7.7	1982	N.A.	N.A.
1963	541.5	-4.6	1983	N.A.	N.A.
1964	565.5	4.4	1984	N.A.	N.A.
1965	611.9	8.2	1985	N.A.	N.A.
1966	628.2	2.7	1987	1742	N.A.
1967	652.9	3.9	1988	2045	17.4
1968	710.1	8.8	1989	2302	12.6
1969	737.7	3.9	1990	2705	17.5
1970	735.4	-0.3	1991	3213	18.8
1971	767.3	4.3	1992	3840	19.5
1972	814.9	6.2	1993	4643	20.9
1973	867.0	6.4	1994	6838	47.3
1974	916.9	5.8	1995	9416	37.7

Source: RBI Bulletin (Various issues)

Figure 2.1 Trends of FDI in India (1955 - 1995)

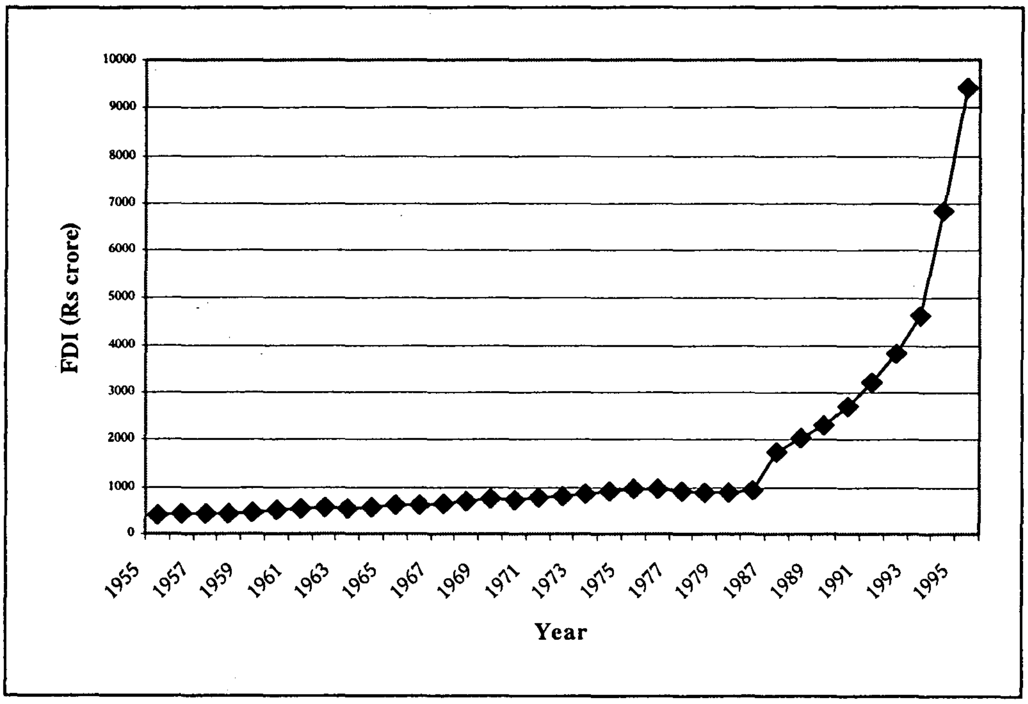

Table: 2.2

Annual Average of Foreign Investment Inflows

Period	Phase	Annual Average Inflow (Rs. crore)	Compound Growth Rate (%)
1955-1966	I	494.9	4.45
1966-1979	II	806.8	3.52
1979-1991	III	1737.1	11.75
1991-1995	IV	5590.0	31.36

Sector-wise distributions of FDI as at the end of four financial years are presented in Table 2.3 along with the phase-wise growth rates. In terms of the share in total FDI, manufacturing sector was the most important recipient over all these four phases. Its share has increased from 27.6 per cent in 1948 to 83.4 in 1995. Among the manufacturing sub-sectors, chemicals and allied products has been attracting the major share of FDI during all the four phases of policy changes. In 1995, within the manufacturing sector, the investment was concentrated in chemicals and allied products (22.2 %), machinery and machine tools (11.3%), electrical and electronics (10.8%), transport equipment (10.5) and food & beverages (7.3%). Consequent to the liberalisation of service and energy sectors, very high growth rates of nearly 139 per cent and 325 per cent are registered respectively in petroleum and financial sector during the post-reform period. In phase IV the main beneficiaries of flows were petroleum, financial sector and textile products.

It is apparent from Table 2.4 that the U.K. and U.S.A. are the two prominent sources of FDI throughout all phases. The share of U.K., the single largest source of FDI in all the phases, has been falling over the years; while that of U.S.A., the second largest source during all phases, has been increasing over the years. In 1955, share of U.K. in the total FDI in India was nearly 86 per cent, by 1995 it had fallen to 28 per cent while the share of USA had increased from nearly 10 per cent to over 24 per cent in the corresponding years. Though the share has been coming down, U.K. retains its predominant position until 1995. A geographical diversification in sources of FDI has also occurred over the years. An interesting point to note is that the value of FDI from Mauritius was negligible till 1991, but the country has become the seventh largest FDI source of India by 1995. Germany, Japan, Netherlands, and Canada have become significant sources of FDI to India.

Table: 2.3

Industry-wise Distribution of Foreign Direct Investment (Rs. Crore)

Industry	End-March 1955	End-March 1966	Growth Rate @ Phase I: 1955-'66	End-March 1979	Growth Rate @ Phase II: 1966-'79	End –March 1991	Growth Rate @ Phase III: 1979-'91	End-March 1995	Growth Rate @ Phase IV: 1991-'95
I. Plantations	87 (24.4)	109 (17.4)	2.07	34 (3.9)	-8.57	304 (9.5)	20.02	449 (4.8)	11.47
II. Mining	9 (2.5)	4 (0.6)	-7.11	8 (0.9)	5.47	10 (0.3)	1.88	24 (0.3)	19.14
III. Petroleum	104 (29.2)	132 (21.0)	2.19	36 (4.1)	-9.51	5 (0.2)	-15.16	274 (2.9)	138.86
IV. Manufacturing	129 (36.2)	297 (47.3)	7.88	760 (86.9)	7.49	2710 (84.3)	11.17	7852 (83.4)	31.36
1.Food & beverages	29 (8.1)	33 (5.3)	1.18	39 (4.5)	1.29	202 (6.3)	14.68	687 (7.3)	39.80
2. Textile products	22 (6.2)	17 (2.7)	-2.32	23 (2.6)	2.35	72 (2.2)	9.97	370 (3.9)	51.09
3. Transport equipment	4 (1.1)	20 (3.2)	15.75	50 (5.7)	7.3	311 (9.7)	16.45	987 (10.5)	34.28
4. Machinery & machine tools	5 (1.4)	21 (3.3)	13.93	65 (7.4)	9.08	418 (13.0)	16.77	1062 (11.3)	27.24
5. Metal & metal products	11 (3.1)	44 (7.0)	13.43	117 (13.4)	7.81	190 (5.9)	4.12	437 (4.6)	23.51
6. Electrical goods & machinery	15 (4.2)	24 (3.8)	4.36	86 (9.8)	10.31	371 (11.5)	12.95	1021 (10.8)	31.94
7. Chemical & allied products	20 (5.6)	88 (14.0)	14.42	281 (32.1)	9.34	875 (27.2)	9.92	2087 (22.2)	23.09
8. Others	24 (6.7)	49 (7.8)	6.7	100 (11.4)	5.64	271 (8.4)	8.66	1201 (12.8)	48.74
V. Trading	N.A.	29 (4.6)	N.A.	19 (2.2)	-3.2	23 (0.7)	1.6	127 (1.3)	46.79
VI. Construction & turkey projects	N.A.	40 (6.4)	N.A.	8 (0.9)	-11.64	52 (1.6)	16.87	52 (0.6)	1.48
VII. Transport	N.A.	*	N.A.	*	N.A.	15 (0.5)	N.A.	1 (0.0)	-39.02
VIII. Utilities	N.A.	*	N.A.	*	N.A.	3 (0.1)	N.A.	14 (0.1)	35.31
IX. Financial	N.A.	2 (0.3)	N.A.	4 (0.5)	5.47	1 (0.0)	-10.91	359 (3.8)	325.23
X. Others	57 (16.0)	14 (2.2)	-11.98	7 (0.8)	-5.19	90 (2.8)	23.71	264 (2.8)	30.12
Total	356 (100.0)	628 (100.0)	4.52	875 (100.0)	2.58	3213 (100.0)	11.44	9416 (100.0)	31.36

Note: *indicates that they were clubbed with Construction & turkey

@ Compounded Annually

Figures in the parentheses show percentage to the total

Source: RBI Monthly Bulletin, Various Issues

Table: 2.4

Home Country-wise Distribution of Foreign Direct Investment

Country	1955	Percent	1966	Percent	1979	Percent	1991	Per cent	1995	Percent
U.K.	331	85.751	467	74.36	460	52.57	1491	46.41	2632	27.95
U.S.A.	37	9.59	93	14.81	201	22.97	615	19.14	2270	24.11
Canada	2	0.52	12	1.91	33	3.77	87	2.71	235	2.50
France	0	0.00	0	0.00	5	0.57	13	0.40	87	0.92
Germany	1	0.26	12	1.91	55	6.29	321	9.99	842	8.94
Netherlands	0	0.00	0	0.00	0	0.00	86	2.68	578	6.14
Sweden	0	0.00	8	1.27	18	2.06	105	3.27	121	1.29
Switzerland	4	1.04	18	2.87	48	5.49	120	3.73	523	5.55
Japan	0	0.00	1	0.16	4	0.46	179	5.57	711	7.55
Mauritius	-	0.0	-	0.00	-	0.00	-	0.00	481	5.11
Others	11	2.85	17	2.71	51	5.83	196	6.10	936	9.94
Total	386	100.00	628	100.00	875	100.00	3213	100.00	9416	100.00

Source: RBI Monthly Bulletin, Various Issues

2.1.1 Liberalisation and Foreign Direct Investment in India

This section examines the impact of the recent policy reforms on FDI in India. It seeks to help our later analysis by providing a closer view of FDI situation in India in recent years. The timing of policy reforms since 1991 in India, has coincided with the dramatic upsurge in the global FDI outflows. Therefore, doubts have been raised as to whether the significant rise in the FDI to India in the post-reform period is provoked by policy liberalisation alone or is due to expansion of scale of global FDI activity (Kumar, 1998). Here, we examine the emerging trends and patterns of FDI in India since the liberalisation. Since we could not come across with detailed information regarding various aspects of FDI in the post reform period from the RBI, our analysis in this section is based on data sets collected from alternate sources like CMIE, UNCTAD, and Associated Chambers of Commerce and Industry of India.

The value of FDI approvals in India increased substantially since the adoption of new economic policies in 1991 (Table 2.5 and Figure 2.2). The size of approved FDI shot up to US $ 15752 in 1997 from a low of US $ 325 in 1991. However, there has been a steep fall in approvals in 1998 compared to 1997 (a reduction of 55.7 per cent). The approvals, however, have been slow in materialising into actual inflows. The actual inflow in 1997 was US $ 3330 million as compared to $ 155 million in 1991. The actual inflows also have shown a decline in 1998 from 1997. However, the gap between the actual flows and approvals are low in 1998 as compared to the previous year.

Table: 2.5

FDI in India during the Post Liberalisation Period: Actual vs. Approvals

Year	Approvals (Rs. Crore)	Actual Inflows (Rs crore)	Approvals (US $ million)	Actual Inflows (US $ million)	Actual as % of approvals (in US $ million)
1991	739	351	325	155	47.69
1992	5256	675	1781	233	13.08
1993	11189	1786	3559	574	16.13
1994	13590	3009	4332	958	22.11
1995	37489	6720	11245	2100	18.67
1996	39453	8431	11142	2383	21.39
1997	57149	12085	15752	3330	21.14
1998	28783	9116	6975	2230	31.97
Total ('91 to 98)	193648	42173	55111	11963	21.71

Source: Government of India (2000), Economic survey, 1999-2000

Figure 2.2

FDI in India during the Post Liberalisation Period: Approvals and Actuals

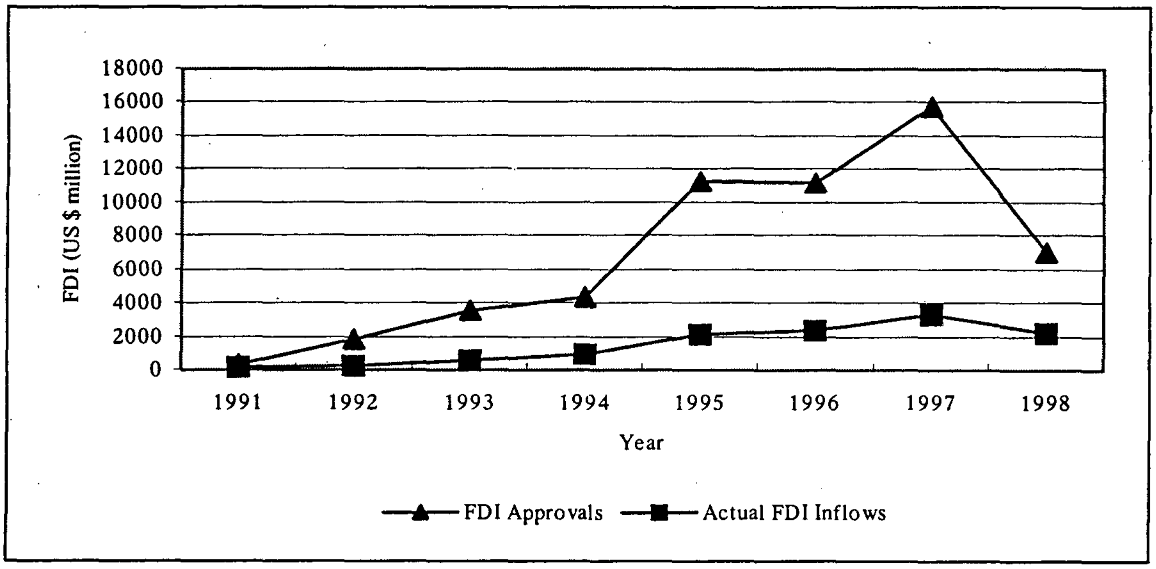

Table 2.6 gives the inflows of FDI to India relative to inflows to the developing countries and the world. As against the annual average of $ 177 million during the pre-reform period 1986-1991, FDI inflows to India steadily increased to $ 2258 million in 1998. The rate of growth of FDI inflow to India during the post-reform period was nearly 50 per cent while that to the developing countries and world respectively was 21 per cent and 23 per cent. Although small in absolute value, the share of FDI inflows to India in the developing countries and in the global FDI has significantly gone up during the post-liberalisation period. From this, we can infer that the phenomenal growth of FDI inflows to India was mainly due to the liberalisation measures introduced in India. Table 2.7 also shows the same trend.

Table: 2.6

Inflows of FDI, 1986-1998 (Millions of Dollars)

	1986-1991*	1992	1993	1994	1995	1996	1997	1998	Growth Rate@
India	177	233	550	973	2144	2426	3351	2258	49.94
Developing Countries	29090 (0.61)	51108 (0.46)	78813 (0.70)	101196 (0.96)	106224 (2.02)	135343 (1.79)	172533 (1.94)	165936 (1.36)	21.23
World	159331 (0.11)	175841 (0.13)	219421 (0.25)	253506 (0.38)	328862 (0.65)	358869 (0.68)	464341 (0.72)	643879 (0.35)	22.76

Source: UNCTAD, World Development Reports-1998 & 1999

Notes: @ compounded annually

Figures in parenthesis indicate India's share of FDI in respective cells.

* Annual average

One of the important roles of FDI in a developing country is that it to helps to bridge the saving-investment gap and supplement the domestic capital formation efforts for the speedy economic growth of the country. Table 2.8 shows the steady increase in the share of FDI in the capital formation of India during the post-reform period. The increase in the ratio is very high in India as compared to the developing countries and the entire world. However, the absolute value of the ratio is very low in India as compared to the developing counties and the global scenario.

Table: 2.7
FDI Inward Stock

(Millions of dollars)

Year	1980	1985	1990	1995	1997	1998
India	1177	1075	1179	5196	10973	13231
Developing countries	132945 (0.89)	237239 (0.45)	370644 (0.32)	769262 (0.68)	1055656 (1.04)	1219271 (1.09)
World	506602 (0.23)	782298 (0.14)	1768456 (0.07)	2789585 (0.19)	3436651 (0.32)	4088068 (0.32)

Source: UNCTAD, World Development Report, 1999
Note: Figures in parenthesis indicates India's share in respective cells.

Table: 2.8
Inward FDI Stock as a Percentage of Gross Fixed Capital Formation, 1986-1997 (%)

Year	1986-1991*	1992	1993	1994	1995	1996	1997
India	0.3	0.4	1.0	1.4	2.6	2.8	4.2
Developing	3.4	4.2	6.4	8.0	7.3	8.4	10.3
World	3.6	3.3	4.3	4.6	5.4	5.8	7.7

Source: UNCTAD, World Development Reports, 1998 & 1999
Note: * annual average

Although insignificant in absolute terms, the increase in the FDI as a percentage of GDP is significant in India after the reforms. (See Table 2.9). FDI as a percentage of GDP in India increased from 0.7 per cent in 1980 to 3.3 per cent in 1997.

Table: 2.9
Inward FDI Stock as a Percentage of Gross Domestic Product (Percentage)

Year	1980	1985	1990	1995	1997
India	0.7	0.5	0.4	1.6	3.3
Developing Countries	5.9	9.8	10.5	14.1	16.6
World	5.0	6.9	8.7	9.9	11.7

Source: UNCTAD, World Development Report, 1999

The approvals and inflows of FDI to from various home countries during the post liberalisation period is presented in Table 2.10. As indicated earlier, over a long period U.K. remained as the most important source of FDI in India. The next important country from the point of view of FDI was U.S.A. During 1980-'90 period West

Table: 2.10

FDI Approvals and Inflow: By Country

Country	Approvals 1991-1998	% to the total	Actual Inflow 1991-1998	% to the total	Actual as % of Approvals
USA	42609.31	23.49	6543.03	12.33	15.36
Mauritius	18395.29	10.14	10575.26	19.93	57.49
UK	13013.67	7.17	1831.91	3.45	14.08
Japan	7512.95	4.14	2333.73	4.40	31.06
Germany	6760.31	3.73	2152.93	4.06	31.85
South Korea	6041.17	3.33	1926.31	3.63	31.89
Australia	5906.28	3.26	169.32	0.32	2.87
Malaysia	5444.47	3.00	132.28	0.25	2.43
Israel	4227.02	2.33	134.58	0.25	3.18
Netherlands	4063.29	2.24	1815.18	3.42	44.67
Belgium	3904.68	2.15	198.37	0.37	5.08
Cayman Islands	3621.87	2.00	3	0.01	0.08
France	3586.81	1.98	701.35	1.32	19.55
Singapore	3333.87	1.84	1058.21	1.99	31.74
Italy	2688.05	1.48	663.83	1.25	24.70
NRIs	7460.96	4.11	8003.61	15.08	107.27
All Countries	181391.55	100.00	53057.	100.00	29.25

Source: CMIE, Monthly Review of Investment Projects, September 1999

Germany and Japan also emerged as important sources in response to the policy measures undertaken. Analysis of the data in Table 2.10 reveals the fact that during the post liberalisation period, there has occurred further diversification of FDI sources. It appears that, non-resident investors, particularly from Mauritius, South Korea, Singapore, Malaysia, etc. have started positively responding to the reforms relating to FDI in India. To illustrate, the value of FDI from Mauritius, until 1991 was negligible. However, while taking the total FDI during the post liberalisation years into account (i.e., 1991 to 1998) this country is the dominant source, followed by USA, Japan, and Germany. One possible reason for the dominance of Mauritius is the double taxation treaty between the two countries, which favours the routing of investments through this country. FDI from South Korea and Singapore also have exhibited buoyancy during this period.

States have been showing considerable interest in attracting FDI. It is apparent from Table 2.11 that there is a high degree of concentration of approved FDI in a few states in India. The first ten states have attracted more around 93 per cent of the total allocated FDI approvals into

India. Delhi has attracted more than one –fourth (25.2%) of the total allocated FDI approvals, followed by Maharashtra (18.4%).

Table 2.11

Foreign Direct Investment Approved: By State
(August 1991 to January 1997)

STATES	APPROVALS		INVESTMENT	
	Nos.	Share in total (%)	(Rs. Crore)	Share in total (%)
Delhi	512	4.94	17330.4	17.1
Maharashtra	1355	13.08	12676.4	12.5
Karnataka	689	6.65	5493.9	5.4
Tamil Nadu	812	7.84	5468.8	5.4
Madhya Pradesh	192	1.85	5268.3	5.2
West Bengal	271	2.62	5249.5	5.2
Orissa	77	0.74	3790.8	3.7
Gujarat	548	5.29	3762.5	3.7
Andhra Pradesh	439	4.24	2511.3	2.5
Uttar Pradesh	395	3.81	2444.5	2.4
Haryana	414	4.00	1788.4	1.8
Punjab	105	1.01	821.2	0.8
Rajasthan	193	1.86	605.5	0.6
Kerala	104	1.00	520.9	0.5
Himachal Pradesh	70	0.68	329.7	0.3
Goa	68	0.66	282.4	0.3
Pondichery	52	0.50	582.9	0.2
Bihar	69	0.67	130.7	0.1
Chandigarh	14	0.14	72.5	0.1
Dadra & Nagar Haveli	48	0.46	69.8	0.1
Arunachal Pradesh	2	0.02	11.1	0
Jammu & Kashmir	1	0.01	8.0	0
Dama & Diu	16	0.15	5.7	0
Meghalaya	1	0.01	2.5	0
Assam	10	0.10	1.5	0
Andaman & Nicobar	5	0.05	1.0	0
Tripura	1	0.01	0.7	0
Lakshadweep	1	0.01	0.5	0
Nagaland	1	0.01	0.0	0
Unallocated	3894	37.59	32592.7	32.1
Total	10359	100.00	101494.0	100

Source: CMIE, Monthly Review of Investment Project, September 1999

The industry-wise break up of FDI presented in Table 2.12 is more disaggregated than the RBI data, which is given, in Table 2.2. This disaggregated data is helpful for our subsequent analysis, particularly for identifying industries for our analysis. Data from 1991-'92 to 1994-95, are actual FDI inflows for the financial years, while that for the next three years is given for the calendar years. As is evident from the table most of the actual investments are concentrated in chemicals, electronics & electrical equipment, non-electrical machinery, transportation, and food and ago products.

Table 2.12

Sector-wise Break-up of Foreign Direct Investments during the Post-liberalisation Period (Rs. Crore)

Industry	1991-92	1992-93	1993-94	1994-95	Total*	(%)	1997#	1998	1999@	Total	(%)
Food & Ago Products	2.04	82.33	143.98	224.92	453.27	8.69	549.76	236.88	409.93	1196.57	4.70
Fermentation industries	0.00	0.00	0.00	34.59	34.59	0.66	32.02	0.00	0.00	32.02	0.13
Food processing industries	2.04	81.33	137.48	188.06	408.91	7.84	517.74	236.88	401.33	1155.95	4.54
Vegetable oils & vanaspati	0.00	1.00	6.50	2.27	9.77	0.19	0.00	0.00	8.60	8.60	0.03
Textiles	4.93	14.01	93.69	112.11	224.74	4.31	159.03	50.35	16.14	225.52	0.89
Textiles	4.93	14.01	93.69	112.11	224.74	4.31	159.03	50.35	16.14	225.52	0.89
Paper	0.00	0.02	0.00	15.20	15.22	0.29	147.17	234.17	7.77	389.11	1.53
Pulp & paper products	0.00	0.02	0.00	15.20	15.22	0.29	147.17	234.17	7.77	389.11	1.53
Chemicals	58.19	170.89	346.64	448.45	1024.17	19.64	1027.18	1153.52	513.50	2694.20	10.59
Chemicals (Other than Fertz.)	44.86	160.25	190.30	416.74	812.15	15.57	821.26	1064.00	451.31	2336.57	9.18
Drugs & pharmaceuticals	11.33	9.60	155.30	31.71	207.94	3.99	188.15	83.84	62.19	334.18	1.31
Dye-stuffs	2.00	1.04	1.04	0.00	4.08	0.08	17.77	5.68	0.00	23.45	0.09
Plastic & Rubber Products	9.73	0.00	20.74	22.97	53.44	1.02	165.55	36.20	7.73	209.48	0.82
Rubber goods	9.73	0.00	20.74	22.97	53.44	1.02	165.55	36.20	7.73	209.48	0.82
Other Non-metallic products	0.57	76.71	29.60	111.39	218.27	4.18	122.87	180.33	184.77	487.97	1.92
Cement & gypsum products	0.00	13.28	4.45	89.27	107.00	2.05	11.82	27.93	9.34	49.09	0.19
Glass	0.00	57.50	0.26	6.50	64.26	1.23	64.61	145.48	171.68	381.77	1.50
Ceramics	0.57	5.93	24.89	15.62	47.01	0.90	46.44	6.92	3.75	57.11	0.22
Basic Metals	0.24	25.93	12.03	40.52	78.72	1.51	101.44	125.90	135.35	362.69	1.43
Metallurgical industries	0.24	25.93	12.03	40.52	78.72	1.51	101.44	125.90	135.35	362.69	1.43
Non-electrical Machinery	26.41	108.47	80.34	299.50	514.72	9.87	379.17	173.50	155.18	707.85	2.78
Industrial machinery	1.35	13.74	15.29	38.83	69.21	1.33	103.96	13.92	25.73	143.61	0.56
Agricultural machinery	0.00	0.00	0.00	136.26	136.26	2.61	0.00	0.00	51.07	51.07	0.20
Industrial instruments	0.00	3.82	14.75	2.01	20.58	0.39	5.73	0.13	0.00	5.86	0.02
Machine tools	0.34	0.72	6.19	1.59	8.84	0.17	36.95	25.60	9.99	72.54	0.29
Boilers & steamgenerating	0.00	0.13	3.53	2.88	6.54	0.13	2.15	6.29	0.29	8.73	0.03
Prime movers other than electrical	0.00	0.00	0.20	11.66	11.86	0.23	16.13	9.45	6.26	31.84	0.13
Misc. Mech.& Engg.	24.72	90.06	40.38	106.27	261.43	5.01	214.25	118.11	61.84	394.20	1.55

Continued...

Electronics & Electrical Machinery	20.63	174.48	221.52	633.14	1049.77	20.13	1363.99	843.65	704.86	2912.50	11.44
Electrical equipments	20.63	125.98	213.34	292.83	652.78	12.52	1331.24	786.59	628.70	2746.53	10.79
Office & household equipments	0.00	48.50	5.47	338.15	392.12	7.52	8.15	17.95	67.77	93.87	0.37
Medical & surgical appliances	0.00	0.00	2.71	2.16	4.87	0.09	24.60	39.11	8.39	72.10	0.28
Transportation	6.11	115.72	72.51	142.85	337.19	6.46	1513.83	1476.92	884.99	3875.74	15.23
Transportation	6.11	115.72	72.51	142.85	337.19	6.46	1513.83	1476.92	884.99	3875.74	15.23
Miscellaneous Products	21.70	66.24	80.22	175.76	343.92	6.59	1934.37	1030.24	1282.86	4247.47	16.69
Miscellaneous industries	21.57	53.56	78.34	159.38	312.85	6.00	1875.09	1024.88	1279.79	4179.76	16.42
Scientific instruments	0.00	0.08	0.84	2.18	3.10	0.06	3.86	0.04	2.92	6.82	0.03
Leather,leather goods & pickers	0.13	12.60	1.04	14.20	27.97	0.54	55.42	5.32	0.15	60.89	0.24
Power & Fuel	2.54	8.34	63.23	115.21	189.32	3.63	1524.59	563.55	547.94	2636.08	10.36
Fuels	2.54	8.34	63.23	115.21	189.32	3.63	1524.59	563.55	547.94	2636.08	10.36
Service Sector	4.83	13.31	146.17	520.81	685.12	13.14	1923.84	2600.95	736.84	5261.63	20.67
Telecommunications	0.00	0.95	0.72	0.00	1.67	0.03	1185.00	1741.02	207.27	3133.29	12.31
Hotel & tourism	0.03	0.71	3.32	51.74	55.80	1.07	103.19	39.95	40.53	183.67	0.72
Trading company	0.00	0.19	6.29	45.55	52.03	1.00	94.51	52.00	95.37	241.88	0.95
Other services	4.80	11.46	135.84	423.52	575.62	11.04	541.14	767.98	393.67	1702.79	6.69
Total	157.91	880.50	1314.44	2862.84	5215.69	100.0	10996.09	8849.76	5605.78	25451.63	100.0

Notes: *Sum of the values of actual inflow of FDI from 1991-92 to 1994-95; ® sum of actual FDI inflows from 1997 to 1999.

\# The values for the years 1997 and 1998 are amounts of FDI for the calendar years

@ From January 1999 to September 1999

Source: Assocham Parliamentary Digest (Various Issues

2.2 CONCLUDING REMARKS

The evolution of foreign investment policy in India during the post-independence period is traced in four phases. The policy changes are clearly reflected in the trends and patterns of FDI in India during the period. The fourth phase is marked by the process of full-scale liberalisation of foreign investment in India. The ongoing liberalisation since 1991 has resulted in substantial growth of FDI inflows, diversification in the countries of origin of FDI, and to some extent, change in the sectoral composition of FDI in India. The share of FDI in the GDP and capital formation of the country has also been steadfastly increasing after the initiation of the structural reforms. The pros and cons of the fast growing FDI in India, particularly after liberalisation, is a matter of considerable concern for policy makers and academicians. The impacts of FDI in the economy can be judged by analysing two types of effects viz., macro-economic and micro-economic effects. The former is concerned with issues of domestic capital formation, balance of payments, and taking advantage of external markets for achieving faster growth, while the latter is concerned with issues of cost reduction, product quality improvements, changing industrial structure and performance, and generating inter-firm linkages and spillovers. In the absence of major studies on some important aspects of the second aspect (i.e., micro-economic effects), we attempts to analyse some of the micro-economic aspects of the FDI (particularly, of multinationals) in Indian economy in the post liberalisation period. Based on our earlier discussion on the industrial concentration of FDI in India, particularly during the post-liberalisation period, we select five industries, viz., chemicals, electrical machinery, non-electrical machinery, electronics, and transport equipment, for an in-depth study of technical efficiency of foreign and local firms and spillovers from foreign firms on local firms.

Chapter III

TECHNICAL EFFICIENCY OF MULTINATIONALS AND DOMESTIC FIRMS: A COMPARATIVE ANALYSIS

3.1. INTRODUCTION

As stated earlier, the focus of the present study is on the analysis of the relative technical efficiency and spillovers of FDI in Indian Industry in the context of increasing inflow of FDI into Indian economy. In this chapter we analyse the relative technical efficiency while the issue of spillovers is reserved for the next chapter. The analysis of technical efficiency is intended to serve two purposes. First, it undertakes an empirical verification of the hypothesis that foreign firms, given their unique ownership-specific advantages, are technically more efficient than their local counterparts. Such an analysis assumes importance as the available empirical studies, mostly in other countries, on the comparative efficiency of foreign and domestic firms have obtained conflicting results[1]. Secondly, it generates, the key variable viz., the efficiency scores for individual firms in different industries, for the analysis of spillovers in the forthcoming chapter.

The remainder of this chapter is divided into five sections. The next section discusses the concepts and measurement of efficiency. Section 3.3 presents a brief review of empirical studies on technical efficiency in Indian industry; it also reviews the studies available in the literature on the technical efficiency of multinationals. Section 3.4 describes the methodology of efficiency measurement used in the present study. The empirical results are presented in section 3.5. The last section highlights the concluding observations.

3.2 TECHNICAL EFFICIENCY: CONCEPT AND MEASUREMENT

In the words of Leibenstein, "at the core of economics is the concept of efficiency" (Leibenstein, 1966, p.392). In the literature on firm growth, efficiency plays a significant role in the growth and decay of firms. Performance of a firm is conventionally judged using the concept of economic efficiency. In micro economic analysis, economic efficiency is conceptualised in terms of 'technical efficiency' and 'allocative efficiency'. Technical efficiency is defined as the capacity and willingness of an economic unit (firm in our case) to

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[1] A brief review of the available empirical studies on the relative efficiency of the two groups of firms is available in section 3.3 of this chapter.

produce maximum possible output from a given bundle of inputs and a technology. Allocative efficiency is defined as the ability and willingness of an economic unit to equate its specific marginal value product with its marginal cost. Thus, technical efficiency exists when a firm makes the best use of its resources. Allocative efficiency occurs when a firm employs inputs in correct proportions. To put differently, technical inefficiency occurs when a given set of inputs produces less output than what is possible given the technology of production. Allocative inefficiency, on the other hand, is associated with the sub-optimal choice of the combination of inputs in the sense that marginal rate of substitution between factors of production deviate from the respective factor price ratios. In line with the approach adopted by a number of previous studies, the term "efficiency" is taken to mean technical efficiency in the present study. It focuses on the measurement of technical efficiency of firms in selected Indian industries. Hereafter, the term 'efficiency' means technical efficiency of industrial units unless otherwise specified.

Although the concept of technical efficiency is as old as neo-classical economics, its measurement has received little attention until the 1950s. For the first time, Debreu (1951) and Farell (1957) introduced a measure of technical efficiency. The Debreu-Farell measure is defined as one minus the maximum equiproportionate reduction in all inputs that still allows continued production of given outputs. A score of unity indicates technical efficiency because no equiproportionate input reduction is feasible, and a score less than unity indicates the severity of inefficiency.

In the pioneering work on the measurement of productive efficiency, Farell (1957) provided definitions and conceptual framework for economic efficiency. Farell's definition of efficiency can be explained in terms of Figure 3.1

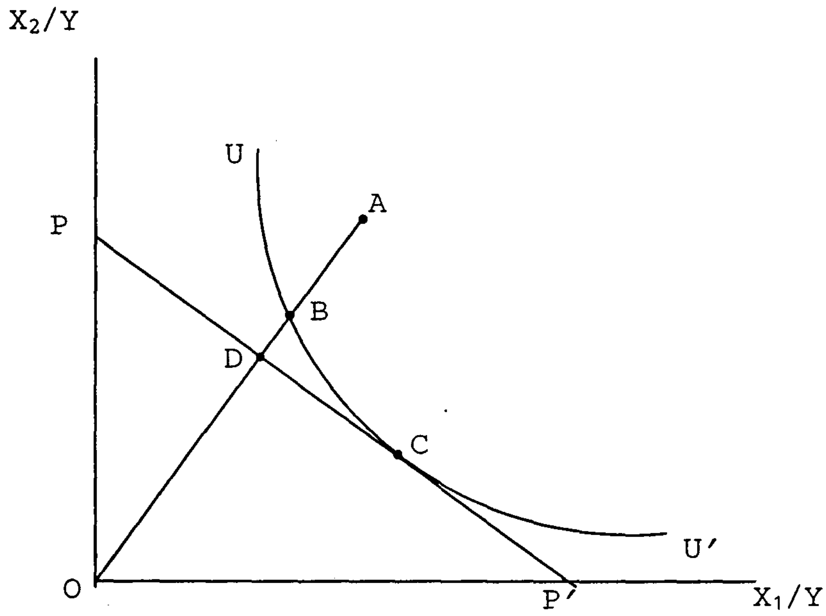
Consider a firm using two inputs X_1, X_2 and producing output Y, and assume that the firm's production function (frontier[2]) is $Y = f(x_1, x2)$. Assuming constant returns to scale frontier technology can be characterised by the unit isoquant UU' in Figure 3.1. The isoquant UU' represents the various combinations of the two factors that a perfectly efficient firm might use to produce unit output. If the relative prices of the inputs are given by the line PP' then Point *C*

[2] A discussion on the concept of 'frontier' is available in the next section.

on UU' indicates the efficient operation of the firm in the sense that it represents the least costly combination of inputs for producing one unit of output. The overall/economically efficient production of the firm occurs at point *C*.

Figure 3.1

Dimensions of Economic Efficiency



If the firm is observed using (x_1^0, x_2^0) to produce y^0 at point A[3]. Then the ratio OB/OA measures the technical efficiency; it is the ratio of inputs needed to produce y^0 to the inputs actually used to produce Y^0, given the input mix used. Thus, (1-OB/OA) is the technical inefficiency of production unit as it measures the reduction possible in X_1^0, X_2^0 (while holding input ratio constant) without reducing output. Obviously, it also suggests the possible reduction in cost of producing Y^0. At the same time, it measures the appropriate amount by which output can be increased holding X_1^0, X_2^0 constant.

Here, OD/OB represents allocative efficiency and (1 - OD/OB) measures allocative inefficiency, since the cost of point D is same as the allocatively efficient point C, and is less than that of the technically efficient but allocatively inefficient point B. This suggests the possible reduction in cost to be achieved by using correct input proportions.

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[3] By definition, this cannot lie below the frontier UU[1]

Finally, OD/OA measures the total efficiency and the corresponding total inefficiency is (1-OD/OA). The inefficiency suggests the possible reduction in cost by moving away from A (the observed point) to C (the cost minimising point).

Thus, it is clear that total efficiency and total inefficiency is made up of technical and allocative components. Of the two components of efficiency, it ought to be pointed out that the measurement of the technical efficiency assumes greater importance given the high probability that where technical inefficiency exists, it is likely to exert an influence on allocative efficiency and that there will be a cumulative negative effect on overall efficiency (Kalirajan and Shand, 1994, pp. viii – ix).

Several measures of efficiency have been introduced in the literature ranging from simple ratios to econometric modelling. For a long time, average productivity of single factors (particularly, labour) was considered as measures of efficiency. The partial factor productivity measures can be very informative but can also be misleading, because they consider a single input in isolation. The criticism that the partial productivity measures ignore the effects of other inputs on efficiency led to an alternative measure of efficiency based on all inputs, that is the total factor productivity (TFP) index.

As the TFP index is a ratio of output to weighted average of inputs, it suffers from the usual index number problem of fixing arbitrary weight to different inputs (Farell, 1957, p.11). It may also be noted that efficiency is only a component of the measure of productivity. Grosskopf (1993) distinguishes the concepts of productivity and efficiency by defining productivity growth "as the net change in output due to change in efficiency and technical change, where the former is understood to be the change in how far an observation is from the frontier of technology and the latter is understood to be shifts in the production frontier" (Grosskopf, 1993, p.160).

Farrell (1957) proposed a method of measuring relative efficiency, which could account for all factors of production simultaneously. He proposed measuring the technical efficiency of a production unit by comparing it's observed output to that output which could be produced by a *fully-efficient firm*, given the same bundle of inputs. Hence, to measure technical efficiency, we need a specified standard against which the observed performance of a firm can be compared. Ever since the seminal paper of Farrell (1957), the concept of frontier has been extensively utilised for establishing such an efficiency standard. Optimisation with respect to the behavioural goal or objective for the firms yields the locus of constrained maximum or minimum values, which is known as a frontier. It is a set of best attainable positions.

Theoretically, the concept of a production frontier is none other than the production function. According to the text book definition, a production function gives the *maximum* possible output which can be produced from given quantities of a set of inputs. Thus, it sets a limit or frontier on the observed values of the dependent variable in the sense that no value of output is expected to lie above the production function. It is therefore referred to as production frontier or production function.

Suppose a situation in which a firm, say i-th firm, is not producing its maximum possible output owing to some slackness in production induced by various non-price and socio-economic-organisational factors. Then the amounts by which the i-th firm produces below its production frontier can be regarded as a measure of its technical inefficiency.

A measure of technical efficiency of i-th firm can be defined as

$$\textit{Technical Efficiency}_i = \frac{\textit{Actual Output}_i}{\textit{Maximum Potential Output}_i}$$

In this basic model for technical efficiency, the denominator (i.e., production frontier) is not observable, it must be estimated. Various methods using different assumptions have been suggested in the literature to estimate the frontier production functions and thereby technical efficiency[4]. It is customary to distinguish between parametric and non-parametric methods to frontier estimation. In the former, the frontier is represented through a functional form (e.g. a Cobb-Douglas or a Translog), derived with econometric techniques. In contrast, the latter methods do not posit any explicit functional form for the frontier and construct it form the observed input-output ratios using linear programming techniques. This mathematical programming approach to frontier estimation has become known as Data Envelopment

[4] Forsund et al. (1980) provide a survey of the various methods of the frontier estimation.

Analysis (DEA)[5]. Within the parametric methods, it is possible to distinguish between the deterministic and stochastic approaches to frontier estimation. The mathematical programming and other deterministic techniques do not accommodate for stochastic shocks to production and cost, and therefore deviations from the frontier are entirely attributed to inefficiency. These methods ignore the very real possibility that a firm's performance may be affected by factors entirely outside it's control (such as poor machine performance, bad weather, input supply breakdowns, and so on), as well as factors under its control (inefficiency). Thus, under the interpretation of the deterministic frontier, for example, an unusual high number of random experiment failures, or even bad weather, might ultimately appear to the analyst as inefficiency. Worse yet, any error or imperfection in the specification of the model could likewise translate into increased inefficiency measures (Greene, 1993). This is an unattractive consequence of the deterministic frontier specification. Another difficulty with this approach is that no test can be made of how well the production function fits the data because the estimates resulting from these techniques do not have known statistical properties. These serious shortcomings of the deterministic approaches have induced econometricians to abandon deterministic as useful models for efficiency measurement in favour of stochastic frontier models.

Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production function (SFPF). The essential idea behind the stochastic production frontier model is that the error term is composed of two parts. The first component captures the effects of measurement error, other statistical 'noise', and random shocks outside the firm's control and the second component captures the effects of technical inefficiency[6]. A stochastic frontier production function may be expressed as

$$Y_i = f(X_i, \beta) \exp(v_i - u_i) \qquad , i = 1, 2, \ldots, n$$

Where Y_i is the output of the i-th firm; X_i is a vector of inputs; ß is a vector of parameters to be estimated; f (.) is a suitable functional form, such as Cobb-Douglas or translog; v_i is the symmetric random error that is assumed to account for measurement error and other factors

[5] Seford and Thrall (1990) provide a thorough review of the DEA literature.

[6] Bauer (1990) and Greene (1993) provide comprehensive review of the literature pertaining to the econometric estimation of stochastic frontiers.

not under the control of the firm; and u_i is an asymmetric non-negative random error assumed to account for technical inefficiency in production. The values of the unknown parameters of the model are usually estimated by maximum likelihood method, after making the assumptions regarding the distribution of u_i and v_i, which are often assumed to be normal and half-normal, respectively.

The principal shortcoming of the SFPF approach is the necessity that the distributional form of the error terms must be explicitly specified. Thus, it is clear that both approaches to frontier estimation have their problems.

An exploration of sources of efficiency is as important as the estimation of technical efficiency. Two methods are available in the literature for the empirical verification of the factors influencing the firm level efficiencies. The first one is a two-stage approach[7]. This method first estimates a frontier production function and obtains the technical efficiency for each firm. In the second stage, the predicted technical efficiencies of the firms are regressed upon firm-specific variables. In the second method, the frontier specifications incorporate models of technical inefficiency and all parameters are simultaneously estimated[8]. The method of simultaneous estimation of all parameters should be preferred to the two-stage approach, as there are inconsistencies in the assumptions regarding the distribution of the technical inefficiency effects in the two-stage approach[9].

3.3 REVIEW OF EMPIRICAL STUDIES

Some serious attempts have been made to analyse the technical efficiency of Indian industries using the frontier production function models. However, there are no studies dealing with relative efficiency of foreign-owned firms in Indian industry. The available studies relate to other developing countries. Table 3.1 presents a list of the major studies using the frontier

[7] A stochastic frontier study by Pitt and Lee (1981) was one of the earliest empirical studies, which has used this method.

[8] This method was proposed by Kumbhakar, Ghosh and McGuckin (1991), Battese and Coelli (1993) and Huang and Lui (1994)

[9]. In the two-stage approach, in the first stage, the technical inefficiency effects are usually assumed to be independently and identically distributed random variables. However, in the second stage, the predicted technical inefficiency effects are regressed upon a number of firm-specific factors implying that the predicted technical inefficiency effects in the second equation are not identically distributed.

production function models in order to show their estimation methods and the results.

Following observations may be made from Table 3.1. The studies in the Indian context are, by and large, confined to the pre-liberalisation period and the preferred method of analysis has been deterministic frontier approach. Here again, there have been hardly any studies, which have dealt with the relative technical efficiency of foreign and local firms in Indian industry. Although some studies have examined the question of relative efficiency of foreign and local firms in the context of other countries, their method of analysis leaves much scope for improvement.

Table 3.1

Review of Selected Studies on Technical Efficiency

Studies of Technical Efficiency in Indian Manufacturing			
Study	Period, Industry	Estimation Methodology	Results
Page, 1984	1980, Soap, printing, footwear, and machine tools.	Deterministic frontier translog production function	Average technical efficiency ranges between 42 and 69 per cent.
Agarwal and Goldar, 1992	1987-88, Engineering	Deterministic frontier, Stochastic frontier (Cobb-Douglas production functions)	Average technical efficiency using deterministic model is 70%; while that using stochastic frontier is 88%.
Jha and Sahni, 1993	1960-61 and 1980-87, Cement, chemical, cotton textiles, fertilizer and pesticides, gas & electricity, iron & steel, locomotive, locomotive & parts, petroleum refining, sugar.	Deterministic translog cost frontier function	Differential but not encouraging trends across various industries. The efficiency has steadily deteriorated in 1980's.
Goldar, 1985	1972, Small-scale washing soap	Deterministic Cobb-Douglas frontier function.	Average technical efficiency is 47 %.
Bhavani, 1991	1973-74, Small-scale metal products.	Deterministic translog frontier	Mean technical efficiency range between 70 to 96 per cent
Ramaswami, 1994	Four small-scale industries: motor vehicle parts, agriculture machinery & parts, machine tools & parts, plastic products.	Deterministic, stochastic frontiers (Cobb-Douglas production function)	Average technical efficiency based on the deterministic range between 35 and 64, but that based on stochastic maximum-likelihood range from 73 to 85%.
Studies on Technical Efficiency of Foreign and local Firms			
Pitt and Lee, 1981	1972-3 and 1975, Indonesia	Stochastic frontier production function. (Cobb-Douglas).	Domestic firms are more efficient than foreign firms.
Sterner, 1990	1972,1976,1981,1982, Mexico, Cement	Deterministic frontier (Cobb-Douglas)	Multinationality has no statistically significant influence on efficiency.

3.4 METHODS USED IN THIS STUDY

To investigate the firm-level technical efficiency, the present study employs stochastic frontier approach. This approach is selected primarily because of concern for effect of outliers, caused by measurement error or other factors, on the measures of technical efficiency. The general stochastic frontier function, which is considered, is defined by

$$Y_{it} = X_{it}\beta + (V_{it} - U_{it}) \qquad ,i = 1,2,...,N; \quad t = 1,2,...,T$$

Where,

Y_{it} denotes the output of the i-th firm in the t-th time period;

X_{it} represents a (k x 1) vector of input quantities of the i-th firm in the t-th time period;

β is a vector of unknown parameters to be estimated;

the v_{it}s are assumed to be independently and identically distributed (iid) random errors which have normal distribution with mean zero and variance, σ_v^2; and

the u_{it}s are non-negative random variables which are assumed to account for technical inefficiency in production and are assumed to be independently distributed as truncations at zero of the normal distribution with mean, μit, and variance, σ_u^2, and where μ_{it} is defined by

$$\mu_{it} = Z_{it}\delta$$

Where Z_{it} is a (px1) vector of variables which may influence the efficiency of a firm; and

δ is a (1xp) vector of parameters to be estimated.

3.4.1 Data and Model Specification

For the analysis, we consider balanced-panel data[10] on foreign and domestic firms for seven years from 1991-92 to 1997-98. In order to estimate frontier production functions we construct separate data sets for five industrial groups *viz.,* chemicals, non-electrical machinery,

[10] The importance of the panel data in the efficiency analysis is listed in Greene, 1997, p.114.

electrical machinery, electronics and transport equipment[11]. The balanced-panel data set for each industrial group consists of equal number of observations from foreign and domestic firms.

A transcedental logarithmic (translog) stochastic frontier production function is assumed to specify the technology of firms in the five manufacturing industries. This functional form is chosen because it is flexible and imposes few restrictions on the data. For example, the translog production function does not require the assumption of homotheticity and seperability. The output, in our model, is assumed to be a function of three inputs: capital, labour and raw materials. Non-neutral technical change is specified; and the error term is assumed to have two components, with properties as discussed below. That is, the production is assumed to be described by:

$$\begin{aligned}\ln Y_{it} = {} & \beta_0 + \beta_K(\ln K_{it}) + \beta_L(\ln L_{it}) + \beta_M(\ln M_{it}) + \tfrac{1}{2}\beta_{KK}(\ln K_{it})^2 + \beta_{LL}(\ln L_{it})^2 + \beta_{MM}(\ln M_{it})^2 \\ & + \beta_{KL}[(\ln K_{it})(\ln L_{it})] + \beta_{KM}[(\ln K_{it})(\ln M_{it})] + \beta_{LM}[(\ln L_{it})(\ln M_{it})] + \beta_{Kt}[(\ln K_{it)}t] \\ & + \beta_{Lt}[(\ln L\ )t] + \beta_{Mt}[(\ln M_{it})t+] + \beta_t(t) + \tfrac{1}{2}\beta_{tt}(t)^2 + V_{it} - U_{it,} \quad i = 1,2,\ldots,N, \;\; t = 1,2,\ldots,T\end{aligned} \qquad \text{----(1)}$$

Where,

Y_{it} = value of output of i -th firm in the t-th year;

K_{it} = capital (Rs in 1981-82 prices);

L_{it} = labour (employees);

M_{it} = material inputs (Rs in 1981-82 prices);

T = a time trend

"ln" refers to the natural logarithm;

the β_is are unknown parameters to be estimated;

the v_{it}s are iid $N(0,\sigma_v^2)$ random errors, independent of the u_{it}s; the u_{it} s are non-negative random variables associated with technical inefficiency, which are assumed to be independently distributed, such that the distribution of u_{it} is obtained by truncation at zero of the normal distribution with mean μ_{it}, variance σ_u^2, where , μ_{it} is defined by

[11] The selection of the industries for the analysis was guided by the industry-wise distribution of FDI in India (see chapter 2 for details)

$$\mu_{it} = \delta_0 + \delta_1 A_{it} + \delta_2 S_{it} + \delta_3 XS_{it} + \delta_4 RMS_{it} + \delta_5 RDS_{it} + \delta_6 ADS_{it} + \delta_7 TMS_{it} + \delta_8 OD_{it} \quad ---(2)$$

Where,

A_{it} = age of the i-th firm in the t-th year;

S_{it} = size of the firm measured by the value of sales;

XS_{it} = ratio of exports to sales;

RMS_{it} = ratio of raw material imports to sales;

RDS_{it} = ratio of research and development spending to sales

ADS_{it} = ratio of total advertisement expenditure to sales;

TMS_{it} =ratio of technology imports (embodied and dis-embodied) to sales;

OD_{it} = ownership dummy taking value 1 for foreign firms and zero otherwise; and δ_is are unknown parameters to be estimated.

The parameters of the model defined by (1) and (2) are estimated simultaneously using the maximum-likelihood method[12]. The variance parameters are expressed in terms of $\gamma = \sigma^2 / (\sigma_u^2 + \sigma_v^2)$, and $\sigma^2 = \sigma_u^2 + \sigma_v^2$ (see Coelli, 1996). Technical efficiency of the i-th firm in the t-th year, given the specifications of the model, is defined by

$$TE_{it} = \exp(-u_{it}) \quad ---(3)$$

The values of the technical efficiencies, for all firms in the periods in which they are observed in the panel data, are predicted along with the model estimation. What follows is a brief account of the hypothesis pertaining to different variables incorporated in the inefficiency model.

Theory does not provide a compact model of the determinants of technical inefficiency, but a strategy for identifying them has been developed in previous studies on this area (See, for example, Pitt and Lee, 1980, Caves, 1990, 1992). In the present study, the sources of efficiency have been attributed to eight firm-specific factors, a brief description of the variables are given below.

Age:- Inefficiency of production may be related to the age of firm. However, the observed influence could be either positive or negative. If older firms, having more experience also use the new vintage capital the influence may be positive. On the other hand, if the firm is using

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[12] The computer programme, *FRONTIER 4.1* is used for the estimation.

old capital stock, despite its longer experience, the observed effect may be negative. In this study age defined as number of years after the incorporation of the firm.

Size:- Another firm specific variable related to inefficiency is firm size. Large firms are usually considered to be more efficient than small firms on account of scale economies or superior organisation and technical knowledge. The evidences furnished by the empirical studies[13] also support the view that firm size has either a positive or zero correlation with technical efficiency. In this study, value of sales is used as a proxy for size.

Export Intensity:- Competitiveness of a firm is reflected in its ability to export. This is because the world markets outside the domestic market bring domestic producers into competition with a large, shifting and unfamiliar group of foreign rivals. Thus, the greater the ability of a firm to export, more is the international competitiveness. This international competitiveness is assumed to promote the technical efficiency of a firm. However, if may be noted that the direction of causation may in the opposite direction wherein the more efficient firms turnout to be the better exporters.

Raw material Import Intensity:- A free access to import raw material may be considered as having positive influence on efficiency of firms for it enhances the quality of the product. However, if there are rigidities in the system, which differentiates firms, the result could be widening disparity across firms. This could lead to a negative effect on efficiency. In the present study this variable is defined as the ratio of imported raw materials to sales.

Technology Import Intensity:- In developing countries like India access to foreign technology – both embodied and dis-embodied- is often considered as a major factor influencing the process of innovation and enhancing efficiency. The effect of imported technology on technical inefficiency is examined by the technology import intensity as represented in the ratio of payments to technology imports (embodied and dis-embodied) to sales of firms.

Research and Development (R & D) Intensity:- Effective use of imported technology calls for investment in in-house R&D either to adapt it to the local conditions and/or to make necessary modifications. Therefore, firms with more in-house R&D are expected to be more

[13] See Lundvall and Battese (2000) for details

capable of bringing about both product and process innovations. Hence, it is hypothesised that there exists a positive relation between firm's R&D and efficiency. To analyse the contribution of innovation to the efficiency, we incorporate the ratio of R & D expenditure to sales in our model.

Advertisement Intensity:- The ratio of advertisement expenditure to sales is used as a proxy of the level of product differentiation, which is assumed to be related to technical efficiency[14]. This variable is able to show the effect of product heterogeneity on the technical efficiency.

Ownership Dummy:- Foreign firms are believed to be more efficient than domestic firms because of superior organisational structure. On the other hand, foreign firms may be inefficient because they generally operate in less familiar environment. In our study, the effect of foreign ownership on technical inefficiency is analysed by incorporating an ownership dummy, taking value one for foreign and zero for domestic firms, into the model.

The eight firm-specific factors included in the analysis are not the only factors that could influence the degree of technical inefficiency of a firm. But it could be noted that a variety of managerial and other factors could also have an influence upon the technical inefficiency of a firm. However, these factors could not be considered in the present study due to the difficulty in getting access to the required data.

4.5 EMPIRICAL RESULTS

The maximum-likelihood estimates of the parameters of the translog stochastic frontier production function defined by equation (1) and (2) are presented in Table 3.2. The estimated t-ratios given in parentheses below each estimate provide indication of the significance of the coefficients. Although some of the individual parameter estimates are not statistically significant, any reduction in the number of explanatory variables in the model should be based on a more appropriate testing procedure, called, log –likelihood ratio (LR) test. The LR test is based on the following test statistic

$$\lambda = -2\,[l\,(H_0) - l\,(H_1)]$$

[14] See Caves (1990) for a detailed discussion.

Where l (H_0) and l (H_1) are the values of the log-likelihood function under the null and alternative hypotheses, respectively. This λ statistic has approximately a chi-square (or a mixed chi-square) distribution with degrees of freedom equal to the number of restrictions imposed under the null hypotheses.

Generalised LR tests of various null hypotheses were carried out and the results are given in Table 3.3. The first three tests consider the stochastic frontier function. The first null hypothesis, that the Cobb-Douglas production function is an adequate representation of the data, is rejected in all the five industries. It, therefore, appeared that the translog functional form is the appropriate one for the data. The second null hypothesis that there is Hicks-neutral technical change is rejected in all sectors. An implication of the non-fulfillment of the Hicks neutrality test is that technical change in the selected industries involves a technical bias[15]. The nature of technical bias can be ascertained by β_{it} coefficients of Table 3.2. As the concerned coefficients are turn out to be insignificant in chemicals, non-electrical machinery and transport equipment, we can not infer the nature of technical bias in these industries. While, electrical machinery has experienced capital saving and material using technical bias, electronics exhibits its material using character.

The null hypothesis of no technical change, which states that the production frontier does not shift over time, is rejected for all industries. The last three tests in Table 3.3 consider restrictions on the parameters in the inefficiency model. In all the cases, the null hypothesis of no inefficiency effects is rejected. Thus, the average response function, in which all firms are assumed to be fully efficient, is not an adequate representation of the data given the assumption of the translog frontier model. The null hypothesis, that the eight firm-specific factors considered in the model do not have a significant influence upon the degree of technical inefficiency is also rejected. Finally, the hypothesis that foreign ownership has no significant influence upon the technical inefficiency of the firms is rejected in all the five industries. Hence, it can be inferred that foreign ownership makes significant influence on the technical efficiency of the firms in all the five industry groups. Given the results of these tests of hypotheses, the preferred model appears to be that defined by equation (1) and (2).

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[15] Technical bias is seen through a significant β_{it} (I = K, L, M) coefficient in the estimated frontier production function. Technical change is termed i-th factor saving if $\beta_{it} < 0$. It is i-th factor using if $\beta_{it} > 0$.

Table 3.2

Maximum Likelihood Estimates of the Parameters of the Translog Stochastic Frontier Production Functions for the Selected Industries

Frontier Function						
Variable	Parameter	Chemicals	Non-electrical Machinery	Electrical Machinery	Electronics	Transport Equipment
Constant	β_0	-5.110 (-2.679)	-7.66 (-6.262)	-9.475 (-3.013)	2.866 (1.732)	-0.234 (-0.267)
Capital	β_K	-0.407 (-2.269)	-0.116 (-0.991)	0.532 (1.914)	2.853 (7.384)	0.992 (7.368)
Labor	β_L	1.951 (6.918)	1.430 (6.062)	0.620 (1.952)	0.434 (1.340)	0.340 (2.544)
Material	β_M	0.862 (2.745)	1.256 (5.859)	1.368 (2.853)	-2.183 (-11.307)	-0.053 (-0.454)
½ (Capital)^2	½β_{KK}	0.053 (3.662)	0.017 (1.035)	-0.017 (-0.422)	-0.243 (-4.713)	-0.026 (-1.699)
½ (Labour)^2	½β_{LL}	0.106 (3.867)	0.084 (2.642)	0.004 (0.127)	0.029 (1.441)	0.0586 (2.612)
½ (Materials)^2	½β_{MM}	0.019 (0.497)	0.024 (1.148)	0.117 (1.870)	0.219 (12.545)	0.152 (8.924)
(Capital)(Labour)	β_{KL}	-0.089 (-6.256)	-0.028 (-1.594)	0.095 (4.142)	0.102 (2.842)	0.039 (2.826)
(Capital)(Material)	β_{KM}	0.032 (1.933)	0.013 (0.802)	-0.071 (-1.826)	0.025 (1.158)	-0.048 (-2.836)
(Labour)(Material)	β_{LM}	-0.081 (-2.823)	-0.101 (-4.752)	-0.125 (-3.391)	-0.137 (-10.967)	-0.090 (-5.362)
(Capital) (Year)	β_{Kt}	-0.0057 (-1.104)	-0.0052 (-0.990)	-0.0188 (-2.307)	-0.001 (-0.102)	0.0054 (1.181)
(Labour)(Year)	β_{Lt}	0.0107 (1.424)	-0.0015 (-0.200)	-0.0092 (-1.270)	0.0159 (1.875)	-0.0046 (-1.007)
(Material)(Year)	β_{Mt}	-0.0056 (-0.643)	0.0046 (0.614)	0.0288 (3.032)	-0.0120 (-1.967)	0.0020 (0.502)
Year	β_t	0.078 (1.011)	0.055 (0.783)	-0.067 (-0.795)	0.017 (0.226)	-0.028 (-0.814)
½ (Year)^2	½β_{tt}	-0.0001 (-0.021)	-0.0032 (-0.602)	0.0010 (0.165)	0.0059 (0.997)	-0.0061 (-2.386)

(Continued...)

Table 3.2 (Continued)

Inefficiency Model						
Variable	Parameter	Chemicals	Non-electrical Machinery	Electrical Machinery	Electronics	Transport Equipment
Constant	δ_0	0.845 (8.293)	0.67165 (8.392)	0.747 (7.350)	-0.057 (-0.323)	0.323 (19.477)
Age	δ_1	0.00232 (3.488)	0.00016 (0.370)	0.00134 (1.564)	0.0270 (4.006)	-0.00238 (-5.143)
Size	δ_2	-0.135E-09 (-10.126)	-0.442E-09 (-10.935)	-0.262E-09 (-8.495)	-0.645E-09 (-8.200)	-0.867E-11) (-6.219)
Export Intensity	δ_3	-0.231 (-2.478)	-0.203 (-2.342)	0.222 (2.070)	0.634 (3.909)	0.084 (1.003)
Raw material Import Intensity	δ_4	0.113 (1.441)	0.313 (6.732)	0.243 (1.235)	-0.012 (-0.061)	-0.013 (-0.416)
R & D Intensity	δ_5	-3.178 (-3.111)	0.188 (1.022)	0.072 (0.473)	0.036 (0.329)	-2.458 (-3.397)
Advertising Intensity	δ_6	-1.645 (-10.153)	-1.321 (-4.828)	-0.790 (-2.584)	-1.607 (-3.107)	-1.827 (-9.488)
Technology Import Intensity	δ_7	0.101 (0.936)	-0.416 (-10.896)	-1.533 (-3.789)	0.189 (1.285)	-0.594 (-3.230)
Ownership Dummy	δ_8	-0.114 (-4.857)	-0.135 (-10.896)	-1.365 (-3.354)	-0.289 (-3.148)	-0.027 (-2.592)
Variance Parameters						
$\sigma^2 = \sigma_u^2 + \sigma_v^2$		0.0382 (15.622)	0.0182 (13.449)	0.0199 (10.294)	0.075 (5.589)	0.00760 (13.176)
$\gamma = \sigma^2 / (\sigma_u^2 + \sigma_v^2)$		0.293 (3.022)	0.0128 (2.659)	0.509 (6.866)	0.979 (71.968)	0.088 (2.064)
Log-likelihood		118.11	216.68	152.45	76.22	415.57
Observations		546	378	266	182	406

Note: Figures in parentheses indicate estimated t-values.

Table 3.3

Generalised Likelihood-Ratio Tests of Hypotheses for Parameters of the Stochastic Frontier Production function for the Selected Industries

Null Hypotheses (H_0)	Chemicals	Non-electrical Machinery	Electrical Machinery	Electronics	Transport equipment	χ^2 Critical value(1 %)
$\beta_{KK} = \beta_{LL} = \beta_{MM} = \beta_{KL} = \beta_{KM} = \beta_{LM} = \beta_{Kt} = \beta_{Lt} = \beta_{Mt} = \beta_t = \beta_{tt} = 0$ (Cobb-Douglas Function)	89.73	83.76	125.99	120.66	335.52	23.21
$\beta_{Kt} = \beta_{Lt} = \beta_{Mt} = 0$ (Hicks-neutral technical change)	228.18	101.55	70.29	23.06	121.54	11.34
$\beta_{Kt} = \beta_{Lt} = \beta_{Mt} = \beta_t = \beta_{tt} = 0$ (no technical change)	226.62	113.63	47.09	28.32	153.99	15.09
$\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$ (no inefficiency effects)	239.14	135.41	122.74	239.64	153.29	21.67
$\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$ (no firm specific factors)	233.15	135.41	123.21	65.20	146.37	20.09
$\delta_8 = 0$ (no ownership effects)	41.86	121.68	66.77	17.32	19.55	6.63

3.5.1 Elasticities, Returns to Scale and Technical Change

The estimates of the first-order coefficients of the variables in the translog function cannot be directly interpreted as elasticities. The production elasticities of the three inputs, the returns to scale and annual percentage change in production due to technical change for foreign and domestic firms are listed in Table 3.4. The elasticity of mean output with respect to the inputs, capital, labour, and materials are estimated at the mean values of the inputs, using the maximum-likelihood estimates of the parameters in the preferred model. These elasticities are obtained using the following expressions:

$$\frac{\partial \ln Y_{it}}{\partial \ln K_{it}} = \beta_K + \beta_{KK}(\ln K_{it}) + \beta_{KL}(\ln L_{it}) + \beta_{KM}(\ln M_{it}) + \beta_{Kt}(t)$$

$$\frac{\partial \ln Y_{it}}{\partial \ln L_{it}} = \beta_L + \beta_{LL}(\ln L_{it}) + \beta_{KL}(\ln K_{it}) + \beta_{LM}(\ln M_{it}) + \beta_{Lt}(t)$$

$$\frac{\partial \ln Y_{it}}{\partial \ln M_{it}} = \beta_M + \beta_{MM}(\ln M_{it}) + \beta_{KM}(\ln K_{it}) + \beta_{LM}(\ln L_{it}) + \beta_{Mt}(t)$$

The production elasticity in all the cases has the expected positive signs. With a few exceptions, the production elasticity for the foreign firms is lower than that for domestic firms. The elasticity for material inputs is higher than capital and labour elasticity in all the five sectors. The elasticity of mean output with respect to capital is lower than that with respect to labour in all the selected industries.

The returns-to-scale is generally found to be less than, but close to unity, in all the models. The returns-to-scale for domestic firms in all sectors, except electronics, are higher than that for foreign firms.

Table 3.4

Input Elasticities, Returns to Scale and Technical Change for Foreign and Domestic Firms in the Selected Industries

Variable	Chemical		Non-electrical Machinery		Electrical Machinery		Electronics		Transport Equipment	
	F	D	F	D	F	D	F	D	F	D
Capital	0.033	0.044	0.057	0.065	0.004	0.002	0.083	0.047	0.102	0.139
Labor	0.022	0.128	0.133	0.139	0.091	0.051	0.249	0.270	0.123	0.134
Materials	0.774	0.804	0.682	0.699	0.746	0.808	0.520	0.513	0.737	0.701
Returns to scale	0.828	0.976	0.872	0.903	0.842	0.861	0.851	0.830	0.962	0.974
Technical change	-0.002	-0.002	0.009	0.006	0.006	0.009	0.046	0.018	0.027	0.024

The final estimate listed in Table 3.4 is a measure of technological change. The technical change is obtained using the following expression.

$$\frac{\partial Y_{it}}{\partial t} = \beta_{Kt}(\ln K_{it}) + \beta_{Lt}(\ln L_{it}) + \beta_{Mt}(\ln M_{it}) + \beta_t + \beta_{tt}(t)$$

In chemical industry, the estimates of technical change for both foreign and domestic firms are negative, implying an inward shift in the production frontier. The technical change over the sample period is positive for both the groups of firms in the other four industries. Among the four industries, only in electrical machinery the technical change of foreign firms is found to be lower than that of domestic firms. The highest technical change of 0.046 is observed for foreign firms in electronics industry. The value 0.046 indicates that the foreign firms in that industry has experienced technical progress at the rate of 4.6 per cent per year over the sample period.

3.5.2 Estimates of the Sources of Technical Inefficiency

The estimates of the inefficiency model are presented in the second part of Table 3.2. Here, the sign of the δ_i need to be considered carefully. The negative sign of the estimated coefficient of a firm-specific factor indicates that an increase in that factor will result in a decrease in the value of technical inefficiency. The opposite is the case when there is a positive sign for the coefficient.

It is seen from the inefficiency model presented in Table 3.2 that the estimated coefficient associated with the average age of firm is positive and significant in chemicals and electronics but it is negative and significant in transport equipment industry. Thus, the older firms appear to have relatively lower levels of technical efficiency in chemicals and electronics; but older firms appears to have higher technical efficiency in transport equipment. This tends to suggest that unlike the transport equipment, firms in both chemical and electronics are employing capital equipment of old vintage. The sign of the coefficient of average firm size in all the selected industries is negative indicating that larger firms are more technically efficient than smaller ones in all these industries.

While the coefficients of export-intensity variable in chemicals and non-electrical machinery are negative and significant, they are positive and significant in electrical machinery and electronics. Thus, high international competition as manifested in higher export intensity seems to improve the efficiency of firms in chemicals and non-electrical machinery while it seems to reduce the efficiency of firms in electrical machinery and electronics industry. A positive and significant coefficient for raw material import intensity is observed for firms in the non-electrical machinery, but it does not seems to have a significant influence on the efficiency of firms in other industry groups.

R & D intensity variable has a negative and significant coefficient in chemicals and transport equipment. Thus, innovation efforts of the firms through in-house R & D appear to have an efficiency enhancing effect in these industries.

The advertising –intensity variable has a significant negative coefficient in all the five industries. Thus, product differentiation and advertising appears to have an efficiency enhancing effect in the industries. The coefficient of technology-import variable is found to be negative and significant in non-electrical machinery, electrical machinery and transport equipment. Thus, technology import appears to be a significant variable improving the technical efficiency of firms in these industries. Finally, negative and significant coefficients are observed for the estimated coefficients of ownership dummy variable in all the five industries. This clearly testifies that foreign ownership has an efficiency enhancing effect in all the five industries studied.

3.5.3 Technical Efficiencies of Foreign and Domestic in Selected Industries

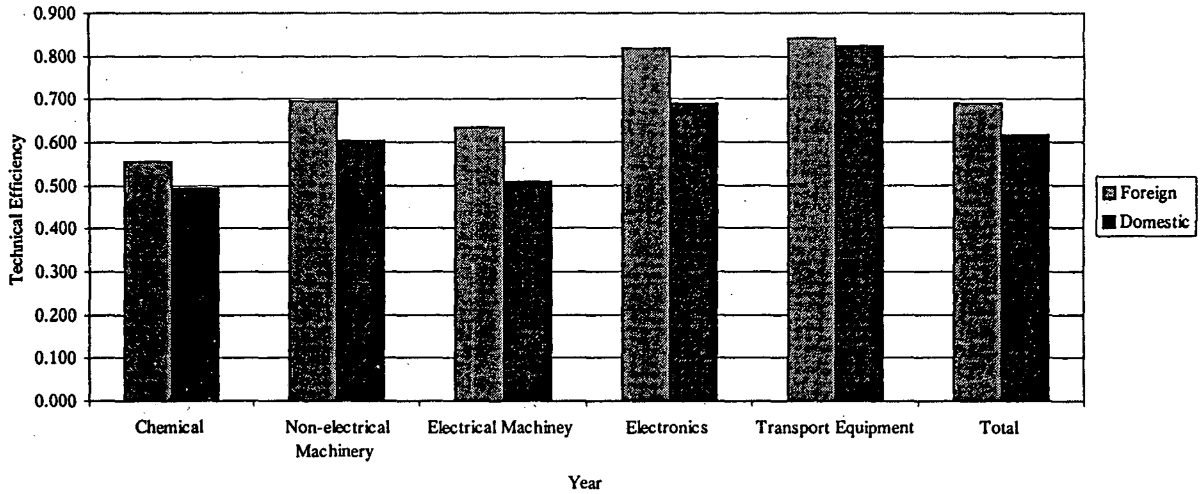
Given the specifications of the preferred model, the technical efficiencies for the foreign and domestic firms are predicted for each year. The average technical efficiencies of the two groups of firms in the selected industries have been presented in Table 3.5 and have been plotted in a graph (Figure 3.2). The predicted technical efficiencies of foreign firms range between 0.202 and 1, while that of their domestic counter parts range between 0.008 and 1. The overall mean technical efficiency of the foreign firms is estimated to be 68.9%. This indicates that, on average, the foreign firms produce 68.9% of the output that could be theoretically produced with the same bundle of inputs by a technically efficient firm. On the other hand, the value of mean technical efficiency is estimated to be 61.5% for domestic firms. Hence, the mean difference in the technical efficiencies of foreign and local firms is calculated to be 7.4%.

Table 3.5

Technical Efficiency Estimates of Foreign and Domestic Firms in Selected Industries

Industry	Category	Mean	Std. Deviation	Minimum	Maximum	N
Chemical	Foreign	0.555	0.117	0.355	0.980	273
	Domestic	0.494	0.127	0.351	1.000	273
Non-electrical Machinery	Foreign	0.694	0.102	0.427	1.000	189
	Domestic	0.604	0.109	0.509	1.000	189
Electrical Machinery	Foreign	0.635	0.160	0.447	0.990	133
	Domestic	0.507	0.079	0.316	0.758	133
Electronics	Foreign	0.817	0.184	0.202	0.986	91
	Domestic	0.689	0.162	0.008	0.978	91
Transport Equipment	Foreign	0.841	0.059	0.759	0.997	203
	Domestic	0.824	0.062	0.728	1.000	203
Total	Foreign	0.689	0.165	0.202	1.000	889
	Domestic	0.615	0.170	0.008	1.000	889

Figure 3.2: Average Technical Efficiencies of Foreign and Domestic Firms in Selected Industries



To test for the significance of the difference between the technical efficiency of foreign firms and local firms, we have employed two methods viz., 'paired t test' and Wilcoxon test[16]. The null hypothesis set up as

$$H_0: TE_F = TE_D$$

Where TE indicates technical efficiency and the subscripts $_F$ and $_D$ represent the foreign and domestic firms, respectively. The null hypothesis states that the mean values of the efficiency are identical for the two groups. In the *Paired Samples t-test,* the t-statistic is estimated to be 15.66 and the associated p value is less than 0.000. This indicates that the null hypothesis that there is no difference in technical efficiency can be rejected at a significance level less than one per cent with a one-tail test. It suggests that the mean efficiencies of the two groups of firms are different and foreign firms tend to be more efficient. A 95 % confidence interval of the mean of paired differences (0.074) extends from 0.065 to 0.083. Like the paired t test, the Wilcoxon test, with an estimated z-statistics -9.609 and p value < 0.000, also indicate that foreign firms are more efficient than their domestic counterparts.

16 For a detailed discussion of the Wilcoxon test, see Conover (1971).

It is apparent from Table 3.5 and Figure 3.2 that, on average, foreign firms in the sample are technically more efficient than domestic firms in all the selected industries. Among the five industries, the highest average difference of efficiency between foreign and local firms is observed in electronics industry (12.8%) followed by electrical machinery (12.7%) whereas the lowest difference is found in transport equipment industry. The possible reasons indicated by the inefficiency model, for the better relative performance of domestic firms in transport equipment industry, as compared to the domestic firms in other industries, seems to be the higher levels of R&D efforts, intensive advertising, more technology imports, and long experience of the domestic firms in this industry. On the other hand, high product differentiation through advertising appears to be the possible explanation for relatively higher efficiency of the foreign firms in electronics industry. Higher technology imports and higher product differentiation seem to have contributed to the relatively higher efficiency of foreign firms in electrical machinery.

Efficiency measures for both the groups of firms are found to be higher for transport equipment industry whereas they are lower for chemical industry. It can be inferred from the inefficiency model that higher intensity in terms of in-house R&D, advertising and technology import are responsible for the high efficiency of sample firms in transport equipment industry. On the other hand, the low efficiency of firms in chemicals looks to be mainly due to the older age and the accompanied use of obsolescent capital and technology.

Given the fact one of the declared objectives of economic liberalisation has been to enhance overall efficiency and productivity, it may be appropriate to examine the trend in technical efficiency after the introduction of reforms. More specifically, we are interested in examining if the observed efficiency gap between foreign and local firms has declined over time. The trends in technical efficiency measures, for foreign and domestic firms, are shown in Table 3.6 as well as in Figure 3.3. It can be seen that the efficiency of the foreign firms is higher than that of their domestic competitors in all the years. The average efficiency of foreign firms has declined from 69.4 per cent in 1991-92 to 61.8 per cent in 1994-95 and then it has steadily increased to 70.2 per cent in 1997-98. The maximum efficiency for foreign firms is observed in 1997-98 while, the minimum in 1994-95. On the other hand, in the case of local firms the minimum and maximum average efficiency is observed in 1991-92 and 1993-94, respectively. More importantly, while the efficiency of foreign firms increased during the post 1994 period that of local firms remained more or less constant. Consequently, the gap in the efficiency of foreign and domestic firms increased. The widening gap is highly intriguing, as it tends to suggest that the domestic firms are yet to reap the advantages of economic reforms in terms of efficiency gains.

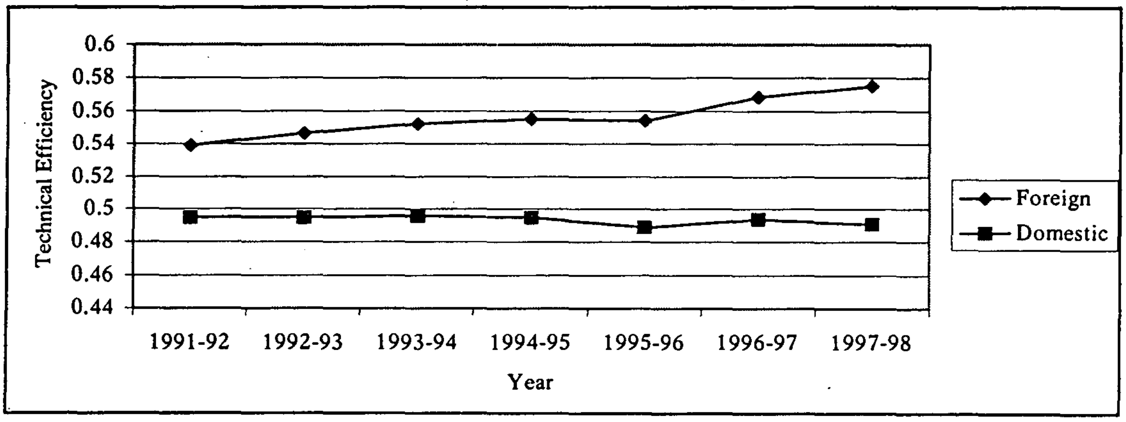
Table 3.6

Trends in Technical Efficiency Measures of Foreign and Domestic Firms (1991/92 – 1997/98)

Year	Category	Mean	Std. Deviation	Minimum	Maximum	N
1991-92	Foreign	0.694	0.166	0.355	0.998	127
	Domestic	0.606	0.160	0.355	0.995	127
1992-93	Foreign	0.687	0.172	0.202	1.000	127
	Domestic	0.616	0.165	0.366	0.998	127
1993-94	Foreign	0.690	0.168	0.354	1.000	127
	Domestic	0.620	0.170	0.375	0.996	127
1994-95	Foreign	0.673	0.161	0.277	0.993	127
	Domestic	0.618	0.168	0.365	0.997	127
1995-96	Foreign	0.683	0.161	0.382	0.996	127
	Domestic	0.609	0.180	0.008	1.000	127
1996-97	Foreign	0.691	0.165	0.385	0.997	127
	Domestic	0.618	0.170	0.351	1.000	127
1997-98	Foreign	0.702	0.166	0.414	0.996	127
	Domestic	0.616	0.177	0.314	1.000	127

Figure 3.3

Trends in Technical Efficiency Measures of Foreign and Domestic Firms



Frequency distributions, in decile ranges, of technical efficiency scores for foreign and domestic firms are shown in Table 3.7 and 3.8, respectively. It can be seen that, about 99 per cent of the foreign firms have efficiency scores in the range from 0.4 to 1.0, while, about 77 per cent of the domestic firms' efficiency ranged from 0.4 to 0.9. The highest frequency for foreign firms is observed in the decile range 0.6 - 0.7, while that for the domestic firms is observed in 0.5 - 0.6 range.

Table 3.7

Distribution of Technical Efficiency Scores of Foreign Firms

Efficiency Interval	Frequency	Percent	Cumulative Percent
0.2 - 0.3	2	0.22	0.22
0.3 - 0.4	6	0.67	0.90
0.4 - 0.5	147	16.54	17.44
0.5 - 0.6	145	16.31	33.75
0.6 - 0.7	178	20.02	53.77
0.7 - 0.8	144	16.20	69.97
0.8 - 0.9	156	17.55	87.51
0.9 - 1.0	111	12.49	100.00
Total	889	100.00	

Table 3.8

Distribution of Technical Efficiency Scores of Domestic Firms

Efficiency Interval	Frequency	Percent	Cumulative Percent
0.0 - 0.1	1	0.11	0.11
0.3 - 0.4	32	3.60	3.71
0.4 - 0.5	241	27.11	30.82
0.5 - 0.6	231	25.98	56.81
0.6 - 0.7	81	9.11	65.92
0.7 - 0.8	140	15.75	81.66
0.8 - 0.9	118	13.27	94.94
0.9 - 1.0	45	5.06	100.00
Total	889	100.00	

The trends and patterns of technical efficiencies of foreign and domestic firms for the five individual industries are discussed, separately, in the subsequent sub-sections.

Chemical Industry

In the present study, the data for chemical industry consists of 39 matched pairs of foreign and domestic firms, taken from twelve sub-sectors of the chemical industry[17]. This section intends to discuss the trends and patterns of technical efficiency in chemical industry and its sub-sectors.

Technical efficiencies among the various sub-sectors of the chemical industry are presented in Table 3.9 and Figure 3.4. It is seen that the average technical efficiency of foreign firms in the sample are lower than that of their domestic counter parts only in three sub-sectors of the chemical industry viz., paints and varnishes, industrial gases, and explosives. In the overall

[17] See Table A1.1 in Appendix I for details.

chemical industry, the foreign firms in the sample are observed to be more efficient than the domestic firms. The mean difference of efficiencies between the two groups of firms is calculated to be 0.061 or 6.1 per cent. We have used paired t-test as well as Wicoxon test to test the null hypothesis that there is no difference in the efficiency of the two groups of firms. The t-statistic is estimated to be 8.032 (p value < 0.000) and the estimated Z-statistic for Wilcoxon test is -8.781 (p < 0.000). It indicates that the null hypothesis can be rejected at a level significance below one per cent. It suggests that the mean differences of the two groups of firms are significantly different and foreign firms tend to be more efficient.

The trends of average technical efficiency in chemical industry during 1991-92 to 1997-98 can be seen from Table 3.10 and Figure 3.5. During all the years, the foreign firms are found to be more efficient than the local firms. The average efficiency of foreign firms shows a slightly fluctuating but increasing trend during the period. Average technical efficiency of the foreign firms has increased from 0.539 in 1991-92 to 0.575 in 1997-98. The average efficiency of domestic firms does not show any notable upward or downward trend during the period; it has registered a little shrinkage from 49.5 % to 0.494 % during 1991/92 – 1997/98.

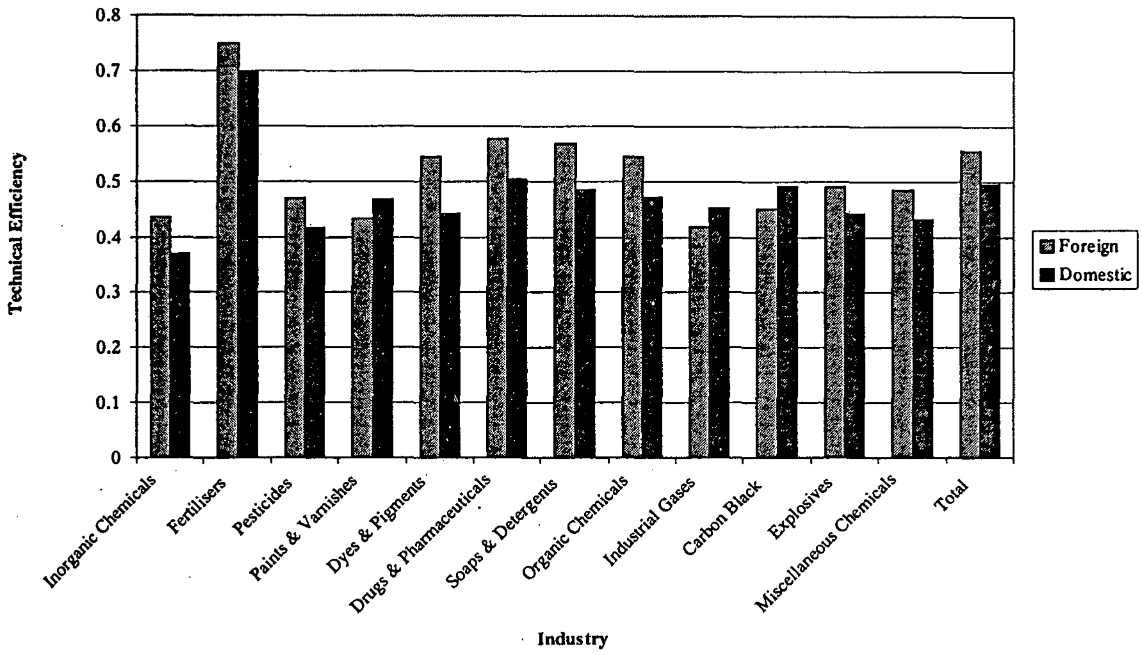
Table 3.9

Technical Efficiencies of Foreign and Domestic Firms among Different Sub-sectors of Chemical Industry

Industry	Foreign Firms		Domestic Firms		N
	Mean	Std. Deviation	Mean	Std. Deviation	
Inorganic Chemicals	0.436	0.026	0.370	0.011	14
Fertilisers	0.748	0.134	0.697	0.218	28
Pesticides	0.469	0.024	0.416	0.017	14
Paints & Varnishes	0.434	0.018	0.468	0.044	14
Dyes & Pigments	0.543	0.044	0.441	0.033	28
Drugs & Pharmaceuticals	0.575	0.103	0.503	0.107	112
Soaps & Detergents	0.568	0.066	0.484	0.076	14
Organic Chemicals	0.545	0.060	0.471	0.031	14
Industrial Gases	0.418	0.023	0.452	0.031	7
Carbon Black	0.451	0.021	0.491	0.024	7
Explosives	0.491	0.019	0.442	0.003	7
Miscellaneous Chemicals	0.485	0.079	0.430	0.021	14
Total	0.555	0.117	0.494	0.127	273

Figure 3.4

Average Technical Efficiencies of Foreign and Domestic Firms among the Sub-Sectors of Chemical Industry



Trends in Technical Efficiencies of Foreign and Domestic Firms in Chemical Industry

Year	Foreign Firms		Domestic firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.539	0.120	0.495	0.125
1992-93	0.546	0.112	0.495	0.127
1993-94	0.552	0.113	0.496	0.130
1994-95	0.555	0.116	0.495	0.130
1995-96	0.554	0.118	0.489	0.125
1996-97	0.568	0.118	0.494	0.127
1997-98	0.575	0.124	0.491	0.133
Total	0.555	0.117	0.494	0.127

Table 3.10

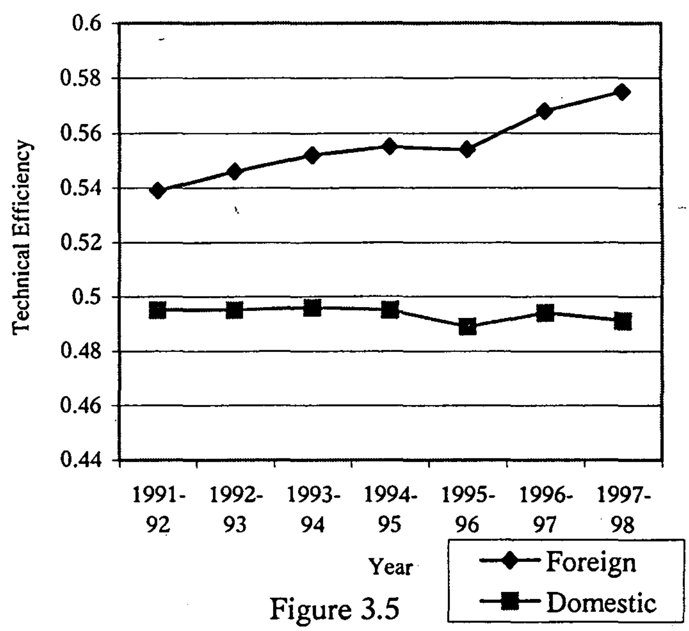


Figure 3.5

The efficiency score distribution of foreign and local firms in decile ranges are presented in Table 3.11 and 3.12 respectively. In both the groups, the highest frequency is observed in the decile range 0.4 to 0.5. However, the majority of foreign firms have technical efficiency scores between 0.4 and 0.7, while the efficiency scores of domestic firms are concentrated between 0.4 and 0.6.

Table 3.11

Distribution of Technical Efficiency Scores of Foreign Firms in Chemical Industry

Efficiency Scores	Frequency	Percent	Cumulative Percent
0.3 - 0.4	3	1.1	1.1
0.4 - 0.5	114	41.8	42.9
0.5 - 0.6	74	27.1	70.0
0.6 - 0.7	56	20.5	90.5
0.7 - 0.8	14	5.1	95.6
0.8 - 0.9	5	1.8	97.4
0.9 - 1.0	7	2.6	100.0
Total	273	100.0	

Table 3.12

Distribution of Technical Efficiency Scores of Domestic Firms in Chemical Industry

Efficiency Scores	Frequency	Percent	Cumulative Percent
0.3 - 0.4	24	8.8	8.8
0.4 - 0.5	172	63.0	71.8
0.5 - 0.6	47	17.2	89.0
0.6 - 0.7	5	1.8	90.8
0.7 - 0.8	12	4.4	95.2
0.8 - 0.9	6	2.2	97.4
0.9 - 1.0	7	2.6	100.0
Total	273	100.0	

The analysis of chemical industry reveals that, in most of its components and in all the years considered the foreign firms are more technically efficient than their indigenous counterparts.

Non-electrical Machinery

This section deals with the trends and patterns of technical efficiency of foreign and local firms. The data used for the analysis contains 27 pairs of foreign and local firms from eight sub-sections of non-electrical machinery industry[18].

It can be observed from Table 3.13 and Figure 3.6 that the foreign firms in are technically more efficient than the domestic firms in the non-electrical machinery group and in all of its sub-sectors. Foreign and domestic firms in the sample are highly efficient in ball bearings.

[18] Table A1.2 in appendix I shows details of the sample.

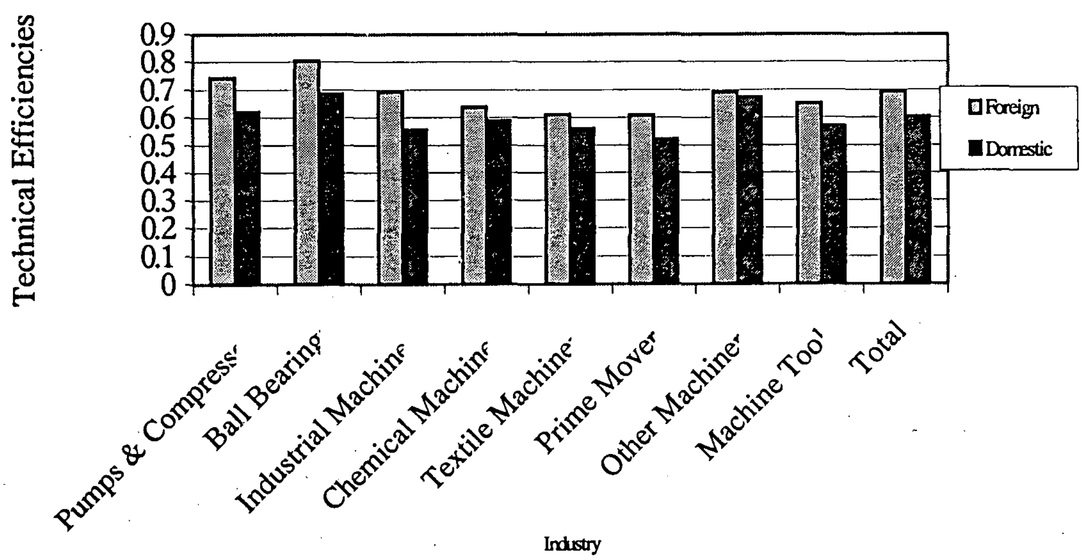
Foreign firms are least efficient in textile machinery whereas local firms are least efficient in prime movers.

Table 3.13

Technical Efficiencies of Foreign and Domestic Firms among Various in Sub-sectors of Non-electrical Machinery Industry

Industry	Foreign Firms		Domestic Firms		N
	Mean	Std. Deviation	Mean	Std. Deviation	
Pumps & Compressors	0.743	0.099	0.622	0.106	35
Ball Bearings	0.805	0.144	0.686	0.191	21
Industrial Machinery (excl.Chem. & textiles)	0.694	0.084	0.556	0.076	35
Chemical Machinery	0.638	0.012	0.590	0.022	7
Textile Machinery	0.612	0.082	0.562	0.026	14
Prime Movers	0.608	0.065	0.522	0.009	7
Other Machinery	0.692	0.059	0.674	0.116	28
Machine Tools	0.651	0.062	0.571	0.043	42
Total	0.694	0.102	0.604	0.109	189

Figure 3.6: Average Technical Efficiencies of Foreign and Domestic Firms



The paired mean difference of technical efficiency measures is calculated to be 0.09 (or 9 %) in the aggregate non-electrical machinery group. Both the paired t-test and Wicoxon test have rejected the null hypothesis that technical efficiency is identical for the two group of firms with t statistic 12.38 ($p< 0.000$) and Z - statistic -10.371 ($p < 0.000$). Thus, we find that the efficiency of the two groups of firms is statistically different at a significance level below one per cent with one-tail test. Thus, foreign firms are seen to be more efficient than domestic firms.

The trends of average of technical efficiency measures are shown in Table 3.14 and Figure 3.7 The mean technical efficiency measures of foreign firms in have risen form 68.1 per cent in 1991-92 to 70.2 per cent in 1997-98, while the efficiency measures or domestic firms increased from 59per cent to 61.1 per cent during this period. The average of technical efficiency measures for foreign firms are higher than domestic firms in all the seven years. Very slow and parallel movement of efficiency measure is seen for the two groups of firms.

Trends in Technical Efficiency Measures for Foreign and Domestic Firms in Non-electrical Machinery

Year	Foreign Firms		Domestic Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.681	0.108	0.590	0.088
1992-93	0.687	0.089	0.596	0.117
1993-94	0.685	0.102	0.606	0.115
1994-95	0.693	0.098	0.604	0.110
1995-96	0.700	0.101	0.609	0.111
1996-97	0.713	0.105	0.613	0.119
1997-98	0.702	0.113	0.611	0.115
Total	0.694	0.102	0.604	0.109

Table 3.14

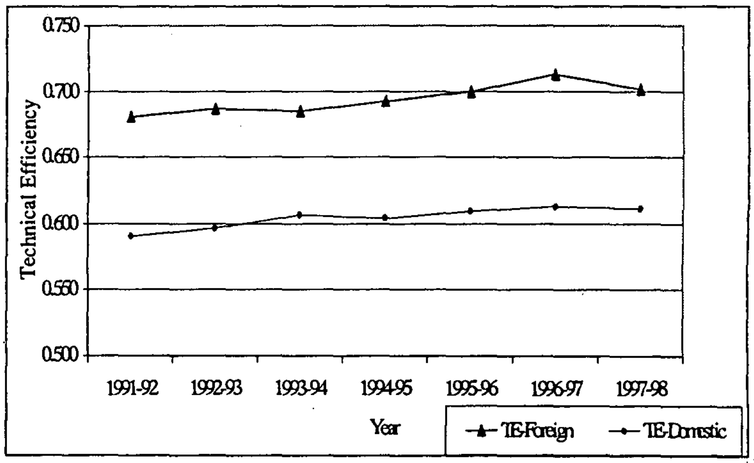


Figure 3.7

Frequency distributions of the technical efficiency measures for foreign and domestic firms are reported in Table 3.15 and Table 3.16. The largest frequency for foreign firms is observed in the range 0.5 to 0.7, whereas that in the local firms is seen in the class 0.5 to 0.6. It is noticed that the majority of foreign firms in the sample has technical efficiency between 0.25 and 0.8, while in the sample of foreign firms, most are concentrated between 0.5 and 0.7.

Table 3. 15

Distribution of Technical Efficiency Scores of Foreign Firms in Non-electrical Machinery

Efficiency Interval	Frequency	Percent	Cumulative Percent
0.4 - 0.5	1	.5	.5
0.5 - 0.6	19	10.1	10.6
0.6 - 0.7	96	50.8	61.4
0.7 - 0.8	48	25.4	86.8
0.8 - 0.9	14	7.4	94.2
0.9 - 1.0	11	5.8	100.0
Total	189	100.0	

Table 3.16

Distribution of Technical Efficiency of Domestic Firms in Non-electrical Machinery Industry

Efficiency Interval	Frequency	Percent	Cumulative Percent
0.5 - 0.6	121	64.0	64.0
0.6 - 0.7	38	20.1	84.1
0.7 - 0.8	17	9.0	93.1
0.8 - 0.9	6	3.2	96.3
0.9 - 1.0	7	3.7	100.0
Total	189	100.0	

The analysis of technical efficiency in non-electrical machinery shows that foreign firms are more efficient as compared to local firms in all the sub-sectors of the industry during all the seven years considered.

Electrical Machinery Industry

This section focuses on a discussion of technical efficiencies of the two groups of firms in electrical machinery industry. Data used for the analysis includes 19 pairs of foreign and local firms combined from six sub-sectors of electrical machinery industry[19].

In Table 3.17 we report the pattern of technical efficiency measures for foreign and domestic firms for the subgroups of electrical machinery industry. Figure 3.8 provides a visual presentation of the pattern. The results show that in all the components electrical machinery industry, except welding machinery, foreign firms are more efficient than domestic firms. In welding machinery, the mean efficiency of foreign firms is nominally higher than that of domestic firms. Mean efficiency of sample foreign firms is found to be higher in the sector of domestic electrical appliances and lower in wires and cables. For the domestic firms, the highest mean efficiency is seen in welding machinery and the lowest in wires and cables. In electrical machinery as a whole, the paired mean difference of the sample foreign and domestic firms is calculated to be 0.127 (or 12.7%).

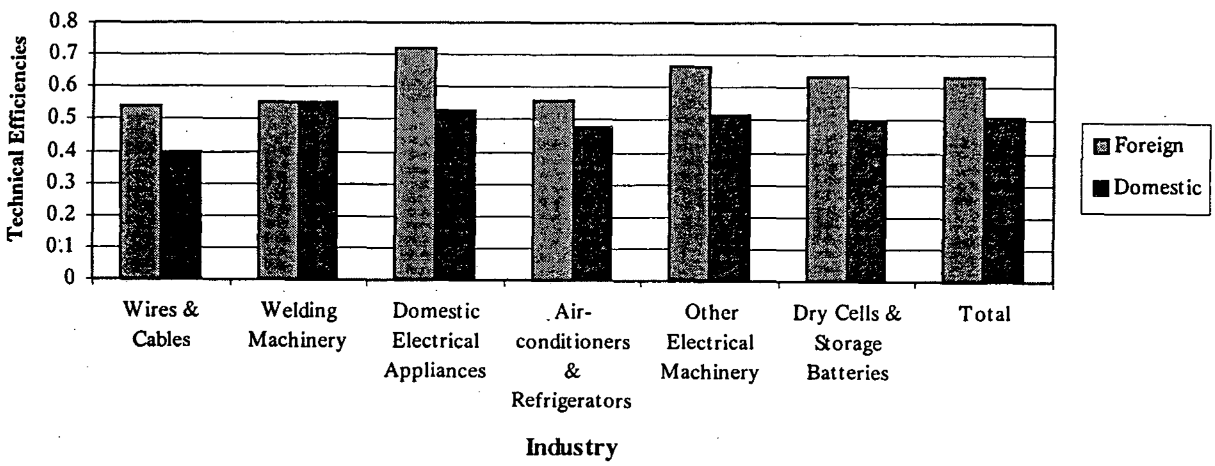
[19] See Table A1.3 in Appendix I for details.

Table 3.17

Efficiency Measures of Foreign and Domestic Firms across Various Components of Electrical Machinery Industry

Industry	Foreign Firms		Domestic Firms		N
	Mean	Std. Deviation	Mean	Std. Deviation	
Wires & Cables	0.542	0.067	0.397	0.019	7
Welding Machinery	0.550	0.043	0.551	0.079	14
Domestic Electrical Appliances	0.722	0.164	0.526	0.037	21
Air-conditioners & Refrigerators	0.558	0.154	0.479	0.075	21
Other Electrical Machinery	0.664	0.177	0.516	0.090	56
Dry Cells & Storage Batteries	0.630	0.099	0.496	0.027	14
Total	0.635	0.160	0.507	0.079	133

Figure 3.8: Average Technical Efficiencies of Foreign and Domestic Firms in Electrical Machinery



Using both paired samples t-test and Wilcoxon signed rank test, we have tested the null hypothesis that the efficiency of the two groups of firms is identical. The estimated t statistic for the paired t test is 8.321 ($p < 0.000$), while the Z statistic for the Wilcoxon test is estimated to be -7.563 ($p < 0.000$). It indicates that efficiency of the two groups of firms is significantly different and foreign firms appear to be higher than domestic firms.

Trends of average technical efficiency of the two categories of firms, during 1991/92 to 1997/98, are given in Table 3.18 and Figure 3.9. The efficiency measure for foreign firms appears to be distinctly higher than that for domestic firms, in all the years under consideration. Foreign firms' average efficiency measure has increased from 58.7% to 69.1% during 1991/92 to 1997/98. On the other hand, the average efficiency measures for domestic firms have registered only an insignificant increase from 50% in 1991-92 to 50.8% in 1997-98. Figure 3.9 portrays a gradually rising trend of efficiency measures for foreign firms during the seven years period, while the trends of efficiency measures for domestic firms appears to be almost constant during the period.

Trends in Technical Efficiency of Foreign and Domestic Firms in Electrical Machinery

Year	Foreign Firms		Domestic Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.587	0.130	0.500	0.071
1992-93	0.588	0.125	0.505	0.070
1993-94	0.604	0.131	0.508	0.072
1994-95	0.642	0.165	0.510	0.073
1995-96	0.657	0.166	0.509	0.084
1996-97	0.672	0.188	0.512	0.089
1997-98	0.691	0.193	0.508	0.101
Total	0.635	0.160	0.507	0.079

Table 3.18

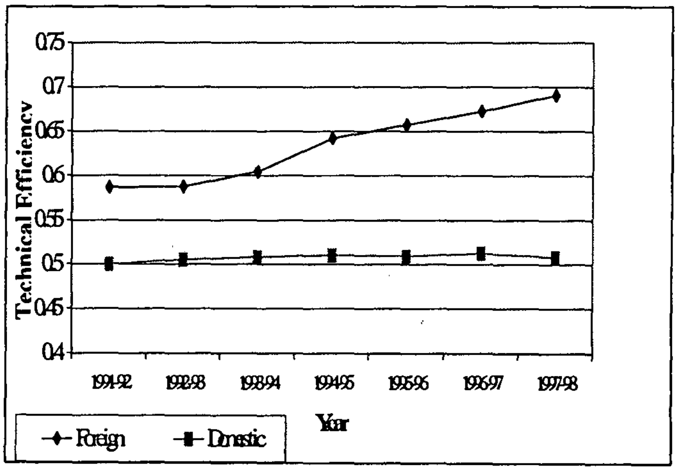


Figure 3.9

Frequency distributions for the efficiency measures of the foreign and local firms are reported in Table 3.19 and 3.20, respectively. The tables reveal that about 83 per cent of the foreign firms have technical efficiency scores in the range 0.4 and 0.8, whereas about 85 per cent of the local firms are concentrated in the efficiency range of 0.4 and 0.6.

Table 3.19

Distribution of Technical Efficiency Scores of Foreign Firms in Electrical Machinery Industry

Efficiency scores	Frequency	Percent	Cumulative Percent
0.4 - 0.5	29	21.8	21.8
0.5 - 0.6	46	34.6	56.4
0.6 - 0.7	21	15.8	72.2
0.7 - 0.8	14	10.5	82.7
0.8 - 0.9	7	5.3	88.0
0.9 - 1.0	16	12.0	100.0
Total	133	100.0	

Table 3.20

Distribution of Technical Efficiency Scores of Domestic Firms in Electrical Machinery Industry

Efficiency scores	Frequency	Percent	Cumulative Percent
0.3 - 0.4	5	3.8	3.8
0.4 - 0.5	65	48.9	52.6
0.5 - 0.6	48	36.1	88.7
0.6 - 0.7	9	6.8	95.5
0.7 - 0.8	6	4.5	100.0
Total	133	100.0	

The results of efficiency analysis in electrical machinery show that efficiency of foreign firms in all the seven years and in most of the sub-sectors of the industry are higher than the efficiency of their local competitors.

Electronics Industry

This section deals with the analysis of technical efficiencies of foreign and domestic firms in electronics industry. The analysis for electronics industry is based on the data for 13 pairs of foreign and domestic firms gathered from four sub-sectors of the industry[20].

It can be seen from Table 3.21 and Figure 3.10, that measures of technical efficiency for foreign firms are higher than domestic firms in the electronics industry sector and in all of its components. The highest average efficiency for sample foreign firms is observed in consumer electronics while the highest average efficiency of domestic firms is seen in communication equipment. The lowest efficiencies for the foreign and domestic firms are noticed in computer software & hardware and other electronics, respectively. The least mean difference between the two groups of sample firms is observed in communication equipment.

[20] Table A1.4 in Appendix I gives details of the data.

Efficiency of Foreign and Domestic Firms across Various Components of Electronics Industry

INDUSTRY	FOREIGN FIRMS		DOMESTIC FIRMS	
	Mean	Std. Deviation	Mean	Std. Deviation
Consumer Electronics	0.934	0.060	0.730	0.161
Computer Software & Hardware	0.774	0.218	0.688	0.213
Communication Equipment	0.866	0.133	0.838	0.153
Other Electronics	0.798	0.182	0.651	0.100
Total	0.817	0.184	0.689	0.162

Table 3.21

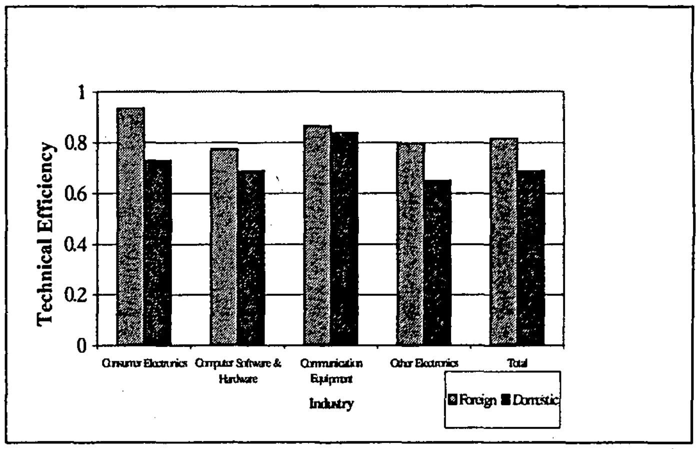


Figure 3.10

The mean difference of the technical efficiency measures for the two groups of firms is computed to be 0.128 (or 12.8%)[21]. Both paired samples t-test, with a t statistic 5.379 ($p < 0.000$) and Wilcoxon test, with a Z-statistic -5.503 ($p < 0.000$), have rejected the null hypothesis that there is no difference between the technical efficiency of the two groups of firms. Thus, it appears that the foreign firms are more efficient than domestic firms.

Table 3.22 and Figure 3.11 show the trend in average technical efficiency measures for foreign and domestic firms for the period between 1991/92 and 1997/98. A mildly fluctuating trend in the efficiency measures, for both the groups of firms, is perceptible. In the initial year's efficiency measures seems to converge. Later, it tends to diverge. Average efficiency of sample foreign firms has dwindled from 88 per cent in 1991-92 to 76.4 per cent in 1994-95 and then it has gradually gone up to 82.8 per cent. However, the average efficiency of foreign firms is higher than the average efficiency of local firms, during the all the seven years considered. For domestic firms, average efficiency has increased from 67.6 per cent in 1991/92 to 74.3 per cent in the next year, but slided down to 61.2 per cent in 1995-96 and in 1997-98 it is observed at 67.2 per cent.

[21] As we have noticed in a previous section, among the five selected industries, the difference of mean technical efficiency measures between foreign and domestic firms is found to be highest in electronics industry.

Trends in the Technical Efficiencies of Foreign and Domestic Firms in Electronics Industry

YEAR	Foreign Firms		Domestic Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.880	0.071	0.676	0.158
1992-93	0.820	0.222	0.743	0.102
1993-94	0.831	0.208	0.727	0.142
1994-95	0.764	0.205	0.715	0.139
1995-96	0.793	0.188	0.612	0.246
1996-97	0.802	0.199	0.679	0.136
1997-98	0.828	0.178	0.672	0.174
Total	0.817	0.184	0.689	0.162

Table 3.22

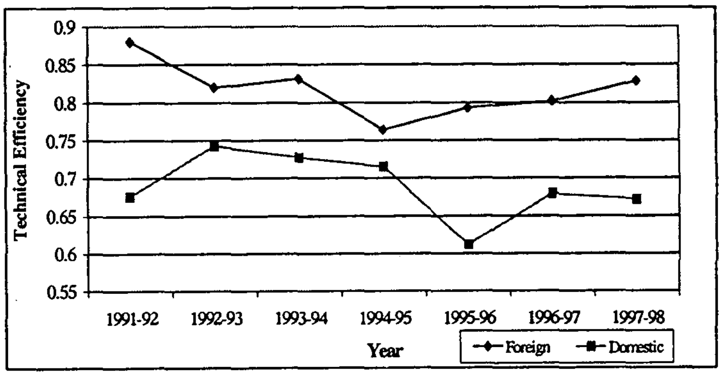


Figure 3.11

Frequency distributions of efficiency measures for foreign and domestic sample firms are given in Table 3.23 and 3.24. An interesting result to be noted is that, about seventy per cent of the sample foreign firms have technical efficiency measures in a small range of 0.8 and 1; while around 91 per cent of local firms has measured efficiency in a comparatively wide range of 0.5 and 1.

Table 3.23

Distribution of Technical Efficiency Scores among Foreign Firms in Electronics Industry

Efficiency Scores	Frequency	Percent	Cumulative Percent
0.2 - 0.3	2	2.2	2.2
0.3 - 0.4	3	3.3	5.5
0.4 - 0.5	3	3.3	8.8
0.5 - 0.6	6	6.6	15.4
0.6 - 0.7	5	5.5	20.9
0.7 - 0.8	8	8.8	29.7
0.8 - 0.9	21	23.1	52.7
0.9 - 1.0	43	47.3	100.0
Total	91	100.0	

Table 3.24

Distribution of Technical Efficiency Scores among Domestic Firms in Electronics Industry

Efficiency Interval	Frequency	Percent	Cumulative Percent
0.0 - 0.1	1	1.1	1.1
0.3 - 0.4	3	3.3	4.4
0.4 - 0.5	4	4.4	8.8
0.5 - 0.6	13	14.3	23.1
0.6 - 0.7	29	31.9	54.9
0.7 - 0.8	17	18.7	73.6
0.8 - 0.9	14	15.4	89.0
0.9 - 1.0	10	11.0	100.0
Total	91	100.0	

The results of the efficiency analysis for the electronics industry also reveal that foreign firms relatively are more efficient as compared to local firms in all the sub-sectors of the industry and in all the years considered.

Transport Equipment Industry

This section analyses the comparative efficiency of foreign and domestic firms in transport equipment industry. The data for the analysis contains 29 pairs of foreign and domestic firms from two sub-sectors of transport equipment industry *viz.*, automobiles (6 pairs of firms) and automobile ancillaries (23 pairs).

The pattern of efficiency measures across the two groups of firms in transport equipment industry and two of its components is presented in Table 3.25. Foreign firms are more efficient in automobiles and in aggregate transport equipment, while, the efficiency measures are found to be identical for the two groups of firms in automobile ancillaries.

Table 3.25

Technical Efficiencies of Foreign and Domestic Firms across the Sub-sectors of Transport Equipment Industry

Industry	Foreign Firms		Domestic Firms		N
	Mean	Std. Deviation	Mean	Std. Deviation	
Automobiles	0.900	0.064	0.817	0.070	42
Automobile	0.826	0.047	0.826	0.059	161
Total	0.841	0.059	0.824	0.062	203

The mean difference of the measures of technical efficiencies, for the two groups of firms, is estimated to be 1.7 per cent[22]. And for the significance of the differences in the technical efficiency between the two groups, we have got a t statistic of 3.04 ($p = 0.0027$) for the paired t test and a Z statistic of -3.037 ($p = 0.00239$) for the Wilcoxon test. Both the tests suggest that foreign firms are technically more efficient than domestic firms in the transport equipment industry.

Frequency distributions of the efficiency measures for the two groups of firms are shown in Table 3.26 and 3.27. As is evident from the table, large number of foreign firms in the sample have efficiency scores in the decile range of 0.8 and 0.9 and about 83 % of the firms have

[22] As we have noted in a previous section, among the five industries the mean difference of the efficiency measures between foreign and domestic firms is observed to be lowest in transport equipment industry.

efficiency scores between 0.7 and 0.9. About 90 % of the domestic firms in the sample have efficiency scores between 0.7 and 0.9.

Table 3.26

Distribution Technical Efficiency Scores of Foreign Firms in Transport Equipment Industry

Efficiency Scores	Frequency	Percent	Cumulative Percent
0.7 - 0.8	60	29.6	29.6
0.8 - 0.9	109	53.7	83.3
0.9 - 1.0	34	16.7	100.0
Total	203	100.0	

Table 3.27

Distribution of Technical Efficiency Scores of Local Firms inTransport Equipment Industry

Efficiency Scores	Frequency	Percent	Cumulative Percent
0.7 - 0.8	90	44.3	44.3
0.8 - 0.9	92	45.3	89.7
0.9 - 1.0	21	10.3	100.0
Total	203	100.0	

Trends in technical efficiency for foreign and domestic firms during the period from 1991/92 to 1997/98 are presented in Table 3.28 and Figure 3.12. It is apparent that the foreign firms are found to be more efficient than domestic firms during all the seven years. The figure purports a gradually rising trend of average efficiency measures for the foreign firms during 1991-92 and 1997-98. The efficiency measures for domestic firms have shown an increasing but cyclical trend during the period. Efficiency measures for both the groups of firms have shown a decline in 1997-98.

Trends in Technical Efficiencies of Foreign and Domestic Firms in Transport Equipment Industry

Year	Foreign Firms		Domestic Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.823	0.053	0.809	0.055
1992-93	0.826	0.052	0.814	0.056
1993-94	0.833	0.058	0.825	0.064
1994-95	0.844	0.061	0.823	0.062
1995-96	0.849	0.06	0.833	0.065
1996-97	0.854	0.061	0.831	0.065
1997-98	0.858	0.065	0.836	0.067
Total	0.841	0.059	0.824	0.062

Table 3.28

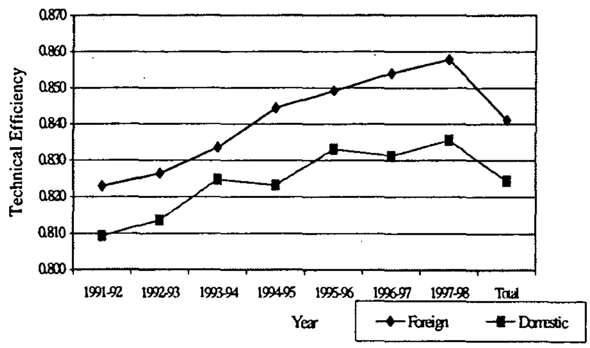


Figure 3.12

In transport equipment industry, foreign firms are marginally higher than domestic firms in all the seven years and in one of its sub-sectors. But, the efficiency levels of the two groups of firms are found to be identical in automobile component of the transport equipment industry.

3.6 CONCLUDING OBSERVATIONS

This chapter has examined the relative efficiency of foreign and local firms in selected Indian industries. For the measurement technical efficiency, we have selected a method, which is more appropriate as compared to the methods used in the previous studies of relative efficiency. The method chosen by us is the stochastic frontier production function incorporating technical inefficiency effects. From the empirical results of our analysis, we can derive the following conclusions. The technical efficiency of the foreign firms are significantly higher than that of their domestic counter parts in all the five selected industries and most of their sub-sectors. However, the magnitude of difference in the efficiency between foreign and domestic firms is not same for all the five industries. The difference is found to be higher in electronics and electrical machinery but it is nominal in transport equipment industry. The average efficiency of foreign firms is higher than that of the local firms in all the seven years considered. Our results clearly validate the hypothesis that foreign firms, given their unique ownership-specific intangible assets, are more efficient than their domestic counterparts. Scale factor (i.e., size), and heavy advertisement appears to promote efficiency of firms in all the five industries. Age of firm has an efficiency retarding effects in all the selected industries. This indicates that technological obsolescence of capital may enhance technical inefficiency of firms. From the results, we can infer that high advertising intensity and usage of new capital equipment embodying innovations and new technology are the common factors[23] for the higher relative efficiency of the foreign firms in all the industries.

Another important result is that, while foreign firms' efficiency has shown a steadily increasing trend particularly during the last three years of our study, efficiency of domestic firms has not shown any improvement. The result has been that the gap between foreign and domestic firms widened. Above observation tend to suggest that while the foreign firms have been able to make use of the liberalised economic policies, the same has not been true in the case of local firms. What prevented the domestic firms from reaping the returns of economic reforms in terms of efficiency gains? An answer to this question calls for more detailed inquiry which falls beyond the scope of the present study.

[23] The effects of other factors, (i.e., factors like R & D, Exporting, etc.) on the efficiency of firms are found to be differing from industry to industry (See the estimated inefficiency model in Table 3.2)

Chapter IV

MULTINATIONALS, SPILLOVERS AND LINKAGES IN INDIAN MANUFACTURING

4.1 INTRODUCTION

The results reported in the previous chapter suggest that multinational firms are significantly more efficient than their local counterparts in five selected industries of Indian manufacturing during the entire time period of study. There is a related question: Has the presence of foreign firms affected the efficiency of domestic firms in these industries? The issue assumes importance, as an of-cited rationale to attract multinational enterprises is that their presence induces local firms to improve their efficiency levels. The present chapter attempts to address this question by analysing the intra-industry "spillovers" of foreign presence on domestic firms. Another closely related issue explored in this chapter is the vertical inter-firm linkage generated by MNEs.

The chapter is organised in four sections. Section 4.2 deals with the analysis of spillovers. This section is divided into four sub-sections, which respectively deal with the concepts, channels and empirical studies of spillovers; data and empirical model; estimation, results and discussion. Section 4.3 deals with the analysis of linkage generation of multinational and local firms in Indian industries. This section has two sub-sections; one deals with generation of total linkages and the other with local linkages. Section 4.4 draws some conclusions from the above exercise.

4.2 MULTINATIONALS AND SPILLOVERS

Foreign direct investment can give rise to indirect gains for the host economy through the realisation of positive externalities. These benefits are generally referred to as 'spillovers'. The externalities or spillovers can be of different kinds. Based on their influence on industry, they can be broadly classified into two categories - intra-industry and inter-industry spillovers. The spillovers of foreign investment may influence both the structure of the industry and the conduct and performance of domestically owned firms. The spillovers that arise owing to the mere presence of MNEs will be referred to as a spillover efficiency benefit if it leads to an increase in efficiency of the domestic firms.

Spillovers from FDI may occur through many different ways; the following important channels for the spillovers have been identified in the literature[1].

(i) The technology and efficiency of local firms may improve as foreign firms enter the market and demonstrate new products, technologies and marketing practices, provide technical assistance to local suppliers and customers, and train workers and managers who are later employed by local firms.

(ii) The entry of MNEs may increase competition and force domestic firms to adopt more efficient methods.

(iii) MNEs may speed up transfer of technology and thereby increase the efficiency of domestic firms.

(iv) Forward and backward linkages created by MNEs may also lead to spillovers.

There are a number of empirical studies examining the spillovers from FDI. However, the existing empirical studies differ in their estimates of the overall direction, size and significance of spillovers. On the one hand, several studies of aggregate manufacturing in other countries suggest that spillovers are generally positive and important. For instance, studies by Caves (1974), on Australian manufacturing in 1966, Globerman (1979), on Canadian manufacturing in 1972, Blomstrom and Persson (1983), on Mexican manufacturing industries in 1970, Chuang and Lin (1999), on Taiwan's manufacturing in 1991 have found positive spillovers of foreign presence in the form of productivity improvement of local firms.

On the other hand, there are studies suggesting that spillovers are not important in general, or that they do not take place in all industries. For example, Haddad and Harrison (1993), on Morocco manufacturing industries during the period 1985-89 and Aitken and Harrison (1991), on Venezuela manufacturing industries between 1976 and 1989, have not found any evidence of positive spillovers from foreign presence on the productivity of domestic firms. Cantwell (1989), explored the response of local firms to the presence of US multinationals in European countries 1955-75, found that spillovers from FDI has not been there in all industries. They have taken place mainly where the local firms were initially relatively strong. Similarly, Kokko (1994) in his study on Mexican manufacturing argues that positive spillovers were less likely to take place in industries with high 'enclave' characteristics, i.e., where large

[1] See, for example, Blomstrom and Pesson(1983) and Blomstrom and Kokko (1998).

technology gaps and high foreign shares coincide. Kokko et al. (1996), examined Uruguay manufacturing industries in 1988 and found a positive and statistically significant spillover effects only in a sub-sample of locally owned plants with moderate technology gaps. They argued that it is not only the industry characteristics but also factors related to the individual local-firms that determine whether spillovers will occur or not.

In the context of conflicting evidence on the magnitude and direction of spillovers in the existing literature on the one hand and the absence of any serious attempt in the Indian context on the other, the present analysis propose to examine the intra-industry spillover effects of foreign presence on the technical efficiency of domestic firms in selected industries of Indian manufacturing.

4.2.1 Data and Empirical Model

The empirical analysis is based on a balanced-panel data set, for a period of seven years from 1991-92 to 1997-98, collected from the CMIE. For the present analysis, we consider the same set of domestic firms that we have used in the previous chapter for the efficiency analysis[2]. Firm-specific data for different variables are obtained from the CMIE database *PROWESS*. Our sample consists of 127 domestic firms belonging to five major industries viz., chemicals, non-electrical machinery, electrical machinery, electronics and transport equipment[3]. Share of foreign firms (i.e., firms with 25% or more foreign equity holdings) in the total industry sales is computed from the data provided by CMIE. Foreign shares of sales have been calculated for 32 sub-sectors of five selected industries[4] for seven years, from 1991-92 to 1997-98.

The statistical models used to examine spillovers in most existing empirical studies of aggregate manufacturing [Caves (1974), Globerman (1979), Blomstrom and Pesson (1983), Kokko (1994), Kokko et al. (1996)] are based on linear estimations of the labour productivity of local firms as a function of foreign firms' market share and various other industry specific characteristics. If the foreign presence is found to have a significant positive effect on labour productivity of local firms (after the effects of other variables have been accounted for), it is concluded that spillovers

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[2] By confining our analysis to the same set of local firms, we are not able to capture the spillover effects on other local firms. This point may be born in mind while interpreting the results.
[3] Appendix I show the details of the sample.

[4] The disaggregation is shown in appendix I

do take place. Our study looks into the spillover effect of foreign presence on the technical efficiency of domestic firms and not on the partial measure of productivity. Technical efficiency, which takes into account all the factors of production, is considered as a broader measure of firms' performance as compared to the partial productivity measures.

The time-varying technical efficiency levels of domestic firms will be the dependent variable in our model. The technical efficiency measures of domestic firms are estimated using the stochastic frontier production function methodology described in chapter 3. The simplest model that one may use to test the spillover effect of foreign presence on the efficiency of the domestic firms is:

$$TE_{ijt}^{d} = f(FS_{jt-1}) \qquad \text{---(1)}$$

Where, TE^d stands for technical efficiency measure of domestic firms; FS is a measure of foreign presence [Following earlier studies on spillovers, the present study use foreign firms' share in the total industry sales (at a disaggregated level) as a proxy for the degree of foreign presence]; and the subscripts $_i$, $_j$ and $_t$ denote firm, industry and time period, respectively.

Spillovers do not arise instantaneously but propagate through some lag mechanism. In the present study, a simple one-year lag has been used for the spillover variable[5] (i.e., FS).

Given the fact that there are a number of other factors influencing spillovers we have incorporated some other variables like R&D, technology import, size, age, and export intensity of firms as well into the basic model. In-house R & D investments would help the firms to decodify and exploit any spilled knowledge. Thus, a local firm that engages in R & D activities would tend to benefit more from the knowledge spillovers from the foreign presence. Another factor that is said to influence the nature and extent of spillovers from foreign presence is technology import. With increasing presence of foreign firms and the resulting competitive pressure, the local firms may be induced to import more foreign technology. The import of technology would help the firms to absorb more spillovers from the foreign presence. In our model, two interaction terms of the spillover variable, one with R &D and other with technology import (i.e., FS_{t-1} * $R\&D_{t-1}$ and FS_{t-1} * TM_{t-1}) are introduced to

[5] Most of the studies estimating R & D spillovers have also used one-year lag. See Griliches (1992) for review of these studies. Basant and Flikkert (1996) has also used one-year lag in their study of Indian situation.

capture the possible effects of R&D and technology imports in absorbing spillovers.

Technology gap between domestic and foreign firms is identified as another factor affecting the spillovers. It has been argued that if the difference in technological capabilities between domestic and foreign firms is too small, foreign presence may transmit few benefits to domestic firms. Thus, some scholars have hypothesised that spillovers grow with the size of technology gap [Findlay (1978), Wang and Blomstrom (1992)]. However, this view is not universally accepted. In the studies of Kokko (1994,1996), a high technology gap in combination with a low degree of competition was found to prevent spillovers. For the analysis, Kokko (1994) makes an interaction term between foreign share and various proxies of technology gap. Similarly, we add an interaction term with the degree of foreign presence and a technology gap variable to the model, in order to examine if the combination of large technology gaps and foreign domination inhibit spillovers. Technology gap has been defined as the difference between the average technical efficiency of foreign firms in the sector and each domestic firm's efficiency level [i.e., TE^{f}_{jt} (average) - TE^{d}_{ijt}].

To be able to test the spillover impacts, it is necessary to take care of other factors influencing technical efficiency of a firm. Five such firm-specific variables are included in the model. They are firm size, age, R & D intensity, export intensity and technology import intensity.

Our final model for the spillover estimation can be expressed in the following functional form:

$$TE_{ijt} = f[FS_{jt-1}, SIZE_{ijt}, AGE_{ijt}, EXS_{ijt}, RDS_{ijt-1}, TMS_{ijt-1}, TMS_{ijt-1}, (FS_{jt-1} * RDS_{ijt-1}), (FS_{jt-1} * TMS_{ijt-1}), (FS_{jt-1} * GAP_{ijt-1})] \quad \text{--- (2)}$$

Where

TE^{d}	Technical efficiency of domestic firms;
FS	share of sales of foreign firms to the total industry sales. This is our spillover variable (±);
SIZE	size of the firm, proxied by total sales (+);
AGE	age of firm (±);
EXS	export intensity; exports as a ratio of total sales (+);
RDS	R & D intensity; ratio of R & D to total sales (+);
TMS	technology import intensity; technology import (embodied and dis-

embodied) as a ratio of total sales (+);

(FS*RD) interaction term between foreign share and R & D (+);

(FS*TM) interaction term between foreign share and technology import (+);

(FS*GAP) interaction term between foreign share and technology gap (±);

The subscripts i, j, t denote i-th firm, j-th industry and t-th time period, respectively.

The signs in the parentheses at the end of each independent variable are expected signs of the coefficients.

The model is linear in form and has been estimated by pooling the observations for all the years for all firms.

4.2.2 Estimation Results and Discussion

In this section we present and discuss regression results of our spillover model. Ordinary least square method is used to estimate equation (2), the results are presented in Table 4.1[6]. Column 1 reports the estimated coefficients of different variables; the corresponding t-statistics and p values reported in the next two columns show the significance of the coefficients. The high R^2 indicates the good fitness of the model to the data. Around 75 per cent of the variation in the technical efficiency is associated with the nine explanatory variables included in the model.

As already stated, the variable FS is constructed to capture the intra-industry spillovers from the presence of foreign firms. If local firms benefit from intra-industry spillovers, one expects a positive and significant coefficient for FS. The results show that estimated coefficient of FS (i.e., spillover variable) is positive and highly significant. A one- percent increase of the foreign share of an industry's gross sales increases domestic firm's efficiency by 0.01 per cent. The result suggests that there are positive spillover effects on domestic establishments from foreign presence within the sector. With this evidence of intra-industry spillovers in selected industries of Indian manufacturing, we conclude that the presence of foreign firms in a sector has helped domestic Indian firms in the sector to catch up and thereby increase their efficiency.

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[6] The 'tobit' estimation also gives identical results

Table 4.1

Results of OLS Estimation

Variable	Coefficient	t-statistic	p value
Constant	0.5681224	64.631	0.000
FS	0.0100432	39.178	0.000
SIZE	0.6.24E-12	4.558	0.000
AGE	-0.0010367	-5.677	0.000
EXS	0.00635	0.281	0.779
RDS	2.608397	4.564	0.000
TMS	-0.0604427	-0.732	0.464
FS*RDS	-0.0881755	-5.244	0.000
FS*TMS	0.0053313	1.045	0.296
FS*GAP	-0.0230088	-45.319	0.000
$F (9, 879) = 295.56$			0.0000
$R^2 = 0.7523$ Adj $R^2 = 7497$			

Note: p value 0.000 denotes very small.

Among the firm-specific variables, it appears that export intensity and technology import intensity of domestic firms do not affect their efficiency, as the variables are statistically insignificant. The sign and magnitude of the coefficient of firm size indicates that large firms are more efficient than small firms. The statistically significant negative sign of the age variable implies that firms that have newer equipment embodying recent technological innovations are more efficient than firms having older equipment. The positive sign with statistically significance of the coefficient of R & D variable indicates that firms with more R & D investment are more efficient than the firms with less R & D investments.

The statistically significant negative coefficient of the interaction variable FS*RDS tends to suggest that increased foreign presence along with more R&D by domestic firms has a dampening effect on the technical efficiency of domestic firms. This indicates that the R&D investments of local firms are inadequate and inappropriate R&D for appropriating the maximum spillovers from the presence of multinationals. The interaction term FS*TMS that looks into the possible complementarities between spilled knowledge and technology imports come out to be positive but is not significantly different from zero. The estimated coefficient for the interaction term FS*GAP is negative and highly significant. It suggests that large technology gaps impede spillovers from foreign presence. It thus appears that domestic firms in Indian manufacturing with relatively advanced technology have benefited more from spillovers.

4.3 MULTINATIONALS AND LINKAGES IN SELECTED INDIAN INDUSTRIES

The results reported in the last section of this chapter suggest that the presence of MNEs have a positive spillover effect on the efficiency of local firms in select Indian industries. As we have noted earlier, one of the important channels through which spillovers take place is the linkage forged between MNEs and other indigenous firms. In this section, we examine the impact of multinationals on local Indian firms through the generation of linkages.

Transnationals, while securing and strengthening their access to markets through international production, can exert a powerful influence on marketing opportunities for other firms in host economies. These effects take place through backward and forward linkages of transnationals to domestic firms in host countries. Linkages are generally considered as essential to the development of an integrated industrial sector. They enhance industrial growth, technology transfer, and job creation while strengthening national self-reliance[7]. More over, by boosting local value-added, they raise domestic incomes and foreign exchange earnings.

Since the appearance of Hirschman's (1958) famous book on economic development, substantial empirical literature has emerged on the area of linkages[8]. Lall has defined linkages as 'direct relationships established by firms in complementary activities which are external to 'pure' market transactions' and 'essential to the functioning of any normal industrial market' [Lall (1980), p.204]. Linkages occur, when, by design or not, any particular firm (in this case an MNE or its affiliates) affects the amount and / or conditions of supply of, or the demand for, other goods and services by another firm or by consumers (Dunning, 1993).

Generally, MNEs generate linkages in two directions, i.e., forward and backward linkages. However, forward linkages have not attracted much attention in empirical literature. According to Lall, this is not a great omission, because one cannot expect very strong forward linkages from TNCs (Lall, 1978). Further, given data constraints, we confine the present analysis to the backward linkages. Hereafter, the term 'linkages' refers to backward linkages, unless otherwise specified. Linkage creation is mainly determined by two kinds of souring decisions of the firm. The first is the 'make or buy' decision, that is, the extent to which the

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[7] For a classic statement on the benefits of industrial linkages, see Hirschman (1958).

[8]. See Lall (1978, 1980; Clare, 1996; and Dunning (1993).

MNE purchases its raw materials and intermediate products from outside suppliers rather than producing them itself. The second is 'procure locally or import decision', i.e., the extent to which the MNE chooses to procure its raw materials and intermediate inputs in the host country or to import from a foreign source. The first decision will show the extent of total linkages[9] generated by the MNE. The second decision will show the proportion of foreign and local linkages in the total linkages. In this study, we compare the performance of foreign and local firms in terms of both these aspects.

4.3.1 'To Make' Versus 'To Buy'

The make or buy decision essentially relates to the degree of vertical integration. It shows the extent to which the MNE affiliates *internalise* the markets for the inputs required for their value added activities. The decision to produce a product in-house or buy from another producer will basically rest on the comparative costs of the two alternatives. The cost involves production cost and transaction costs.

The empirical studies by Cohen (1975) in the case of Taiwan, South Korea and Singapore; and Kumar (1990) in the case of India find that local firms have a greater degree of vertical integration compared to foreign firms. By contrast, Newfarmer and Marsh (1981); and Willmore (1986) in the case of Brazil find a reverse pattern. UNCTC (1981) could not find any significant difference between the extent of subcontracting of a foreign subsidiary and a local company in India.

In order to compare the 'make or buy' decision of the foreign and local sample firms, and thereby to analyse their total linkage creations, in five selected Indian industries, we compute the standard measure of bought-out ratio in respect of 127 pairs of foreign and local firms. It is the ratio of bought-out components to sales. To compute the measure we have deducted the ratio of value added to total sales from one. Table 4.2 shows the calculated bought-out ratios for the two groups of sample firms. It can be seen from the table that the average bought-out ratio for MNEs is nominally lower than their local counter parts, if we take all the five

[9] The 'total linkage' refers to the sum of linkages created in the host country (i.e., local linkages) and in the foreign countries (i.e., foreign linkages).

industries together. However, in non-electrical machinery and transport equipment, the ratio for foreign firms is found to be higher than the local firms. The foreign firms were purchasing, on average, 72.5 per cent of their intermediate inputs from independent suppliers, as against 73 per cent purchase of domestic firms. Using paired t-test, we have tested the null hypothesis that the bought-out ratio for the two groups of firms is same. The t-test accepted the hypothesis with a t-statistic of -0.748. It indicates that the domestic firms purchase of intermediate inputs is not significantly higher than that of their foreign competitors.

Table 4.2
Bought-out Ratio for Foreign and Domestic Firms

Group	Foreign Firms		Local Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
Chemical	0.733	0.088	0.784	0.194
Non-electrical Machinery	0.717	0.733	0.681	0.106
Electrical Machinery	0.759	0.079	0.776	0.097
Electronics	0.684	0.187	0.691	0.190
Transport Equipment	0.720	0.089	0.712	0.122
Total	0.725	0.351	0.735	0.156

The trend in the bought-out ratios for the two categories of firms is shown in Table 4.3. The bought-out ratios for foreign firms are more or less constant after 1994-95, while that of domestic firms is showing a declining trend during the 1991-92 to 1997-98. However, there appears to be wide variation across different local firms as evident from the increasing coefficient of variation.

Table 4.3
Trends in Bought-out Ratio for Foreign and Local Firms

Year	Foreign Firms		Domestic Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.625	0.501	0.737	0.122
1992-93	0.720	0.107	0.738	0.120
1993-94	0.720	0.122	0.737	0.112
1994-95	0.707	0.119	0.733	0.108
1995-96	0.711	0.115	0.716	0.189
1996-97	0.713	0.110	0.722	0.178
1997-98	0.713	0.121	0.690	0.392

The analysis of 'make' or 'buy' decisions of the two groups of firms reveals that the total linkages generated by multinationals are not significantly different from the local firms in the sample. The ratios for the two groups of firms show a converging trend during the period of study. In order to understand the host country benefits from MNEs through the generation of linkages, we have to examine the extent of local linkages created by them. The next section compares the local linkages generated by the transnationals and indigenous firms in the selected Indian industries.

4.3.2 Importation versus Domestic Procurement

Normally, foreign firms are expected to import a higher proportion of their raw materials and other inputs than domestic firms, because they are more familiar with foreign suppliers and local producers are supposed to be inadequate to cater to their needs. Moreover, it may provide a market for products of their affiliates. Several empirical studies have compared the dependence of multinational affiliates and their indigenous counter parts on imported raw materials in order to examine the extent of linkages created in different host countries. The studies in several countries - Cohen (1975) on South Korea, Taiwan, and Singapore; and Riedel (1975) on Taiwan - have found that export oriented firms import a greater proportion of inputs than their local competitors. Studies by Kelkar (1977); and Subrahmanian and Pillai (1979) on India; McAleese and McDonald (1978) on Ireland; and Newfarmer and Marsh (1981) on Brazil find that even foreign firms that produce predominantly for domestic markets, have been dependent more on imports than their indigenous counter parts. Lall and Streeten (1977), in a study of six countries including India, and Kumar (1990) in India, do not find any significant difference between the import dependence of foreign and local firms.

We have calculated the ratio of local to total purchases of firms to examine the magnitude of linkages generated by the two groups of firms in our sample. The difference between total material input consumption and the imported materials is taken as local purchase. The domestic procurement ratio computed for the two groups of sample firms are presented in Table 4.4. It can be seen from the table that the average domestic procurement of domestic firms are higher than their foreign competitors in all the five industries. For five industries taken together, the foreign firms were procuring, on an average, 83.4 per cent of their material inputs from the host countries, while the average local content of local firms is found to be 89.2 per cent. Thus, the local content of foreign firms is lower, on average, by 5.8 per cent than domestic firms. Paired t-test has rejected the null hypothesis that the average domestic procurement of material inputs of the two groups of firms is equal, with a t-statistic 7.137. This indicates that the local content of the material inputs of the two groups of firms are significantly different and domestic firms tend to procure more local material inputs than foreign firms. However, the magnitude of the difference is not found to be large.

Among the five industries, the MNEs' local procurement of material input is found to be highest in electrical machinery and lowest in electronics. The ratio of local firms is highest in chemicals lowest in electronics industry.

Table 4.4

Domestic Procurement Ratio for Foreign and Domestic Firms

Group	Foreign Firms		Local Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
Chemical	0.816	0.161	0.915	0.121
Non-electrical Machinery	0.860	0.216	0.895	0.109
Electrical Machinery	0.882	0.102	0.892	0.128
Electronics	0.703	0.275	0.780	0.226
Transport Equipment	0.862	0.151	0.906	0.188
Total	0.834	0.186	0.892	0.155

The trends in the domestic procurement ratio for foreign and domestic firms are presented in Table 4.5 and Figure 4.2. In all the years the ratio of domestic firms is higher than that of foreign firms. It is interesting to observe that over the years the domestic procurement of foreign firms registered a sharper decline than local firms.

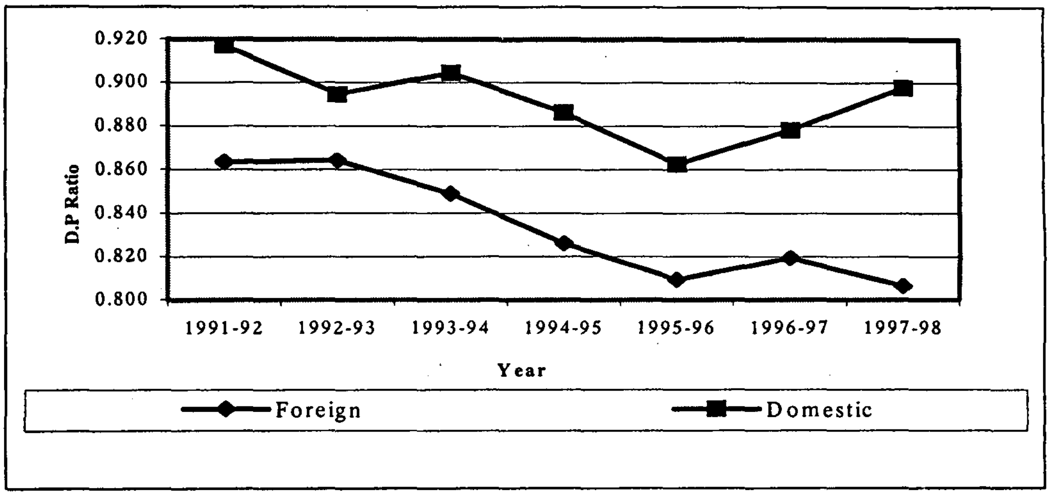
Table 4.5

Trends in Domestic Procurement Ratio for Foreign and Local Firms

Year	Foreign Firms		Local Firms	
	Mean	Std. Deviation	Mean	Std. Deviation
1991-92	0.864	0.202	0.917	0.125
1992-93	0.864	0.149	0.895	0.162
1993-94	0.849	0.171	0.905	0.111
1994-95	0.826	0.194	0.886	0.160
1995-96	0.809	0.196	0.863	0.195
1996-97	0.819	0.183	0.878	0.175
1997-98	0.806	0.198	0.898	0.140

Figure 4.1

Trends in Domestic Procurement Ratio for Foreign and Local Firms



Although the level of domestic procurement of foreign firms is relatively less than that of domestic firms, the fact remains that their local procurement on an average is as high as 83.4 per cent of their material input requirements. This suggests high degree of their backward linkages to the intermediate goods producers. This type of backward linkages strengthens the supplying industries, which in turn feed (via forward linkages) other local firms. The high linkage generation may be one of the possible reasons for the positive spillovers from foreign presence in the Indian industries.

4.4 CONCLUSIONS

This chapter analysed the indirect spillover effects and direct linkage effects from multinational firms in selected industries of Indian manufacturing. The results of our spillover analysis suggest that the efficiency of domestically owned firms in Indian industries is positively associated with the presence of multinationals. This indicates the existence of spillover efficiency benefits from the foreign presence in Indian manufacturing industries. The R&D investments of the local firms appear to be inadequate and inappropriate to appropriate the potential spillovers from the presence of foreign firms. The results concerning the effect of technology gap suggest that the wide difference in the levels of technological capabilities between foreign and domestic firms constitute a major obstacle to maximise the spillover benefits from the presence of multinationals.

While analysing the total linkages, we do not find any significant difference between the extent of total linkages created by foreign firms and their local counter parts in Indian industries. The local linkage generation of multinational firms is found to be lower than their indigenous counterparts in all the years considered. Over the years the domestic procurement of foreign firms registered a sharper decline than the procurement of their local counterparts. However, by procuring more than eighty per cent of their material inputs from local sources, multinationals in seem to strengthen its raw material supplying industries and thereby, other local firms in Indian industries. The high linkage generation of multinationals could be one of the important reasons for the observed positive spillover efficiency benefits to the local firms from the presence of multinationals in Indian industry.

Chapter V

SUMMARY AND CONCLUSIONS

In tune with the general trend of the globalisation process and as apart of the ongoing economic reforms, India has liberalised its policies towards FDI since 1991with a view to exploiting the advantages of technology, marketing, and management associated with foreign firms. The result has been an unprecedented increase in the penetration of MNEs into different sectors of Indian economy. The increasing presence of MNEs has generated a renewed interest among the academia and policy makers on the effects, direct and indirect, of MNEs on the growth and development of the economy. This needs to be viewed against the fact that the basic aim of the structural reforms in India has been to improve the efficiency of the resource use. In this process, the MNEs, given their superior technical, marketing, managerial and other expertise, are expected to play a key role. In this context there arises certain important issues relevant to policy making: Are the foreign firms technically more efficient than the local firms? What are the factors that govern technical efficiency? Has the increased presence of foreign firms had any spill over effects on the efficiency of local firms? The present study is an attempt to answer these questions by analysing the relative efficiency of foreign and local firms and the spillover and linkage effects of foreign firms on the local firms in Indian industry during the post-liberalisation period.

The analysis in this study is based on the balanced-panel data set for 'matched pairs' of foreign and domestic firms. The study covers seven years of liberalised regime (from 1991-92 to 1997-98), covering 127 pairs of foreign and domestic firms belonging to five industries, viz., (i) chemicals, (ii) non-electrical machinery, (iii) electrical machinery, (iv) electronics, and (v) transport equipment. This chapter summarises the main findings of the study, indicate their policy implications.

To set a background as well as to understand the significance of FDI in India, the second chapter of the study has studied the evolution of policies, trends and patterns of FDI in Indian industry. For more than three decades, India maintained a selective approach towards FDI. As a part of the Structural Adjustment Programme, along with virtually dismantling the industrial regulation system, Indian government has considerably liberalised its policy towards FDI in 1991. The liberalisation measures have resulted in an upsurge in approvals as well as actual flows of FDI into India. Our comparative analysis of FDI inflows to India, relative to that to developing countries and to the global economy indicates that the liberalisation measures have a significant effect on the substantial growth of FDI inflows to India. The share of FDI in GDP and in capital formation has been increasing during the post-liberalisation period. The structural reforms have resulted not only in the substantial growth of FDI inflows, but also resulted in the diversification of country-wise origin, and to some extent, change in the industry-wise distribution of FDI in India. The selection of industries for the study of relative efficiency and spillovers was guided by the industry-wise distribution of FDI in India in the post-reform period.

The benefits of the increased flow of FDI to India depend not only on the volume of resource flows but also on how efficiently the resources are utilised in the country. Hence, the relative efficiency of foreign and local firms assumes special significance in the present Indian context. In the third chapter, we have attempted to make a comparative analysis of the technical efficiency of foreign and local firms in the five selected industries. A stochastic frontier production function, incorporating a model for technical inefficiency effects, is employed for the analysis of the relative technical efficiency of foreign and domestic firms. The major findings of this exercise are summarised below.

The technical efficiency of foreign firms is found to be significantly higher than their domestic counter parts in all the five industries and in most of their sub-sectors. However, the difference in the efficiency levels between the two groups of firms is different across individual industries. The average technical efficiency for the foreign firms, for the five industries taken together, is estimated to be 68.9 per cent while that for domestic firms is estimated to be 61.5 per cent. Thus, foreign firms, on average, are 7.4 per cent more efficient than their local counter parts. The mean difference between the efficiency of foreign and local firms is found to be higher in electronics (12.8%) and electrical machinery (12.7%) while it was found to be lower in transport equipment. Foreign ownership is found to have a statistically significant positive influence on the higher efficiency of firms. The inefficiency models suggest that the factors influencing the productive efficiency of the foreign firms differ across industries. However, to generalise, the higher efficiency of foreign firms in most of the industries seem to be due to their higher advertisement expenditure and application of newer capital embodying innovations and technological progress. Higher raw material import intensity and application of modern technology through new capital seems to be the two major reasons for relatively better performance of foreign firms in electronics as compared to other industries. On the other hand, these factors along with higher technology import appear to have contributed to the higher efficiency of foreign firms in electrical machinery. Higher R&D, intensive advertisement and higher technology import seems to be the major factors responsible for the better relative performance of domestic firms in transport equipment as compared to the other industries.

Technical efficiency measures for both the groups of firms are higher in transport equipment while it is found to be lower in chemicals. The observed signs with statistical significance of the relevant coefficients in the inefficiency model suggests that higher intensity in terms of R&D, advertising and technology import, and long experience have contributed to higher efficiency of both foreign and local firms in transport equipment. On the other hand, the lower efficiency in chemical industry seems to be mainly due to the technology obsolescence as reflected in the positive sign of the coefficient of age variable.

Technical efficiency of foreign firms in all the industries is higher than that of their domestic counterparts in the entire time period of analysis. The average efficiency measures for foreign firm shows a slightly fluctuating trend during the first half of our study period (1991-92 to 1993-94). During this period, the efficiency of domestic firms has shown a marginally increasing trend. In the second half of the study period (i.e., 1994-95 to 97-98), when the liberalisation process have come into full swing, the efficiency levels of foreign firms have started a steadily increasing trend. During the same period the efficiency of the domestic firms exhibit a marginally fluctuating, but not increasing trend. This appears to indicate that, as the liberalisation measures have come into real effect the foreign firms are becoming increasingly efficient. Productive efficiency of the two groups of firms does not seem to converge over the years. The precise reasons as to why domestic firms are not catching up with foreign firms need further investigation.

The higher productive efficiency of foreign firms relative to domestic firms observed in the third chapter raises an important question; given a level playing ground how far has the observed efficiency of domestic firms been influenced by the presence of foreign firms? The fourth chapter addresses this question by analysing the indirect spillover effects and direct linkage effects of foreign firms on local firms. The results of the regression analysis suggest that the productive efficiency of domestic firms in Indian industries is positively affected by the presence of foreign firms. To be more precise, the estimates show that one- percent increase in the foreign firm's share in an industry's total sales seems to increase the efficiency of the local firms in that industry by 0.01per cent. This indicates the existence of significant spillover efficiency benefits, on the local firms, from the presence of foreign firms in the sector. However, it is seen that technology gap between foreign and local firms acts as a major obstacle to the positive spillovers from foreign direct investment. In addition, the R&D investments of the domestic firms appear to be inadequate and inappropriate for exploiting the positive spillovers from the foreign firms.

The fourth chapter also examines the direct linkage effects of foreign firms in selected Indian industries. Two standard ratios, viz. bought-out ratio, and domestic procurement ratio are used for the analysis. In terms of the bought-out ratio, there is no significant difference between foreign and domestic firms in the generation of total linkages (total linkage includes foreign and local linkages). As for the local linkage generation, the domestic procurement ratio suggests that local firms are generating more linkages as compared to foreign firms. This is strictly consistent with our assumption that foreign firms import more raw material for reasons explained in a previous section. The domestic procurement ratios for both foreign and local firms have been declining, but the decline in the domestic procurement ratio of foreign firms appears sharper than domestic firms' ratio. However, it may be noted that foreign firms procure more than 83 per cent of their inputs from domestic sources (local firms procure more than 89per cent). Through this high level of procurement of inputs from the local sources, foreign firms in India seem to strengthen the supplying industries and thereby other local firms. This high linkage generation may be one of the possible reasons for the observed positive spillovers.

To conclude, our empirical analysis of Indian situation validates the hypothesis that foreign firms, given their unique ownership-specific advantages, are technically more efficient than their domestic counterparts. There are variations in the levels of relative efficiency among industries; the variation is due to the differences in the intensity of firm-specific efficiency-enhancing factors like R & D, technology import, etc. across industries. The underlying assumption of the liberalisation process is that local firms are efficient enough to face competition from their foreign rivals. This assumption does not find enough empirical support from the results of our analysis. After the initial bottlenecks of the liberalisation process, the foreign firms in Indian manufacturing sector are becoming increasingly efficient, while the local firm's efficiency does not exhibit signs of any substantial improvement. There exist positive intra-industry spillovers on the efficiency of the local firms from the presence of foreign firms. These positive spillovers seem to validate some of the declared objectives of liberalisation policy, namely, the economy will benefit from the advantages of foreign direct investment in terms of technology transfer, marketing expertise and management techniques. The finding that, even with positive spillovers, the productive efficiency of the local firms is not catching up with foreign firms suggests that the local firms are not absorbing maximum spillovers from foreign presence owing to the large technology gap between foreign and local firms. The inadequate and inappropriate R&D investments also appear to prevent local firms from exploiting maximum spillovers of foreign direct investment. The finding of the high linkage generation of the foreign firms in the domestic economy benefits the raw materials supplying industries and other local firms in the domestic economy. It also seems to have facilitated the positive spillovers to the local firms. However, the existence of the large technology gap between foreign and local firms and the inadequate R&D investments by local firms inhibit spillovers. This in turn explains, to a limited extent, why domestic firms are not catching up with foreign firms in productive efficiency.

We feel that the above type findings and conclusions of our study have considerable policy relevance in the present context. The liberal foreign direct investment policy may increase the foreign direct investment inflows. The increased presence of MNEs may also be justifiable due to their higher productive efficiency relative to local firms and the positive spillovers. To the extent that these positive effects do vary in quantum and significance among industries, a general and indiscriminate policy of the across the board liberalisation to promote foreign direct investment needs a close review. Further, a liberal policy for the promotion of foreign direct investment by itself may not be sufficient to generate the expected benefits from it if the technology gap between local and foreign firms is too high. Clearly, efforts to promote FDI need to be followed by vigorous efforts to upgrade technological capability of local firms. In short, selection of industries and selective support to local firms for improving their capability to to identify, adopt and take full advantage of modern technologies are useful ingredients in a comprehensive liberal policy package to promote and maximise the benefits from the foreign direct investment.

The study may be closed with a caveat. The policy inferences and the conclusions on the relative efficiency of foreign direct investments in Indian industry highlighted by our study are based on the findings emerging from a limited number of sample firms from a few industries. Further, due to time and resource constraints the study has excluded firms with less than 25 per cent foreign equity from our sample. Despite these limitations, the revealing nature of our findings signal the significance of the enquiry into the relative effects, direct and indirect, of foreign directs investment in a comparative framework. In particular, the study underscores the need for more research efforts in the area of relative performance and the dynamics of the technology and the efficiency enhancing effects of the foreign direct investments on the local firms in a liberalised policy regime. For, the long run dynamics of the ongoing liberalisation in the Indian economy depends *inter alia* on developing technology dynamism of domestic firms.

APPENDIX I

SAMPLE DESCRIPTION AND VARIABLE CONSTRUCTION

A. Sample Description

For the empirical analysis of the present study, we needed a panel data set on a number of variables for foreign and domestic firms. As mentioned in the introductory chapter, the firm level data used in the study were primarily obtained from the 'Centre for Monitoring Indian Economy' (CMIE) database *PROWESS.* The firms with at least 25 per cent foreign share were considered as foreign; and the firms with 100 per cent local share (or without any foreign share) are considered as local or domestic. The ownership information available in PROWESS also used for the confirmation of the nature of firm ownership[1] (The ownership information shows whether the firm selected is foreign, private or public). Panel data for seven-year period 1991-92 to 1997-98 is taken for five industries, viz., (i) chemicals, (ii) non-electrical machinery (iii) electrical machinery, (iv) electronics, and (v) transport equipment. For each of the above industries two balanced-panel data sets - one for foreign and one for domestic firms - were constructed. The construction of balanced-panel data sets for the two groups of firms, in each industry, involved the following steps. First, data for foreign and domestic firms in each industry were taken separately at a disaggregated level (the level of disaggregation for each industry is shown in tables at the end of this section). In the second step, we have removed all those firms for which the data for the entire seven years were not available. In this step, the firms with outlier values as well as missing values for some important variables also were excluded from the sample. In the third step, we have selected equal number of comparable foreign and local firms from each sub-sectors of the five selected industries and the rest of the firms were removed from the sample. That is, in this step, each foreign (or local) firm in the sample is matched with a local (foreign) firm producing the same or similar products. In addition to the product homogeneity, firm size (proxied by sales) is also used as a criterion for matching the firms[2]. It should be noted that, in some cases, due to the unavailability of local firms comparable in size to

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[1] The ownership information shows whether the firm selected is foreign, private or public

[2] Earlier studies by Manson (1973), Chung and Lee (1980), and Willmore (1986) used similar method for matching foreign and local firms.

foreign firms, we were forced to match firms with some degree of size differences. However, in no case does the size difference in sales exceed 30 per cent. The firms selected at different sub-sectors of each industry were merged to form five pairs of balanced-panel data sets for the five industries. Thus, for each of the five industries, we have two sets of balanced panel data - one for foreign firms and one for domestic firms. Our final sample included 889 pairs of observations (i.e., 889 for foreign firms and 889 for domestic firms) from 127 pairs of firms (127 x 7 = 889). The industry-wise details of the sample are given in the tables below.

Table A1.1

Number of Pairs in the Sample: Chemicals and its Sub-sectors

SL.NO.	INDUSTRY	NUMBER OF PAIRS OF FIRMS	PER CENT
1	Inorganic Chemicals	2	5.1
2	Fertilisers	4	10.3
3	Pesticides	2	5.1
4	Paints & Varnishes	2	5.1
5	Dyes & Pigments	4	10.3
6	Drugs & Pharmaceuticals	16	41.0
7	Soaps & Detergents	2	5.1
8	Organic Chemicals	2	5.1
9	Industrial Gases	1	2.6
10	Carbon Black	1	2.6
11	Explosives	1	2.6
12	Miscellaneous Chemicals	2	5.1
13	Chemicals (Total)	39	100.0

Table A1.2

Number of Pairs in the Sample: Non-electrical Machinery and its Sub-sectors

Sl. No.	Sub-sector	Number of Pairs of Firms	Per cent
1	Pumps & Compressors	5	18.5
2	Ball Bearings	3	11.1
3	Industrial Machinery (excl.chem.& textiles)	5	18.5
4	Chemical Machinery	1	3.7
5	Textile Machinery	2	7.4
6	Prime Movers	1	3.7
7	Other Machinery	4	14.8
8	Machine Tools	6	22.2
9	Non-electrical Machinery (Total)	27	100.0

Table A1.3

Number of Pairs in the Sample: Electrical Machinery and its Sub-sectors

Sl. No.	Industry	Number of Pairs of Firms	Per cent
1	Wires & Cables	1	5.3
2	Welding Machinery	2	10.5
3	Domestic Electrical Appliances	3	15.8
4	Air-Conditioners & Refrigerators	3	15.8
5	Other Electrical Machinery	8	42.1
6	Dry Cells & Storage Batteries	2	10.5
7	Electrical Machinery (Total)	19	100.0

Table A1.4

Number of Pairs in the Sample: Electronics and its Sub-sectors

Sl No.	Industry	Number of Pairs of Firms	Per cent
1	Consumer Electronics	2	15.4
2	Computer Software & Hardware	4	30.8
3	Communication Equipment	1	7.7
4	Other Electronics	6	46.2
5	Electronics (Total)	13	100.0

Table A1.5

Number of Pairs in the Sample: Transport Equipment and its Sub-sectors

Sl. No.	Industry	Number of Pairs of Firms	Per cent
1	Automobiles	6	20.7
2	Automobile Ancillaries	23	79.3
3	Transport Equipment (Total)	29	100.0

B. Variable Construction

The CMIE database provides firm level data in current prices. The variables required for the estimation of different models are derived from the raw data and then they are converted into constant 1981-82 prices by deflating it with appropriate deflators. The data construction procedure of some important variables is explained below.

(i) Output

Value of all output produced by the firm in a given year has been used as a measure of output. To neutralise the price changes value of the output is deflated by a three-digit industry specific wholesale price deflators obtained from the Index Numbers of Wholesale Prices in India (Base 1981-82 = 100).

(ii) Capital

A gross capital stock series at 1981-'82 prices is generated as a measure of capital input of the firm[3]. More vividly, the replacement cost of the existing `real'gross fixed capital employed in the production process is taken as a measure of capital input of the firm.

(iii) Labour

Expenditure of a firm on wages and salaries is available in the PROWESS database. This has been divided by the corresponding (two-digit level) industry wage rate to obtain labour input for the present study. Wage rate has been computed by dividing industry's total emoluments to the workers by total man-days worked. The data for the calculation of wage rate was collected from the Annual Survey of Industries (ASI) [CSO, various issues].

(iii) Material Inputs

Material input includes costs for all items of raw materials, solid and liquid fuel and electricity. Material price index (1981-82 = 100), constructed by combining price indices of the major intermediate input components through suitable weights, has been used to deflate the material input. The weights assigned to the components are calculated from the Input-Output transaction matrix for the year 1989-90 published by the Central Statistical Organisation. The inputs are grouped according to the availability of wholesale price indices that could be used to represent them most closely. Share of each input in the total intermediate input of the industry has been taken as the weights. The resultant sectoral weights are given in Table A1.6.These weights are used to compute weighted average of the input price indices to derive the material price index.

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[3] A detailed discussion on the procedure followed in the estimation of the capital stock serious is given in the appendix II.

Table A1.6

Weights used for Construction of Material Price Index in Selected Industries

Commodity Groups ⇓	Industry ⇒	Chemicals	Non-electrical Machinery	Electrical Machinery	Electronics	Transport Equipment
Food Articles		2.31	0.00	0.00	0.00	0.00
Non-food Articles		6.12	0.05	0.01	0.00	0.42
Minerals		7.04	0.29	0.28	0.00	0.00
Food Products		10.80	0.32	0.28	0.00	0.00
Beverages and Tobacco		0.06	0.00	0.00	0.00	0.00
Textiles		2.08	0.40	0.25	0.23	0.61
Wood and Wood Products		0.11	1.82	1.73	1.65	1.50
Paper & Paper Products		5.09	0.82	2.53	8.31	1.60
Leather & Leather Products		0.01	0.07	0.02	0.05	0.08
Rubber & Plastic Products		1.65	1.65	1.87	4.76	11.37
Chemicals & Chemical products		52.78	3.67	16.16	10.39	12.16
Non-metallic Mineral Products		0.78	0.54	2.37	1.01	0.58
Basic metals & Metal Products		4.23	80.67	66.44	62.46	58.88
Power & Fuel		6.96	9.67	8.05	11.16	12.81
Total		100.00	100.00	100.00	100.00	100.00

APPENDIX II

MEASUREMENT OF CAPITAL

In spite of its crucial place in production theory, capital is the most difficult concept to deal with in the empirical context. The problem of defining and measuring capital is still a controversial issue in both theory and practice. As the issues relating to this area are very much discussed[1], we do not attempt to make a detailed discussion here.

The indispensable nature of capital in the production function analysis necessitates us to adopt a reasonable method to measure the capital input for our study. In the present study, replacement value of gross fixed capital at constant prices (1981-82=100) has been taken as a measure of capital input.

Generally, value of gross fixed capital at constant prices, rather than net fixed capital, has been used as a measure of capital because of several reasons. The net value typically declines much more rapidly than does the ability of a capital good to contribute to production. An empirical study[2] in this regard revealed that capital goods in the U.K. are maintained in good condition until a decision is made to scrap them. Denison (1967) pointed out that the use of gross capital stock involves the extreme assumption that the ability of a capital good to contribute to production remains constant throughout the service life. His conclusion is that the correct measure of capital services would fall somewhere between the gross stock and the net stock, and he advocates the use of a weighted average of gross and net stock with relatively higher weight being given to the former. In our measure of capital input, we did not attempt to take such a weighted measure, as the figures on depreciation given the data source do not adequately represent the actual capital consumption. This unreliable nature of the depreciation values in the context of Indian manufacturing has been pointed out in several studies[3]. Following the line of some major studies[4], the capital used in the present study also has not been corrected for capacity under-utilisation. Working capital has not been included in the measurement of capital; generally it is excluded from the measure of capital on the ground that the relationship between

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[1] See Hashim and Dadi (1973), Goldar (1986) and Jorgenson (1989) for more details.

[2] Tiber (1961)

[3] Banerji (1975), p.19.

[4] Goldar (1986) (pp.63-64) gives a detailed discussion of the problem.

working capital and output is very less influenced by technological factors as compared to the to the technological relation between fixed capital and output.

The information on the gross fixed assets (GFA) at historic costs is available from the CMIE database PROWESS. From the GFA, it is possible to get investment in time t (I_t) as the difference between gross fixed assets across two years:

$$I_t = GFA_t - GFA_{t-1} \quad \text{-------(1)}$$

If the base year capital stock of a firm is P_0K_0, then the replacement cost of the capital stock can straightly be calculated as,

$$P_tK_t = (P_t/P_{t-1})\, P_{t-1}\, K_{t-1} + P_tI_t \quad \text{------(2)}$$

Where, P is the price of capital, K the amount of capital and the subscript *t* indicates the time period.

However, this is clearly not the case since, in the base year, the firm has some asset mix valued at historic costs. For the present study, the base year gross fixed capital is revalued to obtain its value at replacement cost. Since there is no perfect way of doing this, any method used would involve some amount of approximation. The method followed in the present study[5] is based on three important assumptions:

(i) In our sample, the earliest vintage of capital in the base year (1991-92) dates to the year 1975-'76 for firms incorporated before 1975-76; and for the firms, which are incorporated after 1975-76, the earliest vintage of capital dates to the year of incorporation itself.

In the absence, of the exact age distribution of firms as on 1991-'92 (the base year of our study), we assume that the maximum age of capital is 16 years. Generally, for accounting purposes it is

[5] Our method is closely similar to the method of Srivastava (1996)

assumed that full depreciation of capital takes 16 years implying that under the assumption of straight-line depreciation method capital depreciates at a rate of six per cent per annum.

(ii) The price of capital has changed at a constant rate $\pi = P_t / P_{t-1} - 1$ from 1975-76 or the year of incorporation of the firm (whichever is later) up to 1991-92 (the first year in the data).

Values for π were obtained by constructing the capital formation price indices from the series of gross fixed capital formation - in current and constant values - from the National Accounts Statistics (various issues). The value of pi varies for firms incorporated after 1975-76.

(iii) Investment has increased at a constant rate, $g = I_t P_t / P_{t-1,}$ for all firms. The rate of growth of gross capital formation at 1981-82 prices is assumed to apply to all firms other than those, which are incorporated after 1975-76. Average annual growth rates differ for firms established after 1975-76.

Based on these important assumptions, the revaluation factor (RF) for the base year capital stock is obtained as described below.

Now one can define gross fixed assets at historic costs as

$$GFA_t^h = P_tI_t + P_{t-1}I_{t-1} + P_{t-2}I_{t-2} + P_{t-3}I_{t-3} + ...$$

This may be written as,

$$P_tI_t \frac{(1+g)(1+\pi)}{(1+g)(1+\pi)-1} \qquad \text{-----} (3)$$

and gross fixed assets at replacement cost can be can be written as

$$GFA_t^r = P_t + P_tI_{t-1} + PtI_{t-2} + P_tI_{t-3} + ...$$

or which can be written as,

$$P_t I_t \frac{(1+g)}{g} \qquad \text{----(4)}$$

Now we can define the revaluation factor for the gross fixed assets as

$$RF = GFA_t^h / GFA_t^r$$

and by substituting and simplifying we have,

$$RF = \frac{(1+)(1+\pi)-1}{g(1+\pi)} \qquad \text{----(5)}$$

The above expression for the revaluation factor is applicable if the earliest vintage of capital date back infinitely, but if we have made a more realistic assumption that the capital stock of the earliest vintage is - periods old then the revaluation factor becomes,

$$RF = \frac{\left[(1+g)^{\tau+1}-1\right](1+\pi)^{\tau}\left[(1+g)(1+\pi)-1\right]}{g\left\{\left[(1+g)(1+\pi)\right]^{\tau+1}-1\right\}} \qquad \text{-------(6)}$$

We have used the above revaluation factor [Eq.(6)] to scale up the balance sheet value of gross fixed assets in the initial year to arrive at an estimate of the value of the capital assets at replacement cost. In other words,

Replacement cost of capital = RF * [Value of capital stock at historic cost]

The base year capital stock thus obtained is then converted into constant prices (1981-82=100) by deflating it with the whole sale price index of machinery and machine tools. The index is collected from the Index Numbers of Wholesale Prices in India (Government of India, Ministry of Industry). For estimating the real capital stock for the successive years, the standard method of perpetual inventory method is used. The method is described below.

Gross investment figure at constant prices (1981-82=100) for the year *t* is obtained as

$$I_t = (GFA_t - GFA_{t-1}) / P_t \qquad \text{-----(7)}$$

Where, GFA is the book value of the gross fixed assets, P is whole sale price index of machinery and machine tools. The capital stock at year t is derived as

$$K_t = K_{t-1} + I_t \quad or \quad K_T = K_0 + \Sigma I_t \qquad \text{-----(8)}$$

where K_0 is the capital stock in the base year(1991-92) at constant(1981-82) prices.

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