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Economic Reforms and Externalities in a Developing Economy : A Study of Post-reform Indian Industry

By

Murali Patibandla

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Please address all your correspondence to:

Murali Patibandla
Indian Institute of Management Bangalore
Bannerghatta Road
Bangalore – 560076, India
E-mail: muralip@iimb.ernet.in
m_patibandla@yahoo.com

Phone : 080 – 2699 3039
Fax : 080 - 6584050

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Abstract

Presence of externalities can be significant in the developing economies, which have been able to augment aggregate economic growth in response to policy reforms. The empirical results of this paper based on firm level panel data for 12 Indian industries indicate presence of external economies through the expansion of industry level research and development (R&D) investments and aggregate industry output. Apart from this, there are positive externalities from increasing presence of multinational firms in Indian industries.

Key Words: externalities, research and development, industrial output

JEL Classification: 033, F21, 019

1. Introduction

What contributes to an increase in total factor productivity of firms in a developing economy? Apart from the effect of a firm's own effort at R&D, most of the increase is derived from externalities: externality from the expansion of the industry, spillover from the R&D effort of other firms, growth of public institutions, openness to international trade and investment, and general economic growth. One of the interesting questions for research are whether externalities are present and what are the sources of externalities for firms in developing economies, which have undertaken policy reforms towards freer markets? Externalities should be more significant in those developing economies, which have been able to enhance their aggregate economic growth rates in response to policy reforms than those economics that remain stagnant. Growing markets result in increase in investments and technological activities by private firms, which should augment aggregate stock of knowledge and result in externalities for individual firms (Katz, 1985, Aggarwal, 2000). At the same time, growth of markets is also a result of increase in technological dynamism, which reduce costs of production and increase in real incomes and demand for differentiated products. These cumulative dynamics can be given impetus in developing economies by the policy reforms towards freer markets and openness to trade and investment provided the countries in consideration are endowed with a critical level of initial conditions for market reforms to increase competitive conditions and drive firms to undertake deliberate technological and market enhancing efforts.

Indian industry is an interesting case study for the above questions because it has been able to augment its growth rate in response to the policy reforms initiated in the mid 1980s and accelerated from 1991 (Ahluwalia, 2002). Apart from this, India is one of the few developing economies, which built a large industrial base and a critical level of technological capabilities in terms of large pool of skilled manpower and technological institutions through the import substitution policies pursued from 1950 to 1991 (Katrak, 2002). The previous policies also led to significant presence of matured private sector firms in several industries. These endowments function as the critical initial conditions on the basis of which the market reforms generate growth dynamics. These factors determine not only the firm level abilities to undertake their own technological efforts but also the ability to absorb externalities (Cohen and Levinthal, 1989; Lall, 1992) emanating from several elements of market dynamics instilled by the reforms.[1] A few recent studies have documented that the policy reforms in India have not only increased exposure to international trade and multinational investment but also increased competitive markets, which drove firms to undertake systematic technological efforts in several Indian industries (Aggarwal, 2002, Patibandla, 2002).

Externalities are allusive for empirical measurement because externalities imply positive contribution of factors or inputs that are not explicitly paid for a firm's productivity. It is problematic to capture this into functional forms for econometric estimation, especially when one works with production or cost functional forms. Furthermore, there could be several sources of externalities operating with simultaneous effects. For example, a growing market results in technological and pecuniary externalities owing to increase in market size and transactions resulting in learning, imitation and spillovers of best practices at the firm level. The quantitative variables such as industry level output and growth reflect both the effects simultaneously and it is rather difficult to separate the effects. Because of these empirical

[1] See Aggarwal (2000), Katrak (2002) and Ahluwalia (2002) for a detailed discussion of the policy reforms in India and their effect on industrial structure.

complexities, the best one can do is to test empirically for their presence and some of the possible sources.

This paper empirically tests for the presence and sources of externalities on the basis of firm level panel data for 12 Indian industries for the post-reforms period of 1989-1999. This paper estimates firm level productivity indices on the basis of Farrell's production frontier and regresses the indices against a set of variables that capture different sources of externalities. The results indicate significant presence of externalities in Indian industries arising out of expansion of industrial level output and aggregate industry level R&D stock. The plan of the paper is as follows. In Section 2, some of the methodological issues are discussed. Section 3 presents the empirical analysis and Section 4 presents the concluding remarks.

2. Methodological Issues

In production function framework, $Y = T(X, e)$, where Y the observed output of a firm is a function of its own input vector X and e a set of variables through which all the possible externality effects work on Y. Externalities can arise from different sources. In Marshal's characterization, externalities operate at the industry level- a larger industry supports production of a larger base of intermediate inputs. This results in downward shift in the cost curves of final goods producers. In this case, the industry output enters an individual firm's production function in capturing the external economies (Krugman, 1989).

The literature on technological innovation and externalities pioneered by Griliches (1979) aims at capturing public goods properties of private innovative activities for understanding technological diffusion and social returns on R&D. Apart from the effect of a firm's own effort at R&D, most of the increase in total factor productivity can be traced back to externalities arising out of other firms' technological efforts. In this framework, the aggregate industry investment on R&D enters individual production function in capturing technological externalities. Following the seminal work of Griliches (1979, 1995), several authors tested for the presence of R&D spillovers by estimating augmented Cobb-Douglas production functions in which R&D stock enters as an additional input. This work has been extended to cross-border technology diffusion by introducing investment in R&D, technology purchase, import of intermediate and capital goods and the degree of presence of multinational firms into the firm level production functions (Coe and Helpman, 1995; Keller, 1998, Aitken and Harrison, 1999; see Keller, 2001 for a review of these streams).

In the case of Indian industry, works of Ferrantino (1992) Raut (1995) and Basant and Fikkert (1996) have studied the issue. Ferrantino uses a panel data for the pre-reform period of 1975-81 and tests for the effect of R&D and foreign technology purchase on the productivity of firms by estimating cost functions augmented with R&D and technology purchase. He found that firms with higher technology expenditure were less productive than others, which was interpreted in terms of high transaction costs in technological activities owing to pervasive government controls. On the other hand, Basant and Fikkert (1996) estimated augmented Cobb-Douglas functions on the basis of a panel of 1974-75 and 1981-82 for a sample of Indian manufacturing firms. The production function was augmented with technology purchase by firms from overseas and firms' own and other's R&D expenditure. They found that technology purchase contributed significantly to firm's output while there was no evidence of gain through spillovers or from own R&D. They interpreted the difference between their results and Ferrantino's by suggesting that the production function specification does not impose the condition of cost- minimizing behavior. The estimation of cost function for the Indian industry suffer from measurement errors in the input prices and secondly Indian firms in the pre-reforms period were subjected several policy controls which restricted their ability to minimize costs. Raut (1995) used firm level panel data for the years 1976-1986 for three broad groups of industries, namely light, petrochemical and heavy industries, and estimated augmented Cobb-Douglas functions to test for R&D spillovers. Following Griliches (1979), Raut assumes that like physical capital and labor, R&D capital of firm which is the discounted sum of the past R&D investment streams and industry level R&D stock as the additional factors of production. He found that individual firms gain significantly from the aggregate industry level R&D capital in all except petrochemical industries.

The focus of the above studies is the R&D and technology purchases of firms in testing for presence of technological externalities and they referred mostly to the Indian industrial sector in the pre-reforms period. As mentioned in the previous section, the post reforms India presents highly dynamic market conditions in terms of increased economic growth rate, increase in competition and exposure to international trade and multinational investment. Apart from the firm and industry level R&D activities, the other factors such as increasing presence of multinational firms and openness to international trade could be important sources of externalities in interrelated way. For example, increasing presence of multinational firms increase competitive market conditions which drive local firms to undertake technological efforts to compete (Patibandla, 2002) and also presents increased opportunities for imitation and spillovers. It is important to incorporate these factors in the empirical specifications as exclusion of any of these factors could result in a misspecification of the process.

As discussed above, several empirical studies adopt augmented production or cost functional forms to test for presence of externalities. There are certain problems associated with augmenting production functions by including externality-related variables as 'virtual' inputs. Although production and cost functions are basically technological constructs, the econometric estimation requires utilization of functional forms such as the Cobb-Douglas, the CES and the Translog. Production functional forms are derived with the assumption that firms maximize profits (which is the same as cost minimization subject to a given output level or maximization of output given the inputs employed). This assumption implies firms entail paying factors their marginal products. Unless an augmented production function contains inputs that are explicitly paid for, the implicit background assumption does not hold. In the case of own R&D stock or technology purchase, augmentation is on a better footing than in the case of unpaid externalities including industry level R&D stock.

An alternative procedure is proposed in this paper. To avoid heterodox interpretations of the production function, firm level relative efficiency indices (*TE*) are estimated on the basis of Farrell's production frontier approach using only paid inputs in the production function. At the second stage, it is postulated that the distance from the frontier for each firm, an index of its (in) efficiency, is functionally related to the vector e.

4. Empirical Analysis

The paper utilizes firm level panel data for 12 Indian industries for the period of 1989 to 2000 from the publications of the Center for Monitoring the Indian Economy (CMIE). Industries are: air-conditioners, auto ancillaries, communication equipment, electronic process control, commercial vehicles, motor cycles, motors and generators, passenger cars, refrigerators, tyres and tubes, and pharmaceuticals. In all of these industries there is strong presence of well-entrenched private firms making the question of spillover and local R&D meaningful. Since the initiation of reforms these industries have been subjected to increased competitive markets and to a fair degree of exposure to FDI and trade. In the case of air-conditioners, commercial vehicles, motorcycles, passenger cars, and refrigerators the sample covers the total population. The samples for auto ancillaries covers about 50 percent, communication equipment about 80 percent, electronic process controls about 90 percent, pharmaceutical industry about 60 percent and tyres and tubes about 80 percent of total industry sales. For these industries, total population is not covered in the data set because the samples include those firms that have reported data and information that is complete and consistent for the time period.

The panel data estimates allow controlling for unobservable (omitted) variables by using fixed effects and also capture market dynamics through the time series element. We adopt the fixed effects model in the econometric estimations. The fixed effects estimations accounts for dependency between factor inputs and technical efficiency parameter (Cheng, 1986). Instead of taking each firm as distinct in capturing fixed effects, we treat them belonging cohorts of different industries. This is because we take that externalities should be more significantly within a broadly defined industry rather than across industries and significance of externalities will be different in different industries. For example, technological externalities should be more significant in R&D intensive industries such as the pharmaceutical industry than low tech manufacturing industries. Industry dummy variables are used to control for the fixed effects.

Table 1 about here

Variables

V Value-added

L Salaries and wages

K Rental value of capital, (Plant and Machinery*interest rate)+ depreciation

RD A stock measure of R&D expenditure. Previous studies (Raut, 1995; Feinberg and Majumdar, 2001) took a four-year time lag following Griliches (1979) in constructing the RD stock. We take a five year lag as most firms in India invest very little in R&D and few of them in the sample started investing in R&D from the middle of 1990s probably owing to increased competitive conditions. The values are deflated with wholesale producer price indices and the depreciation rate used is 15 percent.

IRD Total R&D stock of an industry i.e., the sum of ***R&D*** across firms in a given industry

FE Percentage of foreign equity in a firm

FP A measure of foreign investment presence in an industry, $\Sigma F_i V_i / \Sigma V_i$

IM Import of intermediate and capital goods/ value added

EX Exports/sales

RYV Royalties and technical fees paid by firms for technology purchases normalized by value-added.

INIM Industry level *IM*/industry level value-added

INEX Industry level *EX*/ industry sales

INRYV Industry level *RYV*/ industry value-added

IV Total industry value-added values for each industry

Estimation of Technical Efficiency (*TE*)

We estimate firm level relative productivity indices on the basis of Farrell's (1957) production frontier approach. Farrell's method shows relative technical (in)efficiency (*TE*) as the extent of deviation of output realized by a firm (for a given level of inputs employed) from the best practice in an industry. Measuring TE on the basis of panel data overcomes shortcomings of the estimates

based on cross-sectional data (see Pitt and Lee, 1981). The panel data capture cross-sectional information of firms in an industry and also repeated observations over time for a given firm. This, in turn, overcomes the shortcomings of strong distributional assumptions about composed error terms. Apart from this, the method does not impose the assumption that technical efficiency is independent of factor inputs. The stochastic production frontier is utilized in estimating firm relative technical inefficiency (efficiency) indices which take values above 0 and less than 1.

By taking the Cobb-Douglas functional form, we can represent the technology as follows;

$$Y_{it} = \alpha + \beta X_{it} + v_{it} - u_i \qquad (1)$$

where Y_{it} is the observed output, X_{it} is a vector of inputs: i index firm (i=1....N); t index time (1....t). α and β are the unknown parameters to be estimated. v_{it} represents symmetrically distributed random errors. u_i represents technical inefficiency with one-sided distribution, which means that output must lie on or below the frontier. The random error v_{it} is assumed to be identically and independently distributed across firms and time with identical zero mean and constant variance. It is also assumed to be un-correlated with factor inputs. u, which represents *TE*, is modeled as half-normal or exponential distribution. Following Battese and Coelli (1995), firm level time-varying *TE* is estimated in which the inefficiency term is modeled as a truncated-normal random variable multiplied by a specific function of time. The model allows *TE* varies across firms and in time. The translog production functional form is adopted because it is less restrictive in assumptions in comparison to the Cobb-Douglas form. In the case of two industries in which the estimation of translog form gave statistically insignificant parameters, the Cobb-Douglas form is utilized. Value-added is taken as output and *K* (rental value of capital) and L (salaries and wages) as inputs. Value-added and capital values are normalized by the wholesale producer price indices and salaries and wages are normalized by the consumer wholesale price indices. The base year of the prices is 1994. The production function is estimated separately for each industry by the maximum likelihood technique to derive the firm level *TE* indices. The results of the estimation of the production function are given in Table 2. The results in general are statistically significant.

Table 2 about here

The Results

The econometric equations are estimated at two stages. In the equation 1, we include only industry level variables except for firm level R&D to test for the presence of externalities for firms emanating from industry level factors. Firm level R&D variable is introduced in the equation 1 under the argument that firms have to make their own technological efforts to absorb externalities emanating at the industry level (Lall, 1992; Aggarwal, 2000; Siddharthan and Safarian 1997; Katrak, 1997). In the second equation, additional firm level variables are introduced which will have direct effect on technical efficiency through paid inputs such as imports of capital goods and royalty payments. The inclusion of firm level variables reduces biases owing to omitted variables. As the industry level variables are basically aggregation of firm level variables for all firms in each industry, there could be multi-colinearity between industry and firm level variables. This could dampen the statistical significance of some of the relevant variables that reflect externalities. This could be especially significant in those industries, which are dominated by a few large firms such as the motorcycles and the light commercial vehicles. This two-stage process helps in testing for whether externalities are present through the industry level factors and their empirical significance. The estimated coefficients of the industry dummy variables are not presented.

1. $TE = 0.70 + 0.00072\ (RD) + 0.00016\ (IRD) + 0.000002\ (IV) + 0.24\ (FP)$

$(17.6)^{*}\quad (2.82)^{*}\quad (2.35)^{*}\quad (1.46)^{**}\quad (2.14)^{*}$

$+1.74\ (INRYV)\ - 0.02\ (INIM)\ - 0.13\ (INEX)$

$(1.6)^{**}\quad (0.12)\quad (0.73)$

Adjusted $R^2 = 0.57$ F = 119 N = 1472

The above results show high degree of statistical significance indicating presence of externalities emanating from industry level factors for firm level productivity. The estimated coefficients of the industry R&D stock and industry aggregate output are positive and statistically significant indicating presence of externalities through the expansion of industry level research and development (R&D) investments and output. As mentioned before, externalities should be more significant in growing industries than stagnant ones. The column 4 of the Table 1 presents the average growth rates of industry level value-added for the sample of the industries for the period of 1989 to 1999. All industries in consideration show double digit growth rates and industries such as the motorcycles, refrigerators and the communication equipment show growth rate above 20 percent.

The estimated coefficient of firm level R&D investments is positive and statistically significant which can interpreted that higher firm level investments in R&D contribute directly to productivity and also determine the ability of firms in internalising externalities. Another notable result is the one associated with the industry level expenditure on royalties and technical fees. Investment in R&D and expenditure on technological purchases reflect the technological activism of firms in an industry in terms of internal R&D investment and purchase of technological licenses and blueprints from developed economies. High degree of these activities at the industry level should contribute to increase in aggregate stock of knowledge and presence of externalities.

The results associated with industry level export and import orientation variables are statistically insignificant which suggests there may not significant presence of externalities at industry level trade orientation. However, in the estimation of the equation 2, we test for the effect of firm level export and import orientation on productivity.

One of the notable results is that the estimated coefficient of the degree of multinational (foreign) presence is positive and statistically significant indicating presence of externalities through foreign direct investment (FDI). FDI can result in externalities in two ways. One is that increasing presence of MNCs may expand the product and input markets, thereby supporting production of larger base of differentiated intermediate products. The second mechanism is generation of technological externalities similar to aggregate industry R&D investment. This is because MNCs from developed economies bring in modem technologies into developing economies, which, in turn, result in technological spillovers to local firms (Gonclaves, 1986, Blomstrom, and Kokko, 1998; Aitken and Harrison, 1999, Patibandla and Petersen, 2002).

2. $TE = 0.69 + 0.0005\ (RD) + 0.00018\ (IRD) + 0.000001\ (IV) + 0.25\ (FP)$

$(17.3)^{*} \quad (2.13)^{*} \quad (2.83)^{*} \quad (0.74) \quad (2.26)$

$+ 1.12\ (INRYV) - 0.\ 0.9\ (INIM) - 0.13\ (INEX) + 0.001\ (FE)$

$(1.06) \quad (0.18) \quad (0.17) \quad (6.85)^{*}$

$+ 0.02(\ IM) + 0.05\ (EX) + 0.03\ (RYV)$

$(1.46)^{**} \quad (2.0)^{*} \quad (4.7)^{*}$

Adjusted R2 = 0.60   F = 107   N = 1472

The results of the equation 2 for the industry level variables are similar to those in the equation 1 for the signs of estimated coefficients with similar implications. However, the estimated coefficients of the industry level output (*IV*) and industry level royalties variables (*INRYV)* turned out to be statistically insignificant owing to multicolinearity arising out of introduction of additional firm level variables. This is indicated by the result that the F value of the equation 1 shows a higher value than that of the equation 2.

The interesting aspect of the results of the equation 2 is that the estimated coefficients of all the firm level variables are statistically significant and have appropriate signs. The estimated coefficient of *FE* variable is positive indicating that firms with higher foreign equity embedded in them realize higher technical efficiency. This result along with the result associated with *FP* (degree of foreign presence in an industry) variable can be interpreted that multinational firms' advantages in intangible assets makes them more efficient than local firms in developing economies. As intangible assets have public goods properties, increasing presence of MNCs results in externalities to firms in general.

The estimated coefficients of firm level export and import orientation and royalties and technical fees variables are all positive. This shows that firm level trade orientation contributes positively to firms' productivity although there is no evidence of externalities out of the degree of industry level trade orientation. Firm level imports (*IM*) and royalties and technical fees (*RYV*) are paid inputs, which have direct bearing on technical efficiency. Externalities for these variables occur when these inputs cost less than their opportunity cost, which includes the R&D costs of product development (Keller, 2001).

Firm level exports variable (*EX*) is not an input but a sales decision of firms with not direct effect on productivity. Exports can be based on comparative advantage reasons and also for extending market size, which is especially germane for industries with high fixed costs of production and R&D. In other words, experts by extending market size helps firms to realize economies of scale with implications on technical efficiency. In dynamic terms, exports engender learning economics both internal and external to firms. Apart from this, for firms exporting from developing economies, it may reduce the idea gap (Romer, 1990) by exposing producers to efficient production and marketing practices of developed economies.

4.Conclusion

Positive externalities should be significant in growing industries than in the stagnant ones. Several Indian industries have been able to augment their growth in response to the policy reforms towards more competitive and open markets initiated in the mid-1980s. Apart from this, India can be considered one of the few developing economies, which acquired the critical level of (initial conditions) technological capabilities through previous import substitution policies. The initial conditions determine firm level abilities to absorb externalities of growth dynamics and increasing exposure to international trade and investment.

Externalities are allusive for empirical measurement owing to theoretical problems in incorporating unpaid inputs into functional forms for econometric estimations. At best one can do is to test for their presence and possible sources. This paper has tested for their presence in a sample of Indian industries for the post-reforms period. Firm level relative efficiency indices are estimated on the basis of Farrell's production frontier approach using only marketed inputs in the production function. Thereafter, relative efficiency is regressed against a set of externality-related variables. The results on the whole show significant presence of external economies through increasing industry level aggregate R&D stock and also from expansion of industry level aggregate output. The external economies get accentuated through increasing exposure to international investment and trade.

References

Aggarwal, A., 2002, 'Liberalization, Multinational Enterprises and Export Performance: Evidence from

Indian Manufacturing', the Journal of Development Studies, 38 (3), 119-137.

Aggarwal, A., 2000. Deregulation, technology imports and in-house R&D efforts: an analysis of the Indian experience. Research Policy 29 (9), 1081-1093.

Ahluwalia, M.S., 2002, Economic reforms in India: has gradualism worked? The Journal of Economic Perspectives 16 (3), 67-88.

Aitken, B., Harrison, A., 1999. Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. American Economic Review 89 (3), 605-18.

Basant, R., Fikkert, B., 1996. The effects of R&D, foreign technology purchase, and domestic and international spillovers on productivity in Indian firms. Review of Economics and Statistics 78 (2), 187-99.

Battesse, G.E. Coelli T. (1995), 'A model for technical inefficiency effects in a stochastic frontier production function for panel data' Empirical Economics, 20, 325-332.

Blomstrom, M., Kokko, A., 1998. Multinational corporations and spillovers. Journal of Economic Surveys 12, 247-277.

Cheng, H. 1986. *Analysis of panel data*. Cambridge University Press, Cambridge.

Coe, E., Helpman, E., 1995., International R&D spillovers. European Economic Review 39, 859-887.

Cohen, W., Levinthal, D., 1989., Innovation and learning: the two faces of R&D. Economic Journal 99, 569-596.

Farrell, M., 1957., The measurement of production efficiency. Journal of Royal Statistical Society

A 120, (3), 253-281.

Feinberg, S.E., Majumdar, S.K., 2001. Technology spillovers from foreign direct investment in the Indian pharmaceutical industry. Journal of International Business Studies 32 (3), 421-437.

Ferrantino, M.J., 1992., Technology expenditures, factor intensity, and efficiency in Indian Manufacturing. Review of Economics and Statistics 74, 689-700.

Griliches, Z., 1995., R & D and productivity: econometric Results and measurement Issues, in Stoneman, P (eds), Handbook of the Economics of Innovation and Technological Change, Blackwell. Oxford, pp. 52—89.

Griliches, Z., 1979., Issues in assessing the contribution of research and development to productivity growth. Bell Journal of Economics 10, 92-116.

Grossman, G., Helpman, E., 1991. Innovation and Growth in the World Economy, Cambridge, MIT Press.

Katrak, H., 2002. Does economic liberalization endanger indigenous technological developments? An analysis of the Indian experience, Research Policy, 31, 19-30.

Katz, 1985. Domestic technological innovations and dynamic comparative advantages: further reflections on a comparative case-study programme. In Rosenberg, N., Frishtak, C. (Eds), International Technology Transfer: Concept, Measures and Comparisions: Praeger Publishers, pp. 127-166.

Keller, W., 2001. International Technology Diffusion, NBER Working Paper, 8573

Krugman, P., 1989. Scale economies, product differentiation, and the pattern of trade. American Economic Review 70, 950-59.

Lall, S., 1992., Technological capabilities and industrialization. World Development 20 (2), 165-186.

Lall S., Siddharthan NS. 1982. The monopolistic advantages of multinational firms: lessons from foreign

investment from the US. Economic Journal 92, 668-83.

Patibandla, M., 2002. Policy reforms and evolution of market structure: the case of India. The Journal of

Development Studies. 38(3), 95-118.

Patibandla, M., Petersen, B., 2002. Role of transnational corporations in the evolution of a high-tech

industry: the Case of India's software industry. World Development, 30 (9), 1561-1577.

Pitt, M., Lee, L., 1981. The measurement and sources of technical efficiency in the Indonesian weaving industry. Journal of Development Economics 9, 43-63.

Raut L K., 1995. R&D spillover and productivity growth: Evidence from Indian private firms, Journal of Development Economics, 48, 1-23.

Romer, Paul., 1990. Endogenous technological change. Journal of Political Economy 98, S71-S102.

Siddharthan, N.S., Safarian, A.E., 1997. Transnational corporations, technology transfer and import of capital goods: the recent Indian experience. Transnational Corporations, 61, 31-49.

UNCTAD, 2001. The world investment report: promoting linkages, United Nations, New York.

Young, A., 1991. Learning-by-doing and the dynamic effects of international trade, Quarterly Journal of Economics, 369-405.

Table 1: The Sample

Industry	# Firms	# Observations	% Average growth rate of industry value-added	% Average Exports to sales (EX)	% Average Imports to sales (IM)
Air conditioners (AC)	5	54	19.09	3.37	7.45
Auto Ancillaries (AA)	22	252	19.4	6.75	9.44
Communication Equipment (CE)	22	227	23.2	7.45	14.71
Electronic Process Control (EP)	5	52	13.9	4.65	12.45
Light Commercial Vehicles (LC)	5	60	17,9	6.08	9.01
Motor Cycles (MC)	4	48	24.1	2.4	5.16
Motors and Generators(MG)	6	66	17.12	6.44	14.1
Passenger Cars (PC)	7	58	17.1	5.89	12.33
Refrigerators (RG)	4	47	25.2	3.76	9.32
Tyres and Tubes (TT)	19	197	16.0	7.82	9.53
Pharmaceuticals (PH)	38	409	19.64	12.9	10.58

Note: The industry level values are taken from the CMIE publications of industry level data. The averages for the period of 1989 to 1999

Table 2. The Estimated Production Functions

Industry	Constant	log L	log K	½ log L^2	½ log K^2	log L* log K	Log-likelihood
AC	2.27	0.88	-0.51	-0.55	-1.3	0.59	47.28
	(0.48)	(8.17)*	(2.34)*	(1.6)**	(4.1)*	(1.8)**	
AA	55.1	0.94	-0.20	0.39	0.45	-0.47	205
	(0.17)	(10.45)*	(2.24)*	(2.09)*	(4.81)*	(4.18)*	
CE	0.62	0.71	0.22	0.29	0.31	-0.30	87.95
	(15.2)*	(9.1)*	(3.9)*	(2.24)*	(2.06)*	(2.28)*	
EP	0.87	1.1	-0.52	-0.08	1.3	-0.56	26.83
	(9.8)*	(5.7)*	(1.8)**	(0.33)	(2.58)*	(1.7)**	
LC	1.2	0.43	0.28				47
	(11.4)*	(3.0)*	(1.97)*				
MC	-0.33	1.2	0.01				75
	(3.0)*	(16.2)*	(1.48)***				
MG	0.93	-0.97	0.30	-0.2.0	-1.0	1.06	60
	(12.4)*	(2.56)*	(3.16)*	(6.2)*	(3.3)*	(3.99)*	
PC	0.19	0.65	0.72	0.93	0.68	-0.87	22.47
	(2.94)*	(4.2)*	(13.6)*	(2.59)*	(3.6)*	(2.93)*	
RG	0.49	1.0	0.17	0.46	0.27	-0.51	42
	(15.22)*	(7.1)*	(1.87)**	(1.84)**	(1.47)***	(2.44)*	
TT	0.85	-0.13	0.85	-1.5	-0.79	1.0	69
	(15.8)*	(1.0)	(5.5)*	(8.9)*	(3.5)*	(5.5)*	
PH	1.4	0.58	0.22	-0.36	-0.14	0.18	404
	(6.5)*	(18.5)*	(9.1)*	(5)*	(2.0)*	(3.1)*	

Note: Figures in parentheses are t-values. * significant at 1% level; ** significant at 5% percent level; *** significant at 10% level. (See Table 2 for number of observations for each industry).