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Trade Liberalization, Imported Inputs and Factor Efficiencies: Evidence from the Auto Components Industry in India

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Abstract: Firm-level data have been used to estimate changes in factor efficiencies—imported inputs being one of them-- over three sub-periods, 1977-84, 1985-91 and 1992-99 respectively denoting eras before liberalization, partial liberalization of the automotive industries and economy-wide liberalization. We see that the average size of firms has increased from that in the protected regime as the degree of liberalization has advanced. We find that the substitutability among inputs changed over the three sub-periods. We also find that the marginal products of all the inputs are very heterogeneous among firms in each period. The distributions of marginal product of labour and domestic materials and has moved to the left in the later periods while that of capital has moved to the right. The distribution of marginal product of imported materials first moved to the right and then to the left as compared to the first period. Overall the smaller firms benefited more in the earlier periods and bigger ones in the last period.

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1. Introduction

The opening up of many countries in the last two decades has made it possible to empirically explore theories of gains from trade. A number of studies have examined the relationship of productivity and liberalization. Results have been mixed[1]. For some countries like Japan, South Korea, Turkey, Yugoslavia, Morocco and Chile studies have found a positive correlation while for some other countries like Bolivia, Sri Lanka, Malawi and India there is no compelling evidence. A few studies have tried to test for the mechanism of efficiency gain after liberalization. Tybout and Westbrook (1995) found insignificant gains from scale effects but significant gains due to reductions in average cost. Harrison (1994), Levinsohn (1993), Roberts and Tybout (1996), and Krishna and Mitra (1998) focussed on gains from increased competition. Our focus is to explore another channel of change long emphasized in the theoretical literature; namely the effect of imported inputs (see Bardhan and Lewis (1970)).

Almost all of the above studies treat productivity as the residual in the production function (Solow's TFP measure) and hence changes in productivity over time is treated as neutral efficiency changes. Since imported inputs are likely to also change factor efficiencies the change in the production function estimates over time is also important. We focus on both aspects of productivity change – the neutral and the factor augmenting.

Most of the previous studies have examined a broad class of industries whereas we focus on one specific industry. The pay off of the narrow focus is that we were able

[1] For instance, Nishimizu and Robinson (1984), Haddad (1991) found positive association between liberalization and productivity for Japan, South Korea, Turkey, Yugoslavia and Morocco while Jenkins (1995), Weiss and Jayanthakumaran (1995), Mulaga and Weiss (1996), and Srivastava (1996) found no such effects for Bolivia, Srilanka, Malawi and India respectively.

to obtain output price information for these firms and hence reliable data on output[2]. As pointed out by Tybout (2000) this is one of the important outstanding problems in productivity measurement. Our choice of auto components is good because raw material is the most important factor of production (in terms of its share in total revenue) and it can respond fairly quickly to policy changes. Further, this industry has been subject to a small-scale liberalization in 1984 followed by the economy-wide liberalization in 1991. So we have regimes of various levels of liberalization that can be studied. We estimate productivity changes over 1977-84, 1985-91 and then for 1992-99.

2. Industry Background and Data

The hallmark of Indian industrial policy after independence was its restrictive nature. Automobile and auto-components were no exception. Under the restricted policy regime the industry was regulated by different government policies among which licensing and trade policies were the main elements. Licenses were required to establish, to expand, to diversify, and to change location of plants. In 1965, about 80 auto-components were reserved for the exclusive production in the small-scale sector. Big industrial houses and firms with more than 25% of market power were required to get permission from the Monopolies and Restrictive Trade Practices (MRTP) Commission from 1969 onwards. Firms with more than 40% foreign equity were further scrutinized under the Foreign Exchange Regulation Act (FERA) 1973. A number of restrictions have been implemented in order to protect the domestic industries from imports. An important one being the rule that the item imported must not be produced by any of the domestic producers. In the case of imports of intermediate goods the phased

[2] Previous studies have used real sales as a measure of output.

manufacturing condition must be satisfied. It means that firms had to substitute at least 90% of imported inputs with the domestic ones within five years of import (known as the phased manufacturing program). Most of the intermediate and capital imports were placed in restricted list of imports, which meant that import of these items has to pass beaurocratic hurdles. Import licenses were issued based on the foreign exchange availability at that time. After satisfying all the conditions the importer has to pay tariffs set by the Government, which were higher than international standards.

In 1985 Auto-components industry was delicensed for non-MRTP and non-FERA companies. Later in the same year both automobile and components industries were exempted from the MRTP rules. Broad banding scheme, which allowed to diversify into related products without obtaining new licenses, was introduced in automotive industry in 1985. Besides these policy changes, the arrival of Maruti Udyog Ltd., (MUL) a collaboration between Indian Government and Suzuki Motor Corporation of Japan in 1983 brought a sea change in the Indian automotive industry. MUL promoted a number of components units in collaboration with the Japanese component suppliers of Suzuki in Japan. New firms also were established with technology and financial collaboration with foreign firms. The quality standards enforced by the Japanese and other collaborators forced the domestic component firms to achieve high standards and compete with each other.

In 1991 economy wide liberalization process was undertaken with different liberalization measures. Industrial licensing policies were totally abolished for auto components and vehicle industries (except passenger cars segment which was delicensed in 1993) in 1991. Automotive industry was identified as a priority sector where automatic approval for 51% foreign equity was to be given. Customs duties were cut; import restrictions on raw materials and capital goods were removed. Number of items reserved for small-scale units were also reduced. Phased manufacturing program was abolished. It must be remarked that in spite of all the liberalization it is not easy for losing firms to exit due to our labor laws. Hence the sample selection bias in measuring productivity does not arise (see Olley and Pakes (1996)).

The data sources and compilation are explained in the appendix. Here we examine the nature of the annual data on firms over time. The variables of interest are output, labor, domestic raw materials (DM), imported raw materials (IM), and capital (K). Table 1 provides the movement of means and medians over time. The relationship of the mean and median will reveal the nature of skewness of the size distribution of firms.

Table 1: Nature of the Data on the Auto-components Industry

Period	No.of obs.	Output Mean-median		Labor Mean—median		DM Mean—median		IM Mean—median		K Mean--median	
1977-84	213	1128	571	1298	502	517	265	111	27	621	335
1985-91	265	1298	662	985	423	533	312	191	58	843	473
1992-99	346	2486	1202	946	377	1033	550	184	48	1350	646

Labor is the number of employees. Other variables are in ’000 s of 1981-82 Rupees.

Table 2: Nature of the Data on the Automobile Industry

Period	No. of obs.	Output Mean--median	Labor Mean-median	DM Mean--median	IM Mean-median	K mean-median

1977-84	102	11598	5020	9077	3836	7076	2703	871	264	5133	1557
1985-91	108	18060	7930	9399	3225	8901	3918	1919	1195	8474	3426
1992-99	126	33259	11905	8669	2206	17852	6530	1931	1161	12580	4099

In both industries we see that the average size of firms has increased from that in the protected regime as the degree of liberalization has advanced. The median values are lower than the means indicating that the size distribution is skewed right. There are a large number of small firms. Employment has consistently gone down (except the mean for auto industry) while domestic raw material use has increased almost doubling in the second to the last period. Surprisingly, however, imported materials increased after the initial liberalization but declined (in median only for auto) after that indicating substitution of domestic materials for imported ones.

The median is the middle value. It tells us that one half of values higher than it and other half lower than it. It is less affected by extreme values. So hence forward we only give the median values. In Table 3 and Table 4 we present the average factor productivities with liberalization. Output per unit of labor is steadily increasing with liberalization in both industries. Employment per unit of output is declining sharply with liberalization but the average productivity of other factors in both industries is non-monotonic with liberalization. The reasons may lie in the nature of complementarity and substitutability of the various factors. Hence we need to examine the production function estimates.

Table 3: Average Factor Productivities in the Auto Components Industry

Period	Labor median	DM Median	IM median	K Median
1977-84	1.10	2.02	17.67	2.05

1985-91	1.57	2.09	11.89	1.57
1992-99	3.08	2.16	28.52	1.99

Table 4: Average Factor Productivities in the Automobile Industry

Period	Labor median	DM Median	IM median	K Median
1977-84	1.27	1.61	18.03	2.77
1985-91	1.99	2.03	11.75	2.27
1992-99	5.45	1.95	15.86	3.06

3. Econometric Methodology

Productivity can be studied by estimating the production function directly or by estimating the cost function. Mundlak (1996) has shown that the former approach is more efficient for productivity measurement and so we adopt it. There is no compelling reason to assume the commonly used Cobb-Douglas production function with its restrictions on the degree of substitution among factors. On the other hand, given that we have four factors and the number of observations in each regime is insufficient for non-parametric estimation such as kernel, we adopt an intermediate approach. We use the translog production function, which is a second-order approximation of the production function and carries the Cobb-Douglas as a special case.

Let Y_{it} be the logarithm of output (or value added) of firm i in year t. Analogously defining L_{it} , K_{it}, DM_{it} and IM_{it} the translog production function can be written as:

$$Y_{it} = ß_L L_{it} + ß_D DM_{it} + ß_I IM_{it} + ß_K K_{it} + ß_{LL} \tfrac{1}{2} (L_{it}^2) + ß_{DD} \tfrac{1}{2} (DM_{it}^2)$$

$+ \beta_{II} \frac{1}{2} (IM_{it}^2) + \beta_{KK} \frac{1}{2} (K_{it}^2) + \beta_{LD} L_{it} DM_{it} + \beta_{LI} L_{it} IM_{it} + \beta_{LK} L_{it} K_{it}$

$$+ \beta_{DI} DM_{it} IM_{it} + \beta_{DK} DM_{it} K_{it} + \beta_{IK} IM_{it} k_{it} + \varepsilon_{it}, \qquad (1)$$

$i=1,\ldots\ldots,N, \qquad t= 1,\ldots\ldots, T_i$

$$\varepsilon_{it} = \alpha_i + u_{it} \qquad (2)$$

The neutral efficiency differences are in ε_{it} , which may be further modeled in terms of α_i plus an error. The α_i 's fixed effect or random effects.

Since it is very hard to defend the uncorrelatedness of the inputs and the unobserved productivity that is included in the error term the random effects approach is not adopted. Since each time-period is relatively short it may not be unreasonable to assume that firm-efficiencies are constant over each period. So we follow a fixed-effects approach for estimating (1) for each of the periods. In the fixed effects approach when we take the first differences of (1) to get rid of the α_I 's the remaining error term may still be correlated with the inputs. Hence we augment the usual fixed effects with instrumental variable estimator and use the Arellano and Bond (1991) approach to get efficient estimates using the generalized-methods of moments estimator (GMM).

4. Results

We estimate the translog production function specified in (1) using both fixed effects (FE) and GMM estimators and the results are given below in Table 5. The Hausman test rejected the fixed effects model. So we base our results on the GMM estimates. The individual coefficients do not have the interpretation of elasticities, which have to be computed. But the signs of interaction coefficients indicate substitution and complementarity possibilities between inputs. The explanatory power of the model is good as shown by the value of R^2 . For the GMM the R^2 is a pseudo - R^2 computed by regressing value added on its predicted value.

Labor and domestic material inputs interaction, $ß_{LD}$, is insignificant in the first but in the second period they are complements whereas in the third period they are substitutes. Labor and imported materials are found to be complements in all the three periods. Capital and labor are complements in the first two periods but no such relationship seems to exist in the last period. Domestic and imported materials are substitutes in the first period and for the later two periods their interaction terms, $ß_{DI}$, coefficient is not significant. Capital and domestic materials are found to be substitutes in the first two periods and in the third period the coefficient is not significant. Capital is substitute for imported material in the first period but no relationship exists in the latter two periods. On the whole, except labor, imported material input is a substitute for all other factors in the first period. In the latter two periods its interaction with domestic materials and capital is not statistically significant. In the second period, labor is a complement of both imported and domestic material inputs. However in the third period the labor and imported materials are found to be complements whereas labor and domestic materials are found to be substitutes. Overall we see that the technological relation among the inputs has been changing when we move from a closed economy to a partially open and then to a fully open economy.

Table 5: Production Function Estimates for the Auto Components Industry

	1977-84 FE--------------GMM	1985-91 FE--------------GMM	1992-99 FE--------------GMM

β_L	1.37 (3.03)	1.05 (6.29)	0.08 (0.26)	-5.54 (4.31)	0.38 (2.28)	4.46 (19.35)
β_D	0.17 (0.64)	0.99 (24.94)	1.06 (5.37)	2.25 (2.74)	0.41 (3.49)	-1.13 (12.54)
β_I	0.27 (2.81)	-0.09 (4.39)	0.20 (2.33)	-1.48 (3.99)	0.28 (6.73)	-0.52 (3.53)
β_K	0.48 (2.86)	-1.27 (22.19)	-0.33 (2.69)	-0.86 (2.97)	0.06 (0.49)	0.43 (3.04)
β_{LL}	0.03 (0.19)	-0.28 (5.3)	0.01 (0.09)	-0.05 (0.16)	0.17 (2.14)	-0.37 (1.96)
β_{DD}	0.21 (2.52)	0.34 (4.16)	0.13 (2.01)	-0.40 (5.09)	0.18 (4.24)	0.39 (7.26)
β_{II}	0.06 (7.06)	-0.004 (0.84)	0.04 (5.38)	0.09 (4.61)	0.01 (3.0)	-0.08 (28.3)
β_{KK}	0.01 (0.95)	0.06 (11.4)	-0.03 (1.33)	0.01 (0.14)	0.06 (2.96)	-0.11 (2.92)
β_{LD}	-0.11 (1.05)	-0.17 (3.04)	-0.15 (2.48)	0.45 (2.75)	-0.12 (2.09)	-0.40 (5.57)
β_{LI}	-0.01 (0.34)	0.31 (12.34)	-0.01 (0.31)	0.12 (2.28)	0.02 (1.35)	0.09 (4.15)
β_{LK}	-0.11 (2.51)	0.22 (13.72)	0.09 (2.61)	0.35 (4.34)	-0.07 (2.29)	0.06 (0.91)
β_{DI}	-0.06 (2.37)	-0.23 (15.05)	-0.05 (2.97)	0.06 (0.81)	-0.08 (5.08)	-0.01 (0.38)
β_{DK}	0.01 (0.70)	-0.08 (6.37)	0.00 (0.06)	-0.23 (3.37)	0.005 (0.20)	0.12 (1.64)
β_{IK}	0.01 (0.68)	-0.08 (9.54)	0.01 (0.83)	0.003 (0.09)	0.01 (1.67)	0.01 (0.39)
R^2 (pseudo)	.87	.94	.89	.83	.86	.94

In order to examine the factor efficiencies we now turn to the elasticity estimates. Tables 6 and 7 give the elasticities and marginal products of output with respect to labor respectively. It shows that one percentage change in number of employees increased median output by 0.3% in the first period and 0.53% in the second and third periods [3]. The negative minimum values shows that there are firms with negative labor productivity. In fact the variance in labor productivity among firms is quite large. The heterogeneity in factor efficiencies is quite striking. Even though the median is positive there are firms with negative labor productivities. The distribution of the marginal product of labor has shifted to the right in the third period as compared to those in the previous periods.

Table 6:Elasticities of Output with Respect to Labor

Period	Min	Max	Median	Std
1977-84	-0.96	2.43	1.31	0.52
1985-91	-0.93	1.46	0.53	0.52
1992-99	-0.31	2.22	0.53	0.40

Table 7:Marginal Product of Labor

Period	Min	Max	Median	Std
1977-84	-1.73	5.34	1.28	0.90
1985-91	-1.51	5.57	0.79	1.20
1992-99	-1.11	15.98	1.35	1.77

Table 8 and 9 respectively give the elasticity of output with respect to domestic materials and its marginal product. The median elasticity of output with respect to domestic materials and its marginal product remained almost same in the second period before falling substantially in the third period. The distribution of both shifted to the left in the second and third periods.

Table 8:Elasticities of Output with Respect to Domestic Materials

[3] In all our tables hence forth, there is no significant difference in the mean and median values.

Period	Min	Max	Median	Std
1977-84	-0.49	1.61	0.37	0.39
1985-91	-0.83	1.48	0.38	0.41
1992-99	-0.89	1.06	0.06	0.35

Table 9:Marginal Product of Domestic Materials

Period	Min	Max	Median	Std
1977-84	-2.04	4.57	0.80	0.81
1985-91	-19.20	3.34	0.78	1.83
1992-99	-39.16	2.11	0.13	3.00

Elasticity of output with respect to imported materials is shown in Table 10, is found to be negative in the first and last periods while it is positive for the second period. Surprisingly, the distribution has shifted substantially to the left in the last period. The situation is different when we consider the distribution of marginal product of imported material. The median value is the lowest in the third period but the distribution of productivity in the third period has shifted substantially to the right as compared to the second period but left as compared to the first period.

Table 10: Elasticities of Output with Respect to Imported Materials

Period	Min	Max	Median	Std
1977-84	-0.43	0.54	-0.06	0.14
1985-91	-0.38	0.49	0.12	0.16
1992-99	-0.66	0.07	-0.23	0.15

Table 11:Marginal Product of Imported Materials

Period	Min	Max	Median	Std
1977-84	-111.07	61.19	-0.54	11.82

1985-91	-366.75	4.43	0.91	35.07
1992-99	-156.16	21.26	-2.93	17.20

Elasticities of output with respect to capital are given in Table 12. It is negative for the first period and positive and increasing for the second and third periods. Its distribution has also been shifting to the right with the degree of liberalization. In Table 13 we see that marginal product of capital was extremely low when the economy was closed. Even though the median value does not show substantial change, the distribution of marginal product has significantly moved to the right.

Table 12: Elasticities of Output with Respect to Capital

Period	Min	Max	Median	Std
1977-84	-0.53	0.54	-0.07	0.24
1985-91	-0.28	0.86	0.18	0.23
1992-99	-0.19	1.12	0.59	0.25

Table 13:Marginal Product of Capital

Period	Min	Max	Median	Std
1977-84	-393.28	0.03	-0.01	28.59
1985-91	-0.15	0.52	0.01	0.07
1992-99	-0.01	2.29	0.02	0.31

Productivity growth rates:

Productivity of a firm at any point in time is given by $\exp(\varepsilon_{it})$. It is computed by replacing ε_{it} by the residual of the ith firm in year t. Tables 14 to 16 give productivity growth rates of auto components industry for the three periods. Annual and period averages of productivity growth rates for the industry are calculated as simple averages and output share weighted growth rates of each of the firm's in the sample. In the last row of the table the period averages are given.

Table 14 gives the average productivity growth rates for the industry for the first period. The simple averages of firm growth rates for the period show that productivity increased by 3.2% during the first period while the weighted average productivity growth rates show 2.61% for the same period. It implies that smaller firms experienced higher growth rates than bigger firms in the auto components industry during 1977-84.

Table 14: Average Productivity Growth Rates
in the Auto Components Industry During 1977-84.

Year	Simple averages	Weighted averages
1977-78	0.0312	0.0017
1978-79	0.0103	0.0084
1979-80	-0.0187	0.2005
1980-81	0.1235	0.0053
1981-82	0.0620	0.0115
1982-83	-0.0104	0.0294
1983-84	0.0234	-0.0738
1977-84	0.0316	0.0261

Table 15 gives the average productivity growth rates for the industry for the second period. The simple average growth rates for the period show that productivity fell on average by 0.01% while the weighted average productivity growth rates decreased by 4.34% in the second period. Again for smaller the firms productivity is lesser than that of the bigger firms.

Table 15: Average Productivity Growth Rates
in the Auto Components Industry During 1985-91.

Year	Simple averages	Weighted averages
1985-86	-0.1152	-0.23
1986-87	-0.0007	-0.1457
1987-88	0.0834	0.3862
1988-89	0.0142	-0.0687
1989-90	0.0149	-0.1499
1990-91	-0.0310	-0.0525
1985-91	-0.0001	-0.0434

Productivity growth rates for the post 1991 period are shown in Table 16. Contrary to the first two periods bigger firms performed better than the smaller firms in terms of productivity growth rates. The simple average growth rates for the period are 1.09 % while the weighted average productivity growth rates are 4.25 %.

Table 16: Average Productivity Growth Rates
in the Auto Components Industry During 1992-99.

Year	Simple averages	Weighted averages
1992-93	-0.0009	0.0656
1993-94	0.0212	-0.0475
1994-95	0.0288	0.1390
1995-96	0.0041	0.1274
1996-97	-0.0433	-0.0372
19997-98	0.0402	0.3130
1998-99	0.0262	-0.2629
1992-99	0.0109	0.0425

Productivity growth rates are found to be important contributors of output in the first and third periods. In the second period it was not significant. This finding is in line with the findings of previous studies [4].

5. Concluding Remarks

This paper attempts to learn about technological changes in the auto-components industry when it moved from a restrictive policy regime to a less restrictive one in 1984 and finally to liberalized one in 1991. With regard to the factor efficiencies we find that the middle period was more-or-less an adjustment period. Capital is the only factor for which we find a monotonic relationship of its productivity with the degree of openness. In all the periods we find that the productivities of all factors is very variable and firms with negative factor productivities are not rare! This is perhaps a result of the fact that losing concerns can not easily shutdown.

With regard to (neutral) productivity (TFP) changes we find that the closed regime of the first period favored the smaller firms more whereas the most open regime of the third period favors the bigger firms more leading to a higher growth in productivity for the industry as a whole.

Currently we are trying to extend this study in two ways. One is to link it to productivity movements in the auto industry. The other is to explicitly bring in the role of imported capital.

[4] Srivastava (1996) found that for the transport equipment and parts industry experienced productivity growth of –0.005 % for the period 1985-89. For the period between the years 1981 and 1984 he calculated this industry's productivity growth as –0.010 %. In another relevant study by Krishna and Mitra (1998) productivity growth in the transport equipment industry is calculated as –0.000 % for the period between the years 1986 and 1993. Ahluwalia (1991) found 6.6% growth in productivity for the intermediate goods sector. Though panel data was used in this study the panel nature of the data was not modelled.

Data Appendix

The data used for the study are the firm-level panel data obtained from the Reserve Bank of India for the period 1976-77 to 1989-99 inclusive. Company Finances Department of Reserve Bank of India compiles these from the annual accounts of the firms in the sector. From this data we have obtained the required variables as follows.

Output is defined as net sales adjusted for changes in inventories. Real output is constructed by deflating output by the wholesale prices of main product of the firm. Number of employees is taken as the labor variable. Amount spent on wages and salaries is given in the data. We have collected per capita average wage of the public sector employees and used it to divide wages and salaries figures to obtain number of employees.

Regarding the domestic material input, domestic materials consumed are deflated by wholesale price index of basic metals, alloys and metal products. Imported materials variable is obtained by deflating the nominal expenditure on imported materials by unit value index of imports of manufactures of metals.

Our data distinguishes between buildings and plant and machinery that together account for about 95% of total gross capital stock. All calculations of the capital stock are done separately for buildings and Plant and machinery. Real capital is obtained by deflating gross capital stocks of buildings by wholesale price index of non metallic mineral products and gross stocks of plant and machinery by wholesale price index of heavy machinery. To calculate net stocks of capital, depreciation is calculated basing on the straight-line depreciation method. For this purpose we considered the life span of plant and machinery as 20 years and buildings as 50 years as suggested by Central Statistical Organization (1989).

All the deflators used are constructed on 1981-82 base. We have collected all the price indices from the Office of the Economic Adviser, Government of India, and Reserve Bank of India Currency and Finance Report.

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