Trade Liberalisation and India's Manufacturing Sector

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Introduction

Several studies have analysed the impact of India's economic reforms initiated in 1991 on the productive efficiency of India's manufacturing sector (Rajan and Sen 2002, Forbes 2001, Joshi and Little 1998, Srinivasan 1996). These studies have provided valuable insights into the impact of liberalisation, principally liberalisation of controls over trade. These studies, however, examine the impact of trade liberalisation at the aggregate industry level or at the level of broad sectors. Such studies at the aggregate industry or sector level fail to capture the response of individual firms to changes in trade policy in each of the sectors. Such responses could differ between firms depending on the sector to which they belong, the nature of their ownership and the age of firms. This study attempts to investigate the impact of liberalisation on productive efficiency at the micro firm level taking into account the differing characteristics of the firms in each of India's major manufacturing sectors.

Section 1 of the paper briefly sketches the scope and scale of the reforms. Section 2 identifies a set of testable hypotheses based on the literature on economic liberalisation. Section 3 discusses the methodology and data utilised in the statistical analysis designed to assess the impact of liberalisation on the manufacturing sector. Section 4 discusses the results of the exercise. Section 5 pulls together the conclusions of the paper.

1. The Reforms

The principal reforms initiated in the year 1991 included; reduction in import tariffs on most goods other than consumer goods, removal of quantitative restrictions and liberal terms of entry for foreign investors. India's simple average tariff rate was reduced from 128% in 1991 to about 32.3% in 2001/02, while the maximum tariff fell to ? % in 2000 from 355% in 1991. Quotas and non-tariff barriers were also reduced The pace of reforms gathered momentum over the period 1991-96 when controls over

trade were relaxed extensively.. Since then the pace of reforms has slowed down. Although the average tariff rate fell rapidly in the early nineties, the uneven structure of tariff rates continues to be a cause for concern: the dispersion across the tariff structure increased from 35 to 41 per cent between 1990-91 and 1997-98 (WTO 1998)[1] Further, India has resorted to anti-dumping duties in a major way, with some 250 cases initiated since 1995. Even so, levels of effective rate of protection and non-tariff barriers declined appreciably during the nineties (Das 2003).[2]

In some respects the 1991 reforms of trade policy are no more than a culmination of the attempts at liberalisation initiated in the mid-eighties by Rajiv Gandhi, the then prime minister of India. The 1985 reforms, however, were piecemeal; they increased the range of capital goods and raw materials which could be imported without licenses, but did not abolish import licenses in total, nor did they reduce the level of import tariffs. The fairly stringent foreign investment regime was not also relaxed. The 1991 reforms in contrast were much broader both in scope and scale, and initiated a departure from the earlier dirigiste regime of controls and permits towards a market oriented regime. [3]

As a result of trade liberalisation since the eighties, the Indian economy has become more outward-looking. Trade intensity (ratio of imports plus exports to GDP) increased from 30 per cent in 1984-85 to over 50 per cent in 2001-02. Foreign direct investment (FDI) inflows increased from an average of around 1 per cent of GDP between 1971-72 and 1984-85 to 2 per cent between 1985-86 and 1998-99. Over the

[1] A lower overall degree of tariff protection does not necessarily entail a less distorting tariff structure, and *vice versa*. A fall in general tariff protection could be more distorting because of the wider dispersion of rates.

[2] Nominal protection rates disregard effects of tariffs on prices for intermediate inputs, and thus misrepresent real protection to the final good. Also tariffs do not account for protection due to quantitative restrictions. These shortcomings can be overcome by estimating the effective protection rates, the concept first proposed by Meade (1951) and later refined by Johnson (1960) and Corden (1966).

[3] Rodrik and Subramanial (2004) distinguish the reforms of the eighties and nineties by describing the former as 'pro-business' and the latter as 'pro-market'. The eighties reforms focused on increasing profitability of existing firms by easing capacity restrictions and reducing corporate taxes, among other things. The reforms of the 90s allowed more competition and paved a way for entry of new domestic firms and MNCs in Indian industries.

same period, FDI inflows increased from 0.4 to 1.1 per cent of GDP. Liberalisation of foreign investment has increased competition through the entry of foreign firms into domestic markets. The manufacturing sector appears to have responded to the reforms and the consequent competitive pressures in the market place.. The annual growth rate of manufacturing which had declined to -3.7 per cent in 1991-92, recovered to 4.2 per cent during the very next year. During the next four year period from 1993-94 to 1996-97 manufacturing output grew at an appreciably high rate of around 10.4 per cent per annum. This improved performance, however, ended abruptly when the economy slid into a recession in early 1997. The years since 1996-97 may be one of turbulence with weak and inefficient firms struggling to cope with increased competition from imports, and new firms trying to establish themselves in the altered competitive market environment. In this respect, Indian experience appears to mirror that of other developing countries such as Chile which embarked on a programme of liberalisation. This aggregate picture, however, conceals developments at the micro level of the manufacturing sector. The objective of this paper is to analyse developments at the level of individual sectors and industries.

2. Trade Reforms and Productivity - Theory

The relationship between international trade and TFP growth has long been the subject of controversy among economists. Although there are a number of theoretical and empirical studies on the impact of of trade on productivity, it is as yet a controversial issue. During the decade of the fifties many developing countries including India adopted import substituting industrialisation strategy in the belief that protective trade policies would promote industrialisation and growth. By the beginning of the decade of eighties however, the failure of the strategy and the social costs and inefficiencies associated with it were demonstrated in a number of studies (Scitovsky and Scott 1970, Krueger 1978, Bhagwati 1978, Little *et al* 1970, Balassa 1978). Even so, empirical studies on the relationship between trade liberalisation and growth have produced a mixed bag of results. The controversy on the impact of liberalisation on growth, and the mixed bag of results empirical tests on the issue have produced are

mostly due to differing interpretations of liberalisation and openness. The debate seems to centre on the following issues. Does liberalisation interpreted to mean lowering of trade barriers alone result in increased growth? What is the direction of causation? Does trade lead to increased growth rates or is it the other way round? Is the empirical evidence in favour of the proposition that openness promotes growth seriously flawed? Is it the case that while openness may shift an economy on to a higher level of growth it cannot result in sustained increases in growth rates over time?

Admittedly reduction of trade barriers alone in the absence of other domestic policies designed to eliminate factor and product market distortions may do little to promote growth.[4] By the same token macroeconomic stability and high rates of investment coupled with excessively high levels of protection may not promote growth either, as exemplified by the Soviet Union and India in the past (Bhagwati and Srinivasan, 1999). This is not to say that there is no positive association between growth and investment, it is just that the quality of investment matters. The quality of investment is influenced by the sectors in which it occurs which in turn largely determines its efficiency. It is more than likely that the sectoral allocation of investment and its productive efficiency will be relatively high in an economy which is open to competition both from domestic and external sources than in one which is closed. The endogenous growth theory developed during the nineties provides additional theoretical support for these propositions (Grossman and Helpman 1991, Romer 1992, Barro and Sala-i-Martin 1995). The theory emphasises the importance of knowledge spillovers for growth. Firms which enter export markets after reforms may absorb new technologies through their contact with international markets and those firms which face relatively more intense import competition may have to innovate in order to

[4] Associated with the problems of quantifying trade variables are the problems of specification and validity of inferences drawn from cross section regression equations. The results of cross country regressions crucially depend on the time period to which the equations relate, sample of countries and variables chosen. As Bhagwati and Srinivasan (2001) observe " given these numerous choices, we can confidentially expect that there are enough de facto degrees of freedom at an analysts command to reverse any "findings" that another analyst using similar regressions has arrived at"

remain viable (Porter 1990).[5] Imports of machinery and components which embody advanced technology could improve productivity. Domestic firms may learn by observing the foreign owned firms. Also greater exposure to imported products may make imitation easier and trade in one sector may enhance productivity in another via input-output relations (Choudhari and Hakura, 2000). Exposure to international competition may drive inefficient firms from the market and reduce the social costs of production by promoting production based on comparative advantage. Access to export markets may induce increased capacity utilisation as well as scale economies. Finally, competition tends to improve the quality of human capital due to improvement in technical skills and thereby productive efficiency of firms.

3. Empirical Evidence f rom India

Although the Rajiv Gandhi reforms were piecemeal they do appear to have promoted growth and productive efficiency of the manufacturing sector (Ahaluwalia 1991, 1995, Srivastava 1996, ICICI 1994)[7]. Empirical studies suggest that trade reforms promoted total factor productivity (TFP) during the decade of the eighties (Goldar 1986, Ahluwalia 1991, and Chand and Sen 2002). There is, therefore, sufficient reason to believe that the manufacturing sector does respond to liberalisation and the high growth rate of the Indian economy during the nineties was, "in part, due to continued structural reform, including trade liberalisation, leading to efficiency gains." (WTO 2002, p 1). This view is supported by Krishna & Mitra (1998) and Unel (2003) who found growth of labour productivity and TFP was substantially higher in the nineties compared to the period up to 1990-91. Das (2001) reports that a positive

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[7]As Golder (1997) however notes, most estimates of TFP in Ahluwalia's study are statistically insignificant. Also, the estimates of Ahluwalia (1991) have been challenged by Balakrishnan and Pushpangadan (1994) who criticise the way prices of intermediate inputs are measured. Using a double-deflation method to construct time series of value added, the Balakrishanan and Pushpangadan study (1994) detects no improvement in TFP in the eighties. Also Mohanty (1992) observed a negligible growth rate (0.0092 percent per annum) for TFP during 1970-71 to 1988-89 for the registered manufacturing sector.

impact of the lowering of NTBs on the manufacturing as well as intermediate goods sectors promoted industrial productivity. Although Goldar and Kumari (2003) report a deceleration of TFP growth in Indian manufacturing in the 1990s, their analysis indicates that the lowering of effective protection to industries promoted productivity growth during the period 1991-98 The results also suggest that gestation lags in investment projects and slower agricultural growth in the 1990s had an adverse effect on productivity growth.

A number of recent studies, however, contradict this view. Several studies (Das 1999, 2003, Singh et al 2000, Kumari 2001, Srivastava 2001) find TFP growth in the manufacturing sector worsened during the the nineties compared with that during the eighties. Srivastava (2001) reports that that TFP growth rate in Indian manufacturing was 3.6 per cent per annum in the period 1980-81 to 1990-91 but had declined to 2 per cent per annum during the period 1990-91 to 1997-98. Balakrishnan et al (2000) also report a significant decline in the growth rate of TFP since 1991-92 in five manufacturing industries and they fail to find a link between trade reforms and productivity in the nineties. Das's (2003) estimates suggest that TFP growth in post-1991 reform period to be either negative or in the range of 0 to 2% for most industries.

Most of the foregoing studies estimate an average production function to evaluate productive efficincy of Indian industries. Some others estimate a frontier production function and measure the distance between the efficiency frontier and the individual firms as a direct measure of efficiency. Table 1 summarises the results reported by these studies on the efficiency of Indian industry for the post-reform period. Whereas Driffield & Kambhampati (2003) find growth in average technical efficiency in four out of six sectors they analysed,, Agarwal (2001), analysing public sector firms in infrastructure, petroleum and engineering sectors, finds a decline in average efficiency in 1998-99 compared to 1990-91 in the petroleum and engineering sectors. Golder, Ranganathan and Banga (2004) show that domestically owned firms tended to catch up with foreign owned firms in terms of technical efficiency after the reforms. Their results also show a positive relationship between international trade orientation of a

firm and its level of technical efficiency. Kumari (2001) finds that locally owned firms registered a higher productivity growth compared to foreign owned firms in both the pre and post-reform period. Kathuria (2002) finds that the productivity of foreign owned firms improved in the post-reform period and Indian owned firms which invested in R&D gained from productivity growth.

Table 1

	Sectors	**Average Technical Efficiency (Max=1)**
Mitra (1999)	Industrial Sector	1976-77/84-85 1985-86/93-94 0.47 0.46
Agarwal (2001)	Public Sector Firms	1990-91 1998-99
	Infrastructure	0.56 0.66
	Petroleum/Oil	0.40 0.22
	Engineering	0.56 0.18
Driffield and Kambhampati (2003)		1987-90 1991-94
	Chemicals	0.92 0.94
	Food	0.86 0.88
	Metals	0.93 0.95
	Textiles	0.92 0.94
	Transport	0.95 0.95
	Machine Tools	0.96 0.96
Kambhampati (2003)	Cotton Textiles	1986-90 1991-94 0.81 0.90
Golder, Ranganathan and Banga (2004)	Engineering	1990-91 to 1999-00
	Foreign Owned	0.79
	Private Indian	0.73
	Public sector	0.67
Kathuria (2002)	Industrial sector	(growth in TE between 1990-96)
	All firms	0.0119
	FDI firms	0.0067
	Non-FDI firms	0.0297

These mixed bag of empirical results suggest the need for further investigation of the links between trade liberalisation and productive efficiency of Indian industry. An investigation of the issue at the micro firm level may add to our knowledge of the issue and shed light on the disparate set of results produced by the extant studies. This paper employs the stochastic frontier production function approach to an analysis of productive efficiency which allows us to utilise firm-level data.

4. Methodology and Data

We evaluate changes in firm-level technical efficiency in India since the 1991 reforms by estimating a frontier production function for 13 manufacturing sectors. *The assumption that firm-specific effects are time-invariant is relaxed by replacing the firm effect with a flexibly parameterized function of time, with parameters that vary over firms. This allows for correlation between technical efficiency and regressors; e.g., changes in technical efficiency may be due in part to adjustments of capital after liberalisation.* The frontier defines an unobservable function, the production frontier, which corresponds to the set of maximum attainable outputs for a given combination of inputs. Given that this methodology estimates the production function on the assumption that the underlying production technology is common to all producers, it makes sense not to pool together data on firms in different industries. Estimation of a common frontier function encompassing every firm in the sample is likely to give biased estimates. Furthermore, if the unobserved technological differences are not taken into account in the estimation, the effects of these omitted unobserved technological differences might be inappropriately labelled as technical inefficiency (Orea and Kumbhakar 2003).

Assuming a Cobb-Douglas production function, this model can be written in logarithmic form as

$$\log Y_{ij} = \alpha + \beta t + \gamma \log L_{it} + \eta \log K_{it} + e_{it} \qquad (1)$$
$$e_{it} = v_{it} + u_{it}$$

where *i(firm) = 1,2…2417*, *t (time) = 1,2…10*, *Y* is real gross value added, L and K are labour and capital inputs, γ and η are the elasticities of labour and capital with respect to output respectively, β measures exogenous technical change and denotes the shift in the production frontier. The existence of constant returns to scale can be checked by testing $\gamma+\eta=1$. The computation of technical efficiency is done by decomposing the residual, e_{it} into separate estimates of statistical noise v_{it} and technical efficiency, u_{it} where the later is time-varying and firm-specific. The

disturbances v_{it} are taken to be *iid* with a zero mean and constant variance σ_2, and are uncorrelated with the regressors and u_{it}. Given that u_{it} is allowed to vary over time, there is a need to impose a specific distribution assumption. In this study the parameterisation of u_{it} is specified to follow (Battese and Coelli, 1992)[8]

$$u_{it} = \eta_{it} u_i = exp[-\eta(t - T)]u_i \qquad (2)$$

where u_i are iid with (u, σ^{2u}), T_i is the last time period in the ith panel. When $\eta>0$, the degree of inefficiency is decreasing over time and when $\eta<0$, the degree of inefficiency is increasing over time. When $\eta=0$, the time varying model reduces to the time-invariant model.

The model is estimated in two stages. Equation 1 is estimated for each industry by using the maximum likelihood estimation procedure for panel data.[9] The model can be tested for skewness of the error terms to decide if the estimation of a stochastic frontier is valid. Technical efficiency (TE) is estimated as [exp $(-\eta_{it} u_i)$]. To be consistent with the concept of a frontier, TE is normalised so that the estimated level of TE has an upper bound of unity and relative TE for each firm is estimated as a difference from the productivity of the most efficient firm in the sector for each year. Productivity growth or rate of learning of a firm would then be $\Delta TE = TE(t) - TE(t-1)$.

The second stage involves analysing whether or not trade reforms have induced significant gains in productivity. The following model is proposed for the determinants of growth in technical efficiency (ΔTE) and is estimated using maximum likelihood random effects estimator for panel data;

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[8] Other than the specification in equation 2, other functional forms have been proposed for u_{it} in the literature. A common feature of them is that all forms are exclusively function of time. Kumbhakar (1990) modelled $u_{it} = \gamma(t)\alpha_i = [1+\exp(bt + ct2)]-1\alpha i$ Cornwell, Schmidt, and Sickles (1990) model it as and $u_{it} = \theta_{i1} + \theta_{i2} t + \theta_{i3} t^2$. See Sickles (2003) for a survey of this literature.

[9] We could not use the dynamic panel data GMM models such as by Arellano and Bond (1991) because of the problem of missing data in initial years and the available instruments for the GMM procedure were limited. For the same reason we did not add lagged dependant variable in the regression which takes into account dynamic adjustments. Also, due to the missing observations in the initial years, we could not estimate separate regressions for the pre- and post-reform periods.

$$\Delta TE = \gamma_i + \gamma_1 (K/L) + \gamma_2 (E/S) + \gamma_3 (CI/S)_{t-1} + \gamma_4 (Age) + \gamma_5 (HHI)_{t-1} + \gamma_6 (OwnDum) + \gamma_7 (LibDum) + \gamma_8 (ForSales)$$

Firm level Variables:

K/L = defined as capital to labour ratio.

Relatively high capital intensity could be expected to increase efficiency. An increase in capital formation can speed up the rate of introduction of new technology and innovation. In our sample, firms in all thirteen sectors increased the capital intensity of their operations in the post reform period compared with the pre-reform period. It is noteworthy that the capital intensity of operation of foreign firms is the relatively low both in the pre-reform and the post-reform periods.

E/S = Export intensity is estimated as the ratio of exports to sales. Relatively high export intensity is expected to increase efficiency because exporting firms have to compete against efficient and competitive firms in world markets. Also, by expanding into export markets firms can achieve economies of scale and growth in productivity. For the sample of firms in this study average exports intensity increased by 53 percent

CI/S = capital import intensity is defined as the ratio of expenditures on capital imports to sales.

This variable is designed to capture imports of technology. Expenditures on technology imports include expenditures on the import of capital goods embodying new technology as well as imports of disembodied technology through licensing. Technology imports are assumed to impact on technical efficiency with a lag of one year. With the exception of firms in the jute sector, computer hardware firms and government owned firms in basic metals and non-electrical sectors, import intensity increased in all sectors.

Age = years since the incorporation of the firm.

It is likely that new firms achieve high growth of labour productivity because of their endowments of capital stock embodying the latest vintages of technology and skilled/innovative managers. New firms, unencumbered by the distortions in the economy of an earlier era, are likely to fare better than the old firms. However, it is also possible that relatively old firms learn from their experience and are better placed to take advantage of new opportunities.

Industry-level variables:

HHI = The Herfindahl index of market concentration is estimated by summing up the square of the market share of each firm in an industry.

According to traditional analysis, highly concentrated industries are likely to have high barriers to entry and low levels of competition allowing considerable inefficiency to persist. However, it is possible that competition among large firms increases efficiency as each firm tries to capture the largest share of the market. We include the HHI with one year lag in the analysis. In our sample, beverages and tobacco, basic metal, leather and leather products and miscellaneous sectors could be considered highly concentrated industries with HHI index greater than 0.18.[10] The HHI index declined for all except beverages and tobacco, and transport equipment sectors in the post-reform period.

Forsales = Foreign Sales/industry sales.

This variable tests for the spillover effect on productivity from the presence of foreign firms in the industry. Substantial gains in productivity may occur through in the face of competitive pressures from imports and new foreign owned firms in domestic markets. Further, industries in which foreign presence is significant may benefit from the technological and informational externalities associated with the operation of MNCs.

[10] The UK competition commission considers industries with HHI index greater than 0.18 as highly concentrated.

Dummy variables:

Libdum = liberalisation dummy which takes value = 0 for pre-reform years and 1 for post-reform years.

We include a liberalisation dummy to capture the effect of reforms not captured by X/Sales and CI/Sales, especially the effects of deregulation of entry, expansion and exit of firms.. We expect efficiency to increase e in a new open and deregulated environment..

Ownership dummy = The dummy variable, owner1=1 if a firm is foreign owned and = 0 otherwise. Owner2 = 1 if a firm is privately owned and = 0 otherwise.

Foreign owned firms are expected to be more efficient than domestically owned firm since they have a relatively better access to advanced technology..[11] A number of studies have found that public sector enterprises are relatively less efficient than their counterparts in the private sector (e.g., Bitros, 2003; Chirwa, 2001; Onder et al., 2003).

Data

We utilise firm level panel data published by the Centre for Monitoring the Indian Economy (CMIE). The data covers the four year period from 1988-89 to 1991-92 for the pre-reform period and the six year period from 1992-93 to 1997-98 for the post-reform period. Although data for a short period of six years may not be sufficient to fully evaluate the long-run implications of reforms, the analysis of productivity trends for the period should provide some insights. Only those firms for which data was available for at least three consecutive years during the sample period are included in the study.. Also, firms, which report zero or negative values for plant and machinery, value added and the wage bill, have been deleted from the sample. The final sample

[11] The studies for developing countries on the link between ownership and efficiency suggest mixed results. While some studies suggest that ownership has no influence on technical efficiency (e.g.,Sterner, 1990), others suggest that foreign firms have higher technical efficiency (e.g., Tu, 1990, Aitken and Harrison, 1999).

consists of 2256 firms in 13 broad industry groups. The sample includes 114 foreign owned firms, 61 government owned firms, and 2081 firms owned by the local private sector. Industry groups include textiles, transport equipment and electrical machinery, among others, most of which were subject to significant tariff reduction since 1991. The choice of industries for analysis was dictated by the availability of data. Our sample of firms accounts approximately 32% of the value of output in the Indian registered manufacturing sector for the year 1988-89, which increases in subsequent years.

Output, labour and capital are expressed in constant prices with base year 1988-89. The output – gross value added – is deflated using sectoral deflator for Index of wholesale prices. Capital Stock is estimated using the perpetual inventory method. This involves assuming some base year capital stock - gross fixed assets in 1989 - as beginning capital stock and then adding deflated gross investment in each year to the base year stock to arrive at each year's stock. The gross fixed capital goods deflator was used to deflate investment.[12] Labour is defined in value terms, i.e., values of wages and salaries at constant prices. Nominal values for wages and salaries were deflated by the consumer price index for industrial workers. Most studies on the Indian manufacturing sector also define labour in terms of value in the absence of employment data at the firm level (Drifield and Kambhapati 2003, Srivastava 1996, ICICI 1994).

5 Production Functions and Efficiency Scores

Table 2 presents estimates for the frontier production functions for each industry. η is significantly different from zero in all industries which permits the estimation of a stochastic frontier production function. $\eta < 0$ in all sectors except leather and miscellaneous firms, which suggests that the degree of inefficiency increased in these industries over time.. As table 3 indicates, the average elasticity of output with

[12] This method does not take into account assets of different vintages bought at different points in time. However, in the absence of an information about the cumulative depreciation and the time pattern of acquisition of assets, appropriate price adjustments can not be made to the data.

respect to labour and capital is approximately 0.5 and 0.3 respectively in all the sectors except the leather sector. The time coefficient is positive and significant in all sectors except miscellaneous manufacturing firms indicating an increase in exogenous productivity over time.

Table 3 shows the means of estimated technical efficiency for the foreign owned firms, domestically owned private sector firms and public sector firms for different years during the period. The mean technical efficiency of all firms was 0.51 in the pre-reform period, it fell to 0.46 immediately following the reforms, and recovered to 0.53 in 1997/98. Mean efficiency of foreign firms was higher than that of domestically owned private sector firms and public sector firms through out the period. The mean of technical efficiency estimates presented in Table 3 reveal a downward trend in technical efficiency in domestically owned private sector firms between 1993 and 1996 and an upward trend in technical efficiency in 1997-98. The upward trend in technical efficiency in the first half of the 1990s is possibly a result of a lag effect of the economic reforms in the late eighties.

Substantial gains in productivity may occur from the closing down of inefficient producers in face of competitive pressures from imports and new foreign owned firms in domestic markets. However, exit or closure of uneconomic units is difficult to achieve in India. Stringent labour laws prohibit de-scaling of labour, and various sorts of subsidies to ailing firms keep the inefficient firms alive.. This is reflected in a decline in average efficiency of private sector firms in the initial phase of the nineties reforms. In contrast, both public sector and foreign firms, gained in technical efficiency (on an average) during both the sub-periods after the reforms.

The difference between the mean technical efficiency of foreign owned firms and that of domestically owned firms is statistically significant at one percent level (one-tail test) for the first three years under study, and statistically significant at five percent level (one-tail test) in the next five years. This is indicative of higher efficiency of foreign owned firms compared to domestically owned firms. It is in the last two years that the difference in mean technical efficiency between the foreign and domestically

owned firms is not statistically significant. The advantage of foreign firms in technical efficiency seems to have declined in the late 1990s.

Whereas mean TE in 1997/98 was higher in the post-reform period in seven out of thirteen sectors for private firms, it increased in all sectors for foreign firms. This is reflected in a decline in the growth rate of TE in table 5. On an average the basic metal sector was the least efficient and the miscellaneous manufacturing sector was the most efficient both in the pre and post-reform periods. Beverages and tobacco registered the highest growth in efficiency over the entire period, followed by non-metallic mineral products. These are the so called 'sunrise' industries which have benefited from access to imported technology in the world market and the new distortion free competitive environment. Indeed, these are the success stories of the reforms.

Table 2 Frontier Production Function for 13 Indian Manufacturing Sector

Dependent Variable: Log of Gross Value Added

Sector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Time	0.031	0.18	0.11	0.09	0.15	0.09	0.09	0.2	0.08	0.06	0.1	0.08	-0.05
Log L	0.49	0.51	0.47	0.45	0.62	0.45	0.48	0.53	0.46	0.58	0.53	0.52	0.5
Log K	0.23	0.3	0.23	0.32	0.06	0.27	0.29	0.25	0.33	0.17	0.25	0.32	0.07
Constant	1.43	1.32	2.17	1.38	1.53	1.73	0.98	1.44	1.32	3.25	1.68	1.34	4.56
Log-likelihood	-987.87	-283.98	-2432.6	-559.6	-128.64	-2224.9	-888.12	-942.12	-1978.7	-1163.74	-1957.82	-984.59	-184
sigma2	0.73	0.738	0.6	0.46	0.28	0.81	0.72	0.8	0.69	0.69	0.61	0.5	0.85
H	-0.5	-0.13	-0.06	-0.09	0.07	-0.08	-0.17	-0.11	-0.08	-0.02	-0.08	-0.05	0.03
Total Firms	182	36	398	103	25	276	149	120	306	162	322	140	37
Foreign	1	2	1	4	1	21	20	5	7	20	28	4	
Government	5	2	5	2	1	16	1	2	8	3	12	4	
Indian	176	32	392	97	23	239	128	113	291	139	282	132	

Notes: 1= Food Products, 2= Beverages & Tobacco, 3= Textile, 4= Paper, 5= Leather, 6=Chemicals, 7= Drugs, 8=Non-Metallic Mineral products, 9= Basic Metals, 10=Non-electrical machinery, 11= Electrical Machinery, 12=Transport Equipment, 13= Miscellaneous

Table 3: Average Technical Efficiency Scores and Growth in efficiency

Sector	All firms			Indian Private			Government			Foreign Owned			Private	Govt	Foreign
	89-92	93-96	97-98	89-92	93-96	97-98	89-92	93-96	97-98	89-92	93-96	97-98	Growth: TE(97/98) - TE (89/92)		
Industries with an increase in Average Efficiency in 1997-98															
B & T	0.511	0.523	0.642	0.480	0.502	0.628	0.387	0.450	0.560	0.870	0.881	0.927	0.147	0.173	0.058
Textile	0.587	0.535	0.595	0.586	0.534	0.594	0.672	0.605	0.691	0.563	0.617	0.655	0.008	0.019	0.092
Leather	0.444	0.386	0.622	0.271	0.344	0.609	-	-	-	1.00	1.00	1.00	0.338	-	-
Non-Metallic Mineral	0.531	0.520	0.612	0.529	0.519	0.611	0.384	0.380	0.587	0.603	0.601	0.614	0.083	0.203	0.012
Basic Metals	0.321	0.294	0.350	0.299	0.280	0.332	0.656	0.683	0.696	0.346	0.359	0.384	0.033	0.041	0.039
Non-elec Machinery	0.621	0.583	0.612	0.610	0.568	0.598	0.644	0.644	0.727	0.664	0.672	0.734	-0.012	0.083	0.070
Electrical Machinery	0.389	0.375	0.418	0.375	0.360	0.405	0.541	0.506	0.540	0.412	0.457	0.492	0.029	-0.001	0.081
Transport Equipment	0.444	0.396	0.457	0.433	0.386	0.447	0.480	0.444	0.525	0.531	0.557	0.573	0.014	0.045	0.042
Industries with a decline in Average Efficiency in 1997-98															
Food Products	0.503	0.383	0.441	0.493	0.381	0.437	-	-	-	0.974	0.999	1.00	-0.056	-	0.026
Paper	0.538	0.480	0.508	0.511	0.457	0.483	0.874	0.892	0.929	0.649	0.722	0.757	-0.027	0.056	0.108
Chemicals	0.531	0.482	0.493	0.493	0.449	0.467	0.815	0.823	0.797	0.547	0.586	0.612	-0.026	-0.018	0.065
Drugs	0.530	0.369	0.463	0.461	0.309	0.426	0.324	0.415	0.504	0.672	0.669	0.696	-0.035	0.179	0.024
Miscellaneous	0.755	0.699	0.704	0.755	0.699	0.704	-	-	-	-	-	-	-0.051	-	-

Notes: Average TE scores during the time periods shown.

Analysis of Efficiency

The results confirm the hypothesis that efficiency decreases with the age of firms in all sectors except textiles. Old firms operate with relatively old technology and may have found it difficult to cope with competition in the market. The effect of export intensity on efficiency is mixed. Contrary to expectations, exports appear to reduce efficiency in food products, chemicals and transport equipment sectors. Earlier studies confirm the mixed effect of export intensity on productivity in India.(Aksoy 1992, Driffield and Kambhampati 2003). Imports of technology however increase efficiency in six sectors and do not appear to have a negative impact in any other sector. This result confirms the findings of other studies (Chand and Sen 2002, Howell and Kambhampati 1998) and provides support to the argument that developing countries benefit from imports that give them access to new technologies and ideas developed in advanced economies and imports are a source of technological and information externalities identified by the new growth theory.

Contrary to the results reported by Patibandla (2001) the evidence on the impact of the presence of foreign owned firms on productivity is mixed.. In six industries relatively high shares of foreign owned firms' sales in total sales decrease efficiency and in three sectors it appears to have a positive influence. However, five out of the six industries (including food products, textiles and leather) in which foreign presence reduces productivity are characterised by a large number of firms and a relatively small foreign presence. Two of the three industries (chemicals and electrical machinery) where foreign presence has appositive impact on productivity have a relatively high foreign presence. It is possible that foreign investment contributes to firm level productivity subject to firm- and /or industry-level attributes such as a firm's own research and development effort. However, in the absence of data on R&D this hypothesis could not be tested.

Increased capital intensity seems to increase efficiency in 5 sectors and reduce it in 3. It is reported that in the post-reform period most firms undertook lumpy investments in plant and machinery with a view to build up productive capacity. But due to the recession in 1996-97 this capacity may not have been fully utilised. Indeed, available evidence suggests that there was a substantial expansion of capacity in Indian industry between 1993-97, but only 22 percent of installed capacity was unutilised in 1997-98 (Nitsure and Joseph 1999).

Market concentration (HHI) seems to have a positive and significant impact on productivity in all industries except the transport equipment sector. Contrary to traditional analysis, highly concentrated industries seem to experience increased internal competition from the incumbent large firms, which compels them to operate on a minimum efficient scale and increase productivity. This finding is in contrast to that reported by Driefield and Kambhampati (2003) who found that market concentration in general decreases efficiency in the manufacturing sector. Patibandla (2001) however, did find a positive influence of market concentration on productivity in three industries – motor vehicles, motor generators and tyres. In these industries where there are significant economies of scale in production, advertising and distribution and research and development, the market would support only a few firms.

A dummy variable for liberalisation is introduced to capture the influence of liberalisation which other variables do not account for. Liberalisation seems to have increased efficiency in basic metal and drugs sectors but not in the others..

Table: Determinants of Efficiency Growth

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13
C	0.17*	0.252*	0.039*	0.031	0.184**	-0.064*	-0.021	0.087*	-0.023**	-0.005	-0.017***	0.061*	
Xsales	-0.005*	0.002	0.012*	-0.038	0.005	-0.0001**	0.0001	0.0001	0.0001	0.004*	0.012*	-0.0002*	
Age	-0.001***	-0.001*	-0.001	-0.001*	-0.003*	-0.0001*	-0.0001*	-0.006*	-0.0004*	-0.0004*	-0.001*	-0.001**	
Libdummy	-0.017	-0.011	-0.001	0.003	0.021	0.0004	0.028*	-0.010*	0.010*	0.010	-0.002	-0.003	
Owner1	-0.026	-0.019	0.007	0.023	0.128**	0.013**	0.014	-0.008	-0.001	0.005	0.008	0.001	
Owner2	-0.005	-0.009	0.011	0.019	-0.026	0.018*	0.033	-0.002	0.011**	0.006	0.014*	0.0034	
K/L	0.006**	-0.007***	0.002*	0.002	0.007	-0.002**	0.004**	-1.168**	0.001	0.002***	-0.002*	0.0004	
ForeignSales	-1.58*	-0.35*	-25.4*	-0.29*	-0.305*	0.429*	-0.335*	0.052*	0.033	0.028	0.337*	-0.039	
MSales(t-1)	0.028*	0.004	.000	0.008	0.132*	0.000	-0.001	0.332*	0.000*	0.028**	0.022*	-0.0002	
HHI (t-1)	1.38*	0.101	1.74*	0.693*	0.271*	1.857*	5.00*	0.087**	0.219**	0.316***	0.183*	-0.255*	
Log Likelihood	1203.60	362.81	3312.5	1216.4	132.52	2482.99	986.48	1795.93	2309.5	2450.6	3696.1	2076.5	

Notes: 1= Food Products, 2= Beverages & Tobacco, 3= Textile, 4= Paper, 5= Leather, 6=Chemicals, 7= Drugs, 8=Non-Metallic Mineral products, 9= Basic Metals, 10=Non-electrical machinery, 11= Electrical Machinery, 12=Transport Equipment, 13= Miscellaneous

Conclusion

The impact of the 1991 reforms on the efficiency of the manufacturing sector appears to be mixed. Average technical efficiency of firms increased in eight out of thirteen sectors studied. Improved access to imported technology in the post-reform period seems to have a positive impact on the efficiency. Although foreign owned firms continue to be the most-efficient, their advantage in technical efficiency seems to have declined in the late 1990s. There is evidence of productivity spillovers from the presence of foreign firms in three sectors. In general there are signs that the reforms have had the desired effect.

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