Productivity Growth In Indian Engineering Industries During Pre-Reform and Post- Reform Period An Analysis at Company Level

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Abstract

Since july 1991, major economic policy changes have been made under the economic reforms programme. The new policies have relaxed or removed many government controls on production capacity, imported capital goods, intermediate inputs and technology. These reforms have altered the economic environment in which the companies operate. This paper makes a comparative analysis of productivity growth of engineering companies in India in the pre-reform and post-reform periods. The study is based on company level balanced panel data relating to Indian engineering industries, electrical and non-electrical groups, for the pre-reform period of 1985-86 to 1990-91 and post- reform period of 1991-92 to 1994-95. The study reveals that productivity growth of engineering industry had declined in the post- reform period as compared to the pre-reform period. The paper also analyses factors affecting company level productivity growth in the two periods. Various factors are considered to explain inter-company variations in productivity growth during the two periods. The analysis reveals that output growth had a significant positive impact on productivity growth in both the periods. Foreign equity participation had a significant negative relationship with productivity growth in both the periods. Thus domestic companies had a higher productivity growth as compared to foreign owned companies in both the periods. Intermediate inputs imports had a strong positive effect on productivity growth in the post-reform period.

PRODUCTIVITY GROWTH IN INDIAN ENGINEERING INDUSTRIES*
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1. Introduction

Productivity growth is a key factor in determining the growth of industries. Total factor productivity growth reflects technical progress and changes in technical efficiency. In India major economic reforms have been undertaken since July 1991 with the objective of increasing the productivity and competitiveness of the companies. The new policies have liberalised many government controls on production capacity, imported capital goods, intermediate inputs and technology. Foreign investment has also been liberalised. These reforms have made imported inputs cheaper and more accessible for companies and have exposed the companies to both domestic and international competition. These reforms have altered the economic environment in which the companies operate. The purpose of this paper is to see the impact of these reforms on productivity of engineering industry. A study of engineering industry is important as it plays a crucial role in the economic development with its close linkage with every single sector of the national economy. It is the base for growth and development in all economic sectors.

This paper seeks to analyse the productivity of engineering industry, electrical and non-electrical groups, during pre-reform and post- reform period of 1991. The study is organised as follows. First, productivity growth of Indian engineering industries at company level in the two periods is analysed. Then the factors which affect company level productivity growth are considered. An analysis of the determinants of productivity growth is useful in identifying the policy needed for improving the growth of productivity. Productivity performance of an industry is the result of many factors operating on the industry. Some of these factors may relate to the overall economic

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environment and some of these may be industry specific where as some of these may be company specific. We shall

also examine whether impact of the factors determining productivity performance have changed substantially in the changed economic environment. In the literature the relationship between productivity growth and output growth, trade and research and development expenditure has been established. Apart from these factors productivity growth also depends on the pace at which advanced technology is acquired. The advanced technology may be acquired through direct purchase of designs or embodied in imported inputs and capital. Using our estimates of productivity growth we shall examine such a relationship for Indian engineering industries.

The scheme of the paper is as follows. Section 2 shall give the factors affecting productivity growth. Section 3 gives a review of Indian studies. Section 4 discusses the methodology. In this section we shall discuss the various methods of measurement of productivity growth. The regression function for analysing determinants of productivity growth shall also be specified in this section. The methods of estimation of specified function are also discussed here. The sources of data and construction of variables shall be given in section 5. Analysis of company level variations in productivity growth and regression results giving determinants of productivity growth shall be presented in Section 6. Finally the summary of findings are given in Section 7.

2. Factors Affecting Productivity Growth

In the literature on productivity growth, various factors are considered to be influencing it. The most important factor influencing productivity growth is found to be output growth. Output growth permits an industry to gain from economies of scale - internal and external, technological progress and learning by doing. Thus, a positive association is expected between output growth and productivity growth. The other key factor is technology advancement. Technological change decides, by its pace, the nature of restructuring inevitable in industry along with how fast will it grow as well as the productivity of industrial production. The technology advancement may take many forms - the flow of technology embodied in the imports of capital goods and intermediate inputs, technology transfers accompanying foreign direct investment, foreign collaborations and imports of technology against lump sum payments, technical fees, royalty etc. After the technology is imported, it is suitably modified and assimilated before it reaches the take-off stage in industrial growth. Thus advances in the technology results in the improvement of productivity. The international trade also affects productivity growth. Exports generate competitive pressure on companies which causes productivity increase. Exports also provide opportunity to learn about new technology and its application in production. On the other hand, imports permit availability of embodied technology whether in capital goods or inputs. This brings about an expansion of domestic demand and widening of the market for the company through improvement in productivity and better quality products. The exports has an effect on productivity growth through growth of demand. It enables the company to exploit the economies of scale which increases productivity growth. During the post-reform period in India various policy measures have been adopted to make trade regime more open. Import restrictions arising out of tariff and import quota have been reduced. Condition have been made more favourable to export. This open trade regime it may be argued tends to generate greater competition, accessibility to foreign markets and also imports of better capital equipment and material input which improve productivity. These issues shall now be taken up for discussion in detail.

Productivity Growth and Output Growth

P.J.Verdoorn found a positive link between productivity growth and output growth in the inter-war period. This link is therefore known as "Verdoorn's Law" after him. The faster a company grows the more it has the opportunity to exploit the benefits of economies of scale. These are often stated as specialization and division of labour in production, the existence of indivisibilities, the economies of increased physical dimension of some plant and economies of massed resources. Some of these economies are obtained because of technological progress while others are obtained because of specialization either within the same industry or in the input supplying industry.

Technological progress can be either exogenous, that is external, or endogenous which is internal. If technological progress is exogenous, then the higher rate of growth of output, the higher is rate of growth in productivity. This is so because faster output growth would allow addition of new and better quality machines.[1] This will lead to higher productivity growth.

The rapid expansion of growth of output allows for the introduction of new techniques because of large scale of production. In situations where the output of company is not expanding rapidly and excess capacity is there, the expansion in the level of operations allows for the utilization of such capacity. This results in better efficiency of factor use. Also, rapid growth of output shortens the time lag in the application of new technological advances. The new technological advances are applied to production scales and utilize better skills. This increases productivity growth. When the output growth is faster, endogenous technological progress also occurs and improvement in the methods of production takes place. Several studies, Fabricant (1942), Verdoorn (1949), Reddaway(1966), Kaldor(1967), Kendrick(1961), Kendrick(1973), Fucns(1968), Kendrick and Grossman(1980) and many other studies found a strong positive association between output growth and productivity growth.

Productivity and Technology Acquisition

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[1] Salter (1960) and Kennedy (1971).

The technology embodied in the imported inputs and capital goods constitute one flow of technology and the other important source of inflow of advanced technological knowledge is technology imports at arm's length i.e. direct purchases of knowledge through lump sum payments or licensing for patents, blueprints, and so on. The lump sum payments and licensing constitute a short term, assured and risk free return to technology transfers. However, not all technologies are available at arm's length. Some may be obtainable only through majority ownership or project specific joint ventures. According to Markusen (1995, 1998), companies will be averse to unbundling and selling knowledge or products if there are important incentives for internalization and thus companies will prefer foreign collaboration for acquiring knowledge(see Pack and Saggi(1997) for a general survey on technology transfer).

Thus the technology advancement through foreign collaboration is also an important means of transfer of technology. Indeed, foreign collaboration in equity seems to bring relatively efficient technologies into host country and thus increases the productivity of the host country. Foreign collaboration also provides management and organisational competence. These assets have spillover effects on the rest of the economy. The foreign collaborator puts pressure and assists the local companies to improve their technology and the product quality. Foreign collaboration also helps the host country in improving its export competitiveness by increasing productivity by improving the product quality. Because of international linkages of foreign collaborators, host country gets better access to foreign markets. Foreign collaboration also contributes to exports directly if equity investments have been made with the specific intention of sourcing parts or components from the host country to take advantage of low cost conditions there. The export expansion overcomes the demand side constraints on growth. Foreign collaboration via equity flows is considered as a long term investment since returns to foreign investor from remitted profits and dividends accrues to him after a time.

Caves' study(1974) for Australian manufacturing found that the very presence of foreign firms have a positive impact on labour productivity growth in the corresponding industries. For Canada, Globerman(1979) also confirmed that foreign firms have a positive impact on productivity growth. For Mexico, Blomstrom and Persson(1983), Kokko(1994), and Blomstrom and Wolff(1994) also found the same effect. But for Morocco, Haddad and Harrison(1993) found that foreign presence has no significant effect on labour productivity.

Productivity Growth and Research & Development expenditure

According to Evenson and Westphall 1995, technology acquisition often amounts to adapting existing methods to local circumstances. Once the advanced technology has been acquired, the recipient company has to make efforts for adaptation and development of the technology and gain mastery over it for achieving the productivity potential of the advanced technology. Research and development(R&D) expenditure is an important part of the competitive strategy of the company as it helps in assimilation and adaptation of foreign technology and making it suitable for indigenous use. Research and development(R&D) expenditures also helps in developing new processes or new products that are different or better than those already existing. The productivity of the company will increase as R&D will change the conditions under which the company operates in markets and also if these goods are exported. Terleckyz(1974), Sherer(1982), Griliches (1984), Odagiri(1985) and Jaffe(1988), Fecher and Perelman (1989), Lichtenberg and Siegel (1991), Coe & Helpman (1993), Coe, Helpman and Hoffmaister (1995), Maury Gittleman and Edward N. Wolff (1998) and many others have studied the nexus between productivity and research and development and have revealed that advances in the technology result in the improvement of productivity growth.

Productivity Growth and Trade Policy

The role of trade in raising productivity has been extensively studied in the literature. Little, Scitovsky and Scott(1970), Bhagwati(1978), Krueger(1978), Nishimizu and Robinson(1984), , Nishimizu and Page(1986), Kajiwara(1994) Kwak(1994) Osada(1994), Urata and Yokota(1994) have concluded that economies with relatively open trade regime show a better performance with respect to growth of productivity than the economies which have restrictive trade regimes,

Exports serve as a conduit for technology transfer from abroad and generate competitive pressure on companies which generates productivity. Chen and Tang (1987), Haddad(1993), Aw and Hwang(1995), Tybout and Westbrook (1995), Aw and Batra(1998) have shown that productivity of exporting companies are more than their counterparts that sell primarily in the domestic market. The productivity improvements may also result from learning by exporting. Companies gain knowledge and expertise as a result of its experience in the export market which gives the opportunity to have access to new product designs and production methods where as the companies which operate in the domestic market do not have the access to these technical expertise. Evenson and Westphal(1995); Grossman and Helpman(1991); Rhee, Ross-larson, and Pursell(1984), World Bank(1993) and Clerides, Lach, and Tybout (1998) examined the link between productivity and exports. They hold the view that exporters learn from their contacts in the export market and as a result they adopt better production methods and achieve higher productivity. Technology may also diffuse from exporters to non-exporters in the same industry through demonstration effects, skilled worker training or expertise imparted to their local suppliers. Clerides, Lach and Tybout(1998) find that when many firms have been exporting from a particular region, all firms in that region tend to enjoy lower average costs.

The other important role of trade is technology transfer through imports. Imports permit availability of embodied technology in capital goods and inputs. The availability of embodied technology in these imported inputs and capital goods allows for a degree of specialisation in the production of goods which has an enhancing impact on the productivity growth of the company. Several studies, such as Coe and Helpman(1995); Coe, Helpman, and Hoffmaister(1997); Evenson (1995); Keller(1997,1998a,1998b); Litchenberg and Van Pottelsberghe de la Potterie(1998b) have assessed that imports play an important role in transmitting foreign technology to domestic companies and increasing productivity growth.

3. Review of Indian Studies

In India, most of the studies of productivity growth relate to the pre- and post 1985 period of liberalisation, when the reforms in the Indian industry were in the initial stage. But very few studies have covered the post-reform period of 1991 when major economic reforms were initiated in the Indian industry. We shall review here some recent studies only.

Industrial Credit and Investment Corporation of India(ICICI,1994) carried out a study on productivity growth for companies to which it provided assistance. The study found that growth rate of TFP was 2.1 per cent per annum for the period 1987-88 to 1991-92. Gangopadhyay and Wadhwa(1998) has estimated total factor productivity(TFP) estimates for various two digit industries and aggregate manufacturing. Using ASI data the study estimated a growth rate of TFP for aggregate manufacturing as 5.01 per cent per annum for 1986-90 and 3.88 per cent per annum for 1991-93. Trivedi, Prakash and Sinate(2000) found that TFP growth rate in Indian manufacturing was 3.60 per cent per annum in the period 1980-81 to 1990-91 and 1.97 per cent per annum in the period 1990-91 to 1997-98. Balakrishnan, Pushpangadan and Suresh Babu(2000) investigated the growth of productivity in Indian manufacturing spread over five industry groups over the period 1988-89 to 1997-98. The industry groups chosen were machinery, transport equipment and parts, textiles, textile products and chemicals. These groups were chosen on the basis of the significant tariff reductions since 1991. Using CMIE database, he used the data for about 2300 firms registered with the Bombay Stock Exchange and found a significant decline in the growth rate of TFP after 1991-92. Srivastava(2000) has estimated productivity growth and technical efficiency in manufacturing firms in India for the period 1980-81 to 1996-97. Using data for about 3000 companies for the period 1980-81 to 1996-97 he found a decline in the rate of productivity growth in the 1990's as compared with the 1980's.

There is widespread evidence of association between productivity growth and various factors discussed above for a number of countries. Now we shall discuss the Indian studies to explain the association between productivity growth and various factors.

Goldar(1986a) analysed the inter industrial differences in TFP growth for 37 three digit industries of India during the period 1960-70 . He found a significant positive relationship between output growth and productivity growth(partial and total). He also used other variables in his analysis of inter-industrial differences in productivity growth during the period 1960-70. Using the effective rate of protection as an indicator of trade policy his analysis revealed a negative but statistically significant link between the trade policy and TFP growth. Goldar(1986b) used a different variable to represent import substitution as an indicator of trade policy and found again a significant negative relationship between TFP growth and import substitution.

Ahluwalia(1991) attempted to explain the inter-industry differences in TFPG in 62 industry groups for the period 1960 to 1986. She regressed TFPG on output growth along with other factors like the degree of import substitution and capital intensity growth. She also tried to capture the impact of competitive pressure on productivity growth by using the variable, rate of growth of factories, along with other explanatory variables. She found output growth as a significant explanatory variable in explaining the inter-industry differences in TFPG. Growth in the number of factories is found to have a significant negative sign though a positive sign was expected apriori. She also found a negative relationship between Chenery measure of import substitution and TFPG.

Basant and Fikkert(1993) studied the impact of firms' R&D, technology purchase expenditures, and foreign and domestic R&D spillovers on productivity at the micro level using panel data for Indian manufacturing firms for the period 1974-75 to 1982-83 and international R&D and patent data from 9 countries. He considered only the disembodied technology purchased from foreign countries acquired through licenses in the form of expenditure on foreign technical licenses in the form of lump sum payments, technical fees, royalties etc. The perpetual inventory method was used to construct the knowledge stocks generated from technology purchase and R&D. After controlling for firm-level heterogeneity through fixed effects estimation, the results indicated high private rates of return to both R&D and technology purchase. They argued that India's restrictions on technology licensing agreements may have had a substantial cost to the economy as the returns to technology purchase expenditures being much higher than those to R&D. The estimates indicated that R&D and technology purchases are substitutes for one another. This suggested that India's technology licensing regulations had their desired effect of stimulating domestic R&D. Furthermore, after controlling for firms' own R&D and technology purchase expenditures, international and domestic R&D spillovers increase productivity, the social benefits of both international and domestic R&D exceeding the private benefits. This gives opportunities to pirate foreign inventions for those Indian firms who are willing to expand their own R&D resources. Fujita(1994) evaluated the effect of liberalisation policies on productivity growth in Indian manufacturing industries for the period 1981-82 to 1987-88. He argued that increase in the share of public sector in value added usually reflects restrictions in attempts at liberalisations. He thus used this share as a proxy for trade policy and found a negative relationship between increase in share of public sector and TFP growth.

Goldar (1995) studied the relationship between technology acquisition and productivity growth for Indian industrial firms. He has done the analysis both at the aggregate level as well as at the firm level using data for 347 large industrial firms for the years 1987-88 to 1989-90. A number of variables are used to capture technology acquisition such as R&D intensity, foreign equity participation, technology import against royalty, technical fees, licensing fees and lump sum payments and capital goods import intensity along with export intensity, intermediate goods import intensity and age of the firm. His study found that in Indian industrial firms there is not any strong positive effect of the technology acquisition activities, including R&D and technology imports on productivity growth. In particular his results suggested that imports of technology contributed very little to productivity advancement, R&D and technology transfers accompanying foreign direct investment were found to have a favourable though small effect on productivity growth. Export intensity, intermediate input import intensity were found to have a significant positive relationship with productivity growth.

Ramaswamy, K.V.(1996) pooled the data for 18 industry groups for the period 1975 to 1990 and estimated a multiple regression model with a time dummy to capture the effects of the two periods,1974-75 to 1979-80 and 1980-81 to 1989-90. He regressed the labour productivity growth on output growth rates, net entry and capital intensity. He found that output growth has a positive effect on productivity growth. His estimates supported the hypothesis that entry in the period of industrial deregulation had a positive impact on productivity growth. He argues that it is the entry of new firms with new and improved technology and the substitution of inefficient plants by efficient plants, that leads to productivity growth. The firms that entered during this period have had presumably better access to imported raw materials and technology. The index of capital intensity is found to be insignificant in explaining labour productivity.

4. Methodology

The previous sections have quickly reviewed the literature. In the following sections, we present the results of our analysis. We begin with a discussion on the methodology adopted, followed in the next section by discussion of data sources and variables. The empirical results are presented in section 6.

4.1 Methods of Measurement of TFPG

We start with the most commonly used approach to TFP measurement, namely that of Solow (1957). He provided an elementary way of segregating variations in output per head due to technical change from those due to changes in the availability of capital per head. Solow index of TFP is based on the Cobb-Douglas production function under the assumption of constant returns to scale, autonomous Hicks-neutral technological progress and payment to factors according to their marginal product.

The discrete method of measurement of productivity due to Solow is obtained as follows:

$$\Delta A(t)/A(t)= \Delta V(t)/V(t)-[S_L(t)(\Delta L(t)/L(t))+S_K(t)(\Delta K(t)/K(t))]$$

where,

$\Delta V(t)/V(t)$ is rate of change of real gross value added

$\Delta L(t)/L(t)$ is rate of change of labour

$\Delta K(t)/K(t)$ is rate of change of real gross fixed capital

$S_L(t)$ is share of labour in gross value added in year t

$S_K(t)$ is share of capital in value added in year t

Thus $\Delta A(t)/A(t)$ gives the annual rates of total factor productivity growth according to Solow method.

The Translog index of technological change is based on a translog production function characterised by constant returns to scale. It allows for variable elasticity of substitution and does not require the assumption of Hicks neutrality. The Translog index is a discrete version of the continuous Divisia index and is obtained as follows:

$$\Delta P(t)/P(t)= \Delta V(t)/V(t)-[\overline{S_L(t)}(\Delta L(t)/L(t))+\overline{S_K(t)}(\Delta K(t)/K(t))]$$

Here $\Delta V(t)/V(t)$, $\Delta L(t)/L(t)$ and $\Delta K(t)/K(t)$ are approximated by corresponding logarithms of ratios of variables over successive years, i.e.,

$$\Delta V(t)/V(t) \sim \ln [V(t)/V(t-1)] = \ln V(t) - \ln V(t-1) = \Delta \ln V(t)$$

$$\Delta L(t)/L(t) \sim \ln [L(t)/L(t-1)] = \ln L(t) - \ln L(t-1) = \Delta \ln L(t)$$

$$\Delta K(t)/K(t) \sim \ln [K(t)/K(t-1)] = \ln K(t) - \ln K(t-1) = \Delta \ln K(t)$$

$$\overline{S_L(t)}=1/2[S_L(t+1)+S_L(t)]$$

$$\overline{S_K(t)}=1/2[S_K(t+1)+S_K(t)]$$

$\overline{S_L(t)}$ and $\overline{S_K(t)}$ being shares of labour and capital in value added. $\Delta P(t)/P(t)$ is thus the translog index of total factor productivity growth.

The above methods are based on the assumptions of constant returns to scale and payments to factors according to their marginal product. The conventional methods do not distinguish between technological progress and changes in the efficiency with which existing technology is applied to production i.e., technical efficiency. Cornwell, Schmidt and Sickles (1990) suggested a model which gives the rate of growth in productivity (TFPG) as a sum of the rate of technological progress and the rate of change in technical efficiency. Assuming a Cobb-Douglas production technology with two inputs, they suggested the following model:

$$\log Y_i(t) = a + \lambda t + \alpha \log L(t) + \beta \log K(t) + e_i(t) \quad \text{--------(1)}$$

and $e_i(t) = v_i(t) + u_i(t)$

where α and β are the elasticities of output with respect to labour and capital respectively, λ is the rate of technological progress, $Y_i(t)$ is the level of output of the i th company at time t and $e_i(t)$ is the error term. $e_i(t)$ is postulated as combining a random error term, $v_i(t)$ and the term associated with technical efficiency $u_i(t)$ which is both time varying and company specific. The term $v_i(t)$ has the usual properties while $u_i(t)$ is assumed to be independent of $v_i(t)$ and non-positive.

Assuming a time varying efficiency approach, efficiency term $e_i(t)$ is estimated (from OLS residuals for each company separately) as a quadratic function of time t.

$$e_i(t) = n_{oi} + n_{1i}(t) + n_{2i}(t^2) + v_i(t)$$

where n_{ki}(k=0,1 and 2) are parameters associated with individual companies. Following the above decomposition of $e_i(t)$, the rate of growth in productivity TFPG(t) is given as

$$TFPG(t) = \lambda + (n_{1i} + 2\, n_{2i}t)$$

where λ is the rate of technological progress and $(n_{1i} + 2\, n_{2i}t)$ is the rate of technical efficiency change.

Following the approach of Cornwell et al., recently applied by Yanrui (1995), Fecher and Pestieu (1993) and Krishna, K.L. and Sahota, G.S. (1991), the above model is implemented for this study in the following steps. First of all, the Cobb-Douglas production function given in equation (1) is estimated using a cross-section of pooled time series data for all the year with time dummy t which takes the value 0 for pre-reform years and value 1 for post-reform years with the residuals saved. (The Cobb douglas production function could have been estimated separately for two periods but a single function was estimated to have the large degrees of freedom). The above model is estimated with pooled cross-sectional and time-series data using OLS. For pooling the data for different industries group panels, the standard Chow test was applied. F-ratio indicated poolability of data for different industry group panels. After pooling the data, panel data techniques of estimating the regression function for pooled cross-section and time series data using OLS were applied. The estimated value of coefficient of t is that of t for the pre-reform period and value of coefficient of t and coefficient of dummy variable and t for the post-reform period. Then, these estimated residuals are regressed against t and t^2 including a constant term separately for each company. The estimated value of coefficient of t from this equation gives an indicator of technical efficiency. Thus, the growth rate of total factor productivity for each company i is estimated as:

$TFP_i(t) = \lambda + n_{1i}+2n_{2i}t$ for the pre-reform period and

$TFP_i(t) = \lambda$ +coefficient of dt+ $n_{1i}+2n_{2i}t$ for the post-reform period and

Where λ is the rate of technological progress for the pre-reform period and λ+ coefficient of t and dummy for the post-reform period and $n_{1i} +2n_{2I}t$ is the rate of technical efficiency change.

4.2 Specification of Function for Inter Company Variations in TFPG

Based on the theoretical and empirical literature of factors affecting productivity growth discussed above we shall develop an econometric model to examine factors influencing productivity growth The postulated hypotheses regarding productivity determinants are stated below:

Function I: TFPG=f(GO)

Function II: TFPG=f(GO,MT,MMI,CGI,FE,RD,KLR,XI)

Where, TFPG is total factor productivity growth, GO is growth rate of output, MT is technology imports intensity, MMI is materials input import intensity, CGI is capital goods import intensity, FE is foreign equity participation, RD is research and development intensity and , XI is export intensity, KLR is capital intensity.

The above model is estimated with pooled cross-sectional and time-series data using OLS. First, for pooling the data for different industries group panels, the standard Chow test was applied. F-ratio indicated poolability of data for different industry group panels. After pooling the data, panel data techniques of estimating the regression function for pooled cross-section and time series data were applied.

4.3 Methodology for Panel Data Analysis

While using the panel data the consistent estimation of equation by OLS is difficult because the error term are not longer homoskedastic. If errors are not homoskedastic OLS estimates will be consistent but inefficient. Thus the reported standard errors will be incorrect. Both the fixed effects and random effects models solve this heteroskedasticity problem, although the random effects model is more efficient. Under panel data techniques three different methods of estimation could be considered: ordinary least squares estimates (OLS), the fixed effects model (FE) or least squares dummy variables (LSDV), and the random effects model (RE). The diagnostic tests were applied so that a best statistical model could be selected among these three models. Three different test statistics are applied to choose the best statistical model. The likelihood ratio (LR) test is applied to test for the OLS model against the FE model, a large value for the LR statistic favours the use of the FE model over the OLS model. The Lagranges multiplier (LM) test is applied to test for the OLS model against the RE model, a large value for the LM statistic favours the RE model against the OLS model. The Hausman specification (HS) test is applied to test for the RE model against the FE model, a large value of the HS statistics favours the FE model over the RE model. The LIMDEP package is used for the panel data analysis of pooled cross-section and time series data. It provides the estimates based on all the three models - OLS, FE and RE.

5. Data and Variables

5.1 Sources of Data

The database of the Reserve Bank of India (RBI) on finances of Medium & Large Public Limited Companies are the basic source of data for this study. Different sets of data[2] were obtained from RBI for engineering companies: 1985-86 to 1987-88, 1987-88 to 1989-90, 1988-89 to 1990-91, 1990-91 to 1992-93, and 1992-93 to 1994-95. All these data sets were matched to get a common subset of companies. Finally, we were left with a subset of 44 large companies belonging to electrical and non-electrical engineering industries common in different sets. Thus, the data set used for this study covers 44 engineering companies for the years 1985-86 to 1994-95. There are 10 companies in Electrical Engineering, belonging to the following groups: Cables, Dry Cells, Electric Lamps and other Electrical Machinery, apparatus, appliances, etc. There are 34 companies in Non-

Electrical Engineering, belonging to the following groups: Machine Tools, Textile Machinery and accessories and Misc. Machinery not elsewhere classified. The econometric analysis presented in the paper is based on the pooled time-series and cross-section data for the 44 companies belonging to these groups. Separate analyses have been carried out for the pre-reform(1985-86 to 1990-91) and post-reform(1991-92 to 1994-95) periods.

5.2 Measurement of Variables:

Out put :

Gross value added has been taken as the measure of output. The data tapes give data on value of production, and manufacturing expenses, namely, raw materials and components consumed, stores and spares consumed, power and fuel, royalty and other manufacturing expenses. We have subtracted the sum of manufacturing expenses from value of production to get value added. This includes depreciation and therefore what we get is gross value added at current prices. This is, then, deflated by the Index number of wholesale prices for relevant product groups. Product groups given in the Index Number of Wholesale Prices are not the same as those given in the RBI. Therefore, product-wise indices of wholesale prices are regrouped to make them comparable to product groups given in the RBI. The groups of WPI used as deflator for different industry groups are given in Appendix - 1. Index number of wholesale prices in India for the financial years from 1985-86 to 1994-95 are taken from Index number of wholesale prices in India, Office of the Economic Advisor, Ministry of Industry, Government of India. This gives the indices at base 1981-82=100. The base of this series is converted to base 1985-86=100. This method of deflation suffers from the limitation that the same price index is used for all companies belonging to a product group which may not be appropriate since the basket of products produced by various companies belonging to a product group (say, textiles machinery) may differ.

Capital Input:

Gross fixed capital stock at constant (1985-86) prices is taken as the measure of capital input. RBI tapes gives the total gross fixed assets at current prices. It consists of land, buildings, plant and

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[2] Each data set is for three years. The coverage of firms differs between the sets.

machinery, capital work in progress, furniture, fixtures and office equipments and others. To estimate real gross fixed capital stock, we employ the perpetual inventory method. This requires bench-year estimates of gross fixed capital stock at 1985-86 prices and real gross investments at 1985-86 prices over successive years for the period under consideration.

Fixed investment for each year is first calculated and deflated by the capital goods price deflator of that year to get the real investment. But where the fixed investment comes out to be negative, deflator taken is the price index for benchmark year. This is so because negative fixed investment implies that some of the gross capital in bench year has been discarded (which had been estimated previously at bench year price index). The deflator used for gross fixed assets is the Index number of wholesale prices for machinery and machine tools. This is taken from Chandhok (1990). Chandhok gives two series on index number of machinery and machine tools: (1) a series from 1971-72 to 1988-89 at base 1970-71=100 and (2) a series from 1982-83 to 1988-89 at base 1981-82=100. The Wholesale price indices from 1971-72 to 1981-82 (at base 1970-71) was merged with wholesale price indices of latter series 1982-83 to 1988-89 (at base 1981-82) and then the base of the combined series was shifted to 1985-86. Once the series with 1985-86=100 is obtained, the deflator for benchmark year i.e., 1985-86 is obtained as the average of indices from 1971-72 to 1985-86 if the company was incorporated more than 15 years prior to 1985-86. But if the company was incorporated after 1972-73 (i.e. less than 15 years prior to 1985-86), the average of indices from the year of incorporation to 1985-86 is taken as the deflator for the benchmark year. Deflator for investments from 1986-87 to 1994-95 is the price index of machinery and machine tools at base 1985-86 for the corresponding year. Index number of wholesale price for the years

1989-90 to 1994-95 is taken from Index Number of Wholesale Prices in India, 1989-90, Office of the Economic Advisor, Ministry of Industry, Government of India.

Labour Input:

The RBI data source o not contain data on number of workers/employees. But it provides salaries, wages and bonus for all the employees and managerial remuneration. Thus, to obtain a measure of labour/employment, we have first aggregated the salaries, wages and bonus for all the employees and managerial remuneration to get total salaries and wages, and then deflated it by the wage rate which has been obtained from ASI (Annual Survey of Industries). From ASI, we get data on total emoluments and total employees for various industry groups belonging to electrical and non-electrical engineering. The industry-wise wage rates (emoluments per employee) are computed from these data and then used as the deflator for company level salaries and wages to arrive at a measure of labour input. One difficulty we have faced in making these computations is that the industrial classification in ASI are not the same as in company finance data of RBI. Thus the industries in the ASI have been re-grouped to match it with the RBI industrial classification. The industry groups combined are given in Appendix-2*:*

Scale of Production (GO)

Growth in real value added is taken as a variable for measuring growth of scale of production. As mentioned earlier, growth in scale of production permits adoption of new technologies which improves productivity. Expansion of scale also generates scale economies which improves productivity. Therefore, we expect a positive relationship between growth in productivity and growth in value added.

Capital Intensity (KLR)

The ratio of real gross fixed capital stock to labour is taken as a measure of capital intensity. Companies with relatively high capital intensity will be the companies with more chances of embodied technical progress (Ahluwalia, 1991). We, therefore, hypothesize that capital intensive companies attain higher rates of productivity growth.

Technology Imports (MT)

The ratio of payments for royalty, technical fees (for know how, of drawings, designs, etc.), professional and consultation fees and others to sales turnover is taken as a measure of technology imports. The import of technology brings know-how and designs etc., which enhances productivity.

Export Intensity(XI)

Export intensity is computed as the ratio of exports to sales. It is hypothesized that higher export intensity induces the companies to make efforts to be more competitive, through greater efficiency in production.

Research Intensity (RD)

Company efficiency may improve with greater research effort. The ratio of research and development expenditure to sales turnover is taken to capture the research intensity.

Intermediate Inputs Import Intensity (MMI)

Imported inputs generates value addition. Further, imported intermediate inputs may embody advanced technology. The ratio of imports of materials, spares, components, etc. to total materials is taken as a variable for intermediate inputs import intensity.

Capital Goods Import Intensity (CGI)

While technology imports constitute one means of technology inflow, the other important source of new technology is capital goods import. Imported capital goods improves technological level. The ratio of import of capital goods to fixed investment is taken as a measure of capital goods import intensity.

Foreign Equity Participation (FE)

Foreign participation in management may improve company efficiency. The share of dividends declared in foreign currency to total dividends paid is taken as a measure of foreign equity participation.

6. Empirical Results

6.1 Company Level Variations in Productivity Growth

Table 1 presents a comparison of mean and standard deviation of the key variables in the pre- and post-reforms period. It is interesting to note from Table 1 that the average growth rate of real value added in the sample firms declined in the post-reform period as compared with the pre-reform period. The fall in the growth rate was from 10.6 to 5.8 per cent per annum. A decline is observed also, to a lesser extent, in the average rates of growth of labour and capital. The fall in the growth rate of capital was from 9 per cent per annum in the pre-reform period to 7.5 per cent per annum in the post-reform period. The fall in the growth rate of employment was from 3.2 per cent per annum in the pre-reform period to 2.1 per cent per annum in the post-reform period. The average technology import intensity was higher in the post-reform period (0.92 per cent) than that in the pre-reform period (0.58 per cent). Similarly, the average R&D intensity of the firms was relatively higher in the post-reform period (0.43 per cent as against 0.15 per cent). The mean values of other variables did not differ much in the two periods. This comparison depicts that while the rate of technology acquisition has gone up in the post-reform period, this has not been accompanied by a faster growth of output. Thus the reforms seems to have constrained the growth of the large engineering firms.

Tables 2 &3 show the productivity performance of companies at the aggregate level by all the three methods, viz., Solow, Translog and cornwell method in the pre- and post-reforms period respectively. These tables bring out clearly that productivity performance of companies are varying. In the pre-reform period, though a large number of companies are recording significant growth in productivity, yet considerable number of companies show decline in productivity. At the aggregate level of all companies, total factor productivity growth rate is moderate. The companies which record a fall in productivity are pulling down the aggregate productivity growth rate. If these companies are excluded, then average productivity growth rate is quite impressive. Further, productivity growth shows low contribution to output growth at aggregate level, but if companies with falling productivity are excluded as earlier, then productivity share in growth of output becomes very impressive. In the post-reform period, according to Solow and Translog method the number of companies showing decline in productivity are more than the number of companies showing increase in productivity thereby showing a decline in productivity performance at the aggregate level. However, according to the cornwell method, the number of companies showing increase in TFPG are more than those showing decline in TFP. Therefore at the aggregate level TFPG is moderate by this method. But if we exclude the companies showing decline in productivity, the average TFPG is quite impressive. Thus in the post-reform period also the companies showing decline in TFPG are pulling down the aggregate productivity growth rate. Also productivity growth shows low contribution to output growth at the aggregate level but if the companies with falling productivity are excluded as earlier, then productivity share in growth of output increases. At the aggregate level it was also found that, according to all the methods, number of companies showing positive productivity growth has declined from pre-reform to post-reform period whereas number of companies showing decline in productivity performance has increased from pre-reform to post-reform period. Average productivity growth at the aggregate level, comprising all companies, has declined in the post-reform period as compared to the pre-reform period. It has even recorded negative growth in the post-reform period by Solow and Translog methods

The distribution of companies according to productivity performance is shown in table 4. This table depicts that both in pre-reform as well as post-reform period there are quite a large number of companies showing a decline of more than 5 % per annum. Among the companies recording positive productivity growth, while some companies show low growth rates, several other companies record very high growth rates. A large number of companies are in the range of 0 to 5% of TFPG in the pre-reform period. This number has however declined in the post-reform period.

6.2 Determinants of TFPG During Pre- and Post- Reforms Period

The above analysis reveals that there are wide variations in productivity growth among companies according to all the methods. In this section we shall examine the factors which affect inter company variations in productivity growth according to the hypothesis postulated above. This analysis shall be based on the translog index of total factor productivity which is derived from translog production function. The translog production function is a more general specification of the production function. It is a flexible functional form imposing relatively few a priori restrictions on the properties of the underlying technology. It allows for variable elasticity of substitution. It does not require a Hicks-neutral or a constant rate of technological change. Therefore we have used the TFPG measured by translog method in the analysis of determinants of total factor productivity growth. Chow test(Chow,G.C.,1960) was applied for homogeneity with respect to different engineering industries. Chow test confirms the homogeneity. The functions specified in the earlier section are estimated. The results are given in tables 5 and 6.

Table 5 presents the results of the function-I using the OLS, FE and RE statistical models. The estimates are based on the sample of 44 companies for the electrical and non- electrical engineering industries for both pre- and post-reform periods. This table shows that significance levels and parameter magnitudes are different in the three models. Thus we have to choose one of the three models depending on different test statistics as discussed in the methodology. In the estimates for pre-reform period, LR statistics is found to be insignificant showing that OLS is better than FE model. LM statistics is significant implying that RE model to be preferred over OLS. The HS is insignificant which further supports that RE model is better than FE model. The consideration of all the three statistics leads us to choose the RE model as the best specification in the pre-reform period. The chosen model i.e. the RE model explains about 71% of the variations in productivity growth in this period.

In estimates for the post-reform period, the LR statistics is found to be insignificant indicating that OLS model is better than FE model, and LM statistics is also insignificant indicating that OLS model is even better than RE model. But the high value of HS statistics argues in favour of FE model against RE model. The consideration of all the three statistical models thus suggested that OLS is the best statistical model for the post- reform period. The chosen model, that is the OLS model, for this period explains 76% of the variation in the productivity growth.

In both the pre- and post-reforms period, the coefficient of growth rate of value added is found to be positive and highly significant. This finding is consistent with "Verdoon's Law". Thus it may be argued that economies of scale have been a source of productivity growth in both the periods. Thus growth in output has provided an opportunity for employing techniques of production which are more efficient and generates higher growth in productivity. This finding is consistent with the finding of Goldar(1986) & Ahluwalia(1991) for Indian manufacturing industry. The elasticity of total factor productivity growth with output is 0.68 in the pre-reform period. However the elasticity has increased to 0.78 in the post-reform period. Hence, after reforms output growth is generating faster productivity growth.

In table-6, the effect of other variables apart from the effect of growth of value of output on total factor productivity growth i.e. function-II are shown. For function-II also, we have to first choose the best statistical model from the given three models-OLS, FE and RE. In the results for pre-reform period LR statistics is insignificant suggesting that OLS model is better than FE model. The LM statistics is also insignificant indicating OLS model to be even better than RE model. The insignificance of HS statistics, however, argues in favour of RE model against FE model. The consideration of the three test statistics leads us to choose the OLS as the best statistical model in the pre-reforms period. As regards the results for the post-reforms period, both the LR statistics and LM statistics are insignificant indicating that OLS model is better than both FE and RE models. The HS statistics is statistically significant at 10% level of significance suggesting that FE model is better than RE model but it is insignificant at 5% level suggesting that RE model is better than FE model. But, since based on LM and LR statistics, OLS is found to be better than both RE model and FE model, it may be argued that the right model for the post-reform period is the OLS model.

Turning to the coefficients to various explanatory variables, the coefficient of capital intensity is found to be insignificant for pre-reform period. For the post-reform period, this coefficient is negative and statistically significant. This is contrary to the expected positive coefficient as the companies with relatively higher capital intensity should be the companies with greater chances of embodied technical progress and more scope for learning by doing. It may be inferred that the policies in the post-reform period encouraged companies to create more capacity which was not fully utilised causing a negative relationship to arise with TFPG. This is consistent with the finding of Ahluwalia(1991) for the Indian manufacturing industry. Ahluwalia gives two explanations for a negative relationship between capital intensity and TFPG. First, there must be certain other factors (not included in the specification of the equation) which are highly correlated with the capital-labour ratio and which have a negative effect on productivity growth. Second, the policy regime with its emphasis on discretionary licences and permits encouraged overcapitalization.

Among the technology acquisition variables, the coefficient of capital goods import intensity is insignificant for the pre-reform period but it is negatively significant for the post-reform period. This indicates that though capital goods were imported these probably could not be optimally utilised. The imported material intensity has an insignificant coefficient in the pre-reform period where as contrary to capital goods import intensity, it has a positive and significant coefficient for the post-reform period. During the post-reform period import relaxations permitted better quality imports. These imported materials may have contributed to productivity increase either by requiring less labour/capital use for further processing and conversion into final product or by helping in the production of better quality products. The coefficient of foreign equity participation is statistically significant with a negative sign for both the periods. Though foreign equity is supposed to generate a positive influence it is showing a negative influence in both the periods. This may be because foreign participation brings in such technologies which are very expensive and there may be a time lag in getting the positive influence. Technology acquisition through imports of technology against lump sum payments, technical fees, royalty etc. is found to have no influence in both the periods. The coefficient of research intensity is negative and significant at 10 % in the pre-reform period and is insignificant in the post-reform period. The negative relationship in the pre-reform period is however not very strong statistically. In this context it needs to be recognized that R&D intensity of industrial firms in India is generally very low as compared to that of the firms in the industrialised countries.

This low level of R&D intensity cannot be expected to lead to a significant advancement in technology (Goldar, 1995). He found a positive but statistically insignificant relationship between TFPG and R&D intensity. Export intensity is found to be insignificant in both the periods. Though a greater export orientation was expected to be favourable to productivity growth, no favourable impact of exports was found to be there. It may be because export orientation was not yet large enough.

7. Summary of Findings

In this paper, productivity performance of companies at the aggregate level in Indian Engineering industries in the pre and post reforms period has been analysed. Also the factors affecting inter company variations in productivity growth in the pre- and post-reforms period were considered. It was found that the productivity growth of companies has declined in the post-reform period as compared to the pre-reform period. Average output growth at the aggregate level has also declined in the post-reform period as compared to the pre-reform period. Even after excluding the companies showing decline in output growth, the average output growth shows a deceleration in the post-reform period. The average productivity growth of such companies has also declined, in general, between the two periods. The number of companies showing increase in productivity has declined from pre-reform to post-reform period whereas number of companies showing decline in productivity has increased from pre- to post-reform period. Thus the results indicated that the reforms had not shown any improvement in the productivity growth.

An analysis of the factors affecting productivity changes has been carried out by estimating a regression function using panel data techniques of analysis. The results indicated that growth of scale significantly generates productivity growth. Its marginal contribution has increased in the post-liberalisation period. After reforms the companies which had relatively low levels of capital intensity were having better productivity performance. More capital intensive companies had a relatively lower productivity growth. The companies having better access to imported materials had better productivity performance. On the other hand imported capital goods were not having a desired positive impact on productivity performance. The arms length purchase of technology and exports intensity have increased in after reforms. But, these appear to have had no positive effect on the productivity performance of companies in both the periods. The technology acquisition through technology transfer accompanying foreign equity participation and research and development expenditure needed for modifying and adapting imported technology was mainly showing a time lag in showing its positive influence

Table 1

Averages of Variables in the Pre and Post- Reform Period

Variable	Pre-Reform	Post-Reform
GL(% p.a.)	3.21 (12.46)	2.05 (10.78)
GK(% p.a.)	9.02 (13.2)	7.48 (15.8)
GO(% p.a.)	10.6 (21.95)	5.82 (21.42)
MT(%)	0.58 (0.87)	0.92 (1.95)
MMI(%)	24.42 (18.36)	21.9 (16.99)
CGI(%)	16.72 (75.99)	10.99 (37.05)
FE(%)	12.26 (16.18)	13.55 (17.10)
RD(%)	0.15 (0.64)	0.43 (0.53)
KLR	11.42 (11.047)	13.54 (8.31)
XI(%)	5.46 (7.85)	6.80 (8.37)

Notes: Figures in the parentheses are standard deviations

GL = growth rate of employment; GO = growth rate of output;

Gk = growth rate of capital; MT = technology import intensity ,

MMI=materials input import intensity; CGI= capital goods import intensity;

FE = foreign equity participation; RD = research and development intensity;
KLR= capital-labour ratio; XI= export intensity.

Table 2
Productivity Performance of Companies at Aggregate Level
Pre-Reform Period (1985-86 to 1990-91)

	Solow	Translog	Cornwell
Total No. of Companies	44	44	44
Average TFPG	3.18	1.97	4.70
Average Output Growth	10.60	10.60	10.60
Share of TFPG in Output Growth	30.00	18.58	44.34
No. of Companies showing Increase in TFPG	33	32	35
Average TFPG	6.83	5.16	6.58
Average Output Growth	13.06	12.78	12.74
Share of TFPG in Output Growth	52.30	40.38	48.59
No. of Companies showing Decline in TFPG	11	12	9
Average TFPG	-7.75	-6.54	-2.66
Average Output Growth	3.21	4.78	2.25
Total No. of Companies showing positive Output Growth	40	40	40
Average TFPG Growth	4.09	2.71	5.28
Average Output Growth	11.81	11.81	11.81
No. of Companies showing Increase in TFP Growth	32	31	34
Average TFPG Growth	6.95	5.21	6.05
Average Output Growth	13.59	13.32	12.86
No. of Companies showing Decline in TFP	8	9	6
Average TFPG	-7.34	-5.90	-2.96
Average Output Growth	4.69	6.61	2.34

Table 3
Productivity Performance of Companies at Aggregate Level
Post-Reform Period (1991-92 to 1994-95)

	Solow	Translog	Cornwell
Total No. of Companies	44	44	44
Average TFPG	-0.43	-1.49	3.04
Average Output Growth Share of TFPG in Output Growth	5.82 -7.39	5.82 -25.60	5.82 52.23
No. of Comp anies showing Increase in TFPG Average TFPG Average Output Growth Share of TFPG in Output growth	19 6.23 11.79 52.84	16 4.88 13.32 36.64	32 6.36 8.48 75.00
No. of Companies showing Decline in TFPG Average TFPG Average Output Growth	25 -5.49 1.28	28 -5.14 1.54	12 -5.84 -1.28
No. of Companies showing Posiive Output Growth Average TFPG Average Output Growth No.of Companies Showing Increase in TFPG Average TFP Growth Average Output Growth No. of Companies showing Decline in TFPG Average TFPG Average Output Growth	34 1.83 9.50 19 6.23 11.79 15 -3.73 6.59	34 0.79 9.50 16 4.88 13.31 18 -2.84 6.11	34 5.25 7.60 29 6.62 9.83 5 -2.76 7.60

Table 4

Distribution of Firms According To Total Factor Productivity Growth

	Pre- Reform			Post- Reform		
TFP Gr. (%)	Solow	Translog	Cornwell	Solow	Translog	Cornwell
Below -5%	8	8	1	9	10	5
-5% to <-2%	1	2	4	10	10	5
-2% to < 0%	2	2	4	6	8	2
0% to <2%	4	10	4	5	5	9
2% to <5%	16	11	13	4	5	6
5% to 10%	8	7	12	6	5	9
Above 10%	5	4	6	4	1	8
Total No. of Companies	44	44	44	44	44	44
Annual TFP Gr.(%)	3.18	1.97	4.69	-0.43	-1.49	3.04

Table 5

Estimates of TFPG Based on Translog Method of Measurement

Dependent Variable : TFPG

	OLS		FE		RE	
	Pre-Reform	Post-Reform	Pre-Reform	Post-Reform	Pre-Reform	Post-Reform
Constant	-0.0516*** (-7.319)	-0.0603*** (-8.170)			-0.0525*** (-6.25)	-0.0604*** (-8.077)
GO	0.6732*** (23.229)	0.7797*** (23.381)	0.6956*** (23.535)	0.8341*** (22.810)	0.6820*** (24.386)	0.7818*** (23.562)
LR Test	81.358*** [43]	53.268 [43]				
LM Test	7.8504*** [1]	0.0008 [1]				
HS Test	2.0243 [1]	11.571*** [1]				
R^2	0.71	0.76	0.80	0.82	0.71	0.76
No.	220	176	220	176	220	176

Note : Figures in the parentheses () are t-ratios, [] are d.f.
* Significant at 10%
** Significant at 5%

*** Significant at 1%

Table 6
Estimates of TFPG
Translog Method

Dependent Variable: TFPG

	Pre-Reform			**Post-Reform**		
	OLS	FE	RE	OLS	FE	RE
Constant	-0.0427*** (-2.864)		-0.0440*** (-2.669)	-0.0504*** (-2.604)		-0.0505*** (-2.458)
GO	0.6749*** (22.865)	0.6994*** (22.439)	0.6805*** (23.603)	0.7903*** (23.486)	0.8228*** (22.868)	0.7957*** (23.843)
MT	0.6446 (0.890)	-0.8570 (-0.701)	0.4549 (0.587)	0.5425 (1.475)	0.6244 (1.104)	0.5780 (1.530)
MMI	0.0485 (1.379)	0.0366 (0.405)	0.0497 (1.276)	0.1006*** (2.423)	0.1213 (1.359)	0.1030*** (2.367)
CGI	0.0016 (0.192)	0.0035 (0.399)	0.0020 (0.250)	-0.0435** (-2.278)	-0.0427** (-2.093)	-0.0433** (-2.284)
FE	-0.1278*** (-3.160)	-0.0653 (-0.945)	-0.1221*** (-2.824)	-0.0724* (-1.709)	-0.0399 (-0.455)	-0.0737* (-1.665)
RD	-1.7948* (-1.803)	0.1636 (0.111)	-1.5326 (-1.464)	-0.9881 (-0.727)	0.5068 (0.234)	-0.9233 (-0.658)
KLR	-0.0003 (-0.492)	-0.0004 (-0.294)	-0.0003 (-0.490)	-0.0015* (-1.688)	-0.0090*** (-2.718)	-0.0016* (-1.694)
XI	-0.0589 (-0.716)	0.0688 (0.436)	-0.0488 (-0.549)	0.0218 (0.242)	0.1323 (0.742)	0.0241 (0.257)
LR Test	67.352[43]			59.525[43]		
LM Test	1.2175[1]			0.0312[1]		
HS Test	8.8715[8]			14.9269*[8]		
R-Square	0.73	0.80	0.73	0.78	0.85	0.78
No. of Observation	220	220	220	176	176	176

Note : Figures in the parentheses () are t ratios, []are d f
* Significant at 10%
** Significant at 5%
*** Significant at 1%

Appendix-1

Output Deflators

Industry Group	RBI Group	WPI
Cables	445	IIkb2
Dry Batteries	446	IIIkb3(414)
Electric Lamps	447	IIIkb4(417+418)
Other Electrical Machinery,Apparatus, Appliances,etc.	448	IIIkb
Machine Tools	449	IIIka393
Textile Machinery and Accessories	450	IIIka2(385+386+387)
Miscellaneous Machinery n.e.s.	451	IIIka

Appendix-2

Wages Deflators

Industry Group	RBI Group	ASI
Cables	445	361
Dry Batteries	446	362
Electric Lamps	447	363
Other Electrical Machinery,Apparatus, Appliances,etc.	448	36-(361+362+363)
Machine Tools	449	357
Textile Machinery and Accessories	450	353
Miscellaneous Machinery n.e.s.	451	35-(353+357)

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