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CONTRIBUTION OF SERVICES TO OUTPUT GROWTH AND PRODUCTIVITY IN INDIAN MANUFACTURING: PRE AND POST REFORMS

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Contents

Foreword

The stylised facts about changes in sector shares as a country develops are by now well known. As per capita income starts to grow from a very low level, the share of agriculture in total GDP declines as does the proportion of people employed in agriculture. This decline continues till a minuscule share of population is employed in agriculture at the high-income level. As manufacturing is the leading sector in growth at low-income levels its share in GDP and the proportion of people employed in it rise. This share eventually stabilises and then starts to decline as the share of services rises at high-income levels. India has followed the standard pattern with respect to GDP shares but not with respect to the share of employment. The share of labour force in agriculture employment remains too high and that in manufacturing too low relative to the standard pattern of development. It has been argued that this is primarily due to the labour laws, rules and procedures applicable to any manufacturing organisation that wants to employ more than 100 people, which make it virtually impossible to remove an employee from service. The effective cost of an employee in such an organisation is therefore not just the current (nominal) wage but the lifetime wage arising from virtually guaranteed lifetime employment. The productivity of such employees can also fall sharply if they are convinced that they cannot be removed from service. The problem is compounded if the minimum wage for unskilled workers raises the wage above the marginal productivity of labour.

The service sector in India has during the last 55 years always grown faster than the tradable goods sector (manufacturing, agriculture and mining). Part of this is due to the traditionally slower growth of the Agriculture sector that underlies the conventionally expected structural transformation from agriculture to manufacturing. In the eighties, however, the rate of growth of services accelerated above that of manufacturing and the growth rate gap has widened in the nineties (ICRIER WP #122). With the phenomenal growth of exports of software and IT enabled services, attention has turned to the service sector. Some have seen this a panacea that allows India to bypass the policy problems of manufacturing employment and growth and go straight to the third stage of higher employment shares in modern services. Others have asserted that without manufacturing growth the high growth rates in services cannot be maintained, since services depend critically on manufacturing for their existence and in the absence of sufficient growth in manufacturing the tempo of services sector growth cannot be maintained.

Though there have been some studies analysing the prospects of a sustained, rapid growth of the services sector and put forward arguments in favour of or against that possibility, very few studies have empirically examined these issues. In particular, hardly any study exists that has made an empirical assessment of the growing importance of services input in the manufacturing sector and the contribution made by services to manufacturing output growth and productivity. This study attempts to fill this gap in the literature by introducing services as input in the production function for the Indian manufacturing sector.

This is a pioneering study on the role of services in production in India. Using the available data from the Annual Survey of Industries, it estimates a production function for registered manufacturing that explicitly includes services as an input along with energy and materials (and labour & capital). These estimates are then used to evaluate the contribution of different inputs to overall manufacturing output (sources of growth). It shows that though service inputs contributed little to production of the registered manufacturing sector during the eighties, the contribution of services has increased dramatically during the nineties. The study then goes on to estimate Total Factor Productivity. A significant positive relationship is found between technology acquisition and productivity.

To understand what caused the use of services in manufacturing to go up in the 1990s, a multiple regression analysis has been undertaken. The results of the analysis indicate that trade reforms played an important role in increasing the use of services in the manufacturing sector. The implication of the research findings is that the services sector in India has augmented its own demand by raising output growth and productivity of the manufacturing sector in the post-reforms period and this should help the services sector to a certain extent to sustain its growth performance.

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Contribution of Services to Output Growth and Productivity in Indian Manufacturing: Pre and Post Reforms

Rashmi Banga* and Bishwanath Goldar**

Abstract

As an input to the production process, services are playing an increasingly important role in manufacturing industries, world over. Yet, this fact has received very little attention in the empirical economic literature on producer behavior and productivity. The production function and productivity studies for manufacturing industries have commonly applied the value-added function or the KLEM (capital-labor-energy-materials) production function as the basic framework of analysis in which the contribution of services to production and productivity does not get an explicit recognition. The present paper aims at filling this gap in the literature. An analysis of the contribution of services to output growth and productivity in Indian manufacturing is carried out using the KLEMS (capital-labor-energy-materials-services) production function framework, explicitly recognizing services as an input to the production process. Panel data for 148 three-digit level industries for 18 years, 1980-81 to 1997-98, are used for estimating the production function, using which an analysis of sources of growth is undertaken. The results of the analysis bring out that the growing use of services had a significant favorable effect on growth of output in Indian manufacturing in the 1990s, when major trade and industrial reforms were carried out. The contribution of services input to output growth in manufacturing (organized) was about one per cent in the 1980s, and it increased to about 25 per cent in the 1990s. To study the impact of services input on manufacturing productivity, a multilateral total factor productivity index is constructed for 41 major industry groups for the period 1980-81 to 1999-00, with and without services. It is found that the productivity growth estimate for the post-reforms period is over-stated when services are not taken into account. Regressing the total factor productivity index on a set of explanatory variables including the ratio of services input to employment, a positive relationship is found between services input and industrial productivity. It seems from the results that the increasing use of services in manufacturing in the 1990s might have favorably affected productivity. Multiple regression analysis undertaken to explain inter-industrial and inter-temporal variations in the intensity of use of services in Indian industries, using data for 41 major industry groups for the period 1980-81 to 1999-00, indicates that trade reforms were responsible in a significant measure for the rapid growth in use of services in manufacturing in the 1990s. The process appears to have been aided by other reforms undertaken in this decade.

Key words: use of services, Indian manufacturing, sources of growth, industrial productivity, trade reforms

JEL Code: D24, L60, L80

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1. Role of Services as Input to Manufacturing

Economic growth has been associated with increasing share of services in GDP, investment and employment (Fisher, 1935; Clark, 1940; Kuznets, 1957; Chenery, 1960; Fuch, 1968). Different explanations have been put forward to explain this phenomenon. These include high-income elasticity of demand for final product services[1], slower productivity growth in services and structural changes, which make contracting out services more efficient than producing them in the firm or household.

Cross-country analysis has revealed that the share of services in aggregate output and employment rises with the level of development (Francois and Reinert, 1996; Kongsamut *et al*., 1997). Making comparison across countries, a positive relationship has been found between the level of per capita income and the intensity of use of services in manufacturing industries (Francois and Reinert, 1996). A part of the growth in use of services in manufacturing is due to splintering, i.e. outsourcing of indirect production activities (Bhagwati, 1984). But, a bigger part is attributable to certain structural changes in manufacturing industries (Francois and Reinert, 1996). These are changes taking place within the manufacturing industries, raising their demand for services as intermediate input.[2]

Industrial firms make use of services procured from outside because of the advantages these services offer. The use of services adds value to the firms' produce and

[1] There is a great deal of overlap between the output of service industries and final product services, but the former includes purely intermediate activities as well as activities that are considered intermediate when performed for a business purchaser and as final when performed for a household (e.g., repair and maintenance).

[2] Two different approaches have been taken to explain the inter-relationship between the services sector and the manufacturing sector. One set of studies argue that the demand for producer services grows with development and this expansion is linked to growth in round-about production and the associated conversion of local markets into national markets (e.g., Greenfield, 1966; Katouzian, 1970; and Francois, 1990). As against that, Bhagwati (1984), in his seminal work, emphasized "splintering" or outsourcing of indirect production activities as a possible source for the apparent growth in producer services. He put forward different ways in which technical and structural changes define a continuous process during which services splinter-off goods and goods splinter-off services. He argued that services that splinter-off from goods are technically progressive and possibly capital-intensive since these services arise due to specialization, which reflects economies of scale. Being a part of dynamic process of change in the economic system they are not technically stagnant. But the services that are left after the goods-from-services splintering process are mostly technically unprogressive and labor intensive.

helps in cutting down costs of operations, both contributing to productivity of firms. Since procurement of services from an outside agency would generally be cheaper than in-house provision of the services, outsourcing saves costs. Globalization, adoption of modern manufacturing practices such as Just-in-time and Build-to-order, and increasing export orientation make it necessary for industrial firms to use high quality services of various kind which have to be procured from specialized service providers. Thus, to what extent a manufacturing firm will use, in the production process, services procured from outside depends on:

(1) the pressure on the firm to raise efficiency, reduce cost and improve competitiveness, which in turn depends on the domestic and international competition it is facing,
(2) the availability of services, which depends on the level of development of the services sector in the economy, and
(3) the relative cost of in-house provision of services as against their procurement from outside agencies, which depends among other factors on the size of the firm and the wage rate prevailing in the firm.

There is growing recognition that services procured from service provider firms are increasingly becoming an important input to manufacturing. The growing complexity of manufacturing production and distribution resulting from the application of new technologies, and increasing problems of coordination caused by these changes in manufacturing firms are raising the service content of manufactured goods (Guerrieri and Meliciani, 2003). Yet, this fact has so far received very little attention in the empirical economic literature on producer behavior and productivity. The empirical studies on production function or productivity in industries undertaken prior to the 1980s mostly used a two-input framework in which value added was taken as the measure of output, and labor and capital as two inputs. This framework did not explicitly recognize the role of services in the production process. Many studies undertaken in the 1980s and later used the KLEM (capital-labor-energy-materials) production function framework in which the role of materials and energy found explicit recognition, but that of services did not. How these studies treated services while measuring inputs, was not always clearly spelt out. However, it seems many of the studies employing the KLEM framework took services as a part of materials input, M. Thus, the price index for materials was used for deflating the value of services as well, which can obviously be questioned. Also, the lumping of services with materials involved restrictive assumptions about the substitutability between materials and services and the substitutability of these inputs with other inputs, such as labor, capital and energy.

In recent years, there has been some appreciation of the need for taking services as a separate input in the production function for carrying out productivity analysis. The OECD productivity manual (OECD, 2001), for instance, generalizes, at the conceptual level, the KLEM model to KLEMS (capital-labor-energy-materials-services) model by including the services as an input. However, it is hard to find an actual empirical study on production function or productivity in which services have been taken as a separate input. The present paper aims at filling this gap in the literature. To this end, a study of the contribution of services to output growth and productivity in Indian manufacturing industries is undertaken using the KLEMS production function framework.

To indicate the importance of the issue, it may be pointed out that there has been a rapid growth in the services sector in India in the last two decades, especially in the 1990s, a decade of major trade and industrial reforms[3] in India (Gorden and Gupta, 2003; Virmani, 2004). During 1981-90, services sector output grew at the rate of 6.6 per cent per annum. During 1991-00, the growth rate was 7.5 per cent per annum, ahead of the growth rate of industry at 5.8 per cent per annum and that of agriculture at 3.1 per cent per annum. Business services have been the fastest growing sector in the 1990s, attaining a growth rate of about 20 per cent per annum. Some of the other services sectors which have grown relatively fast in the 1990s are communication (growth rate, about 14 per cent per annum) and banking (13 per cent per annum), both of which are extensively used by industries. Against this backdrop, three questions addressed in the paper are:

[3] Since 1991, India has undertaken a major economic reforms program. Under the program, significant and far-reaching changes have been made in industrial and trade policy. Import liberalization has been a principal component of the economic reforms undertaken. Tariff rates have been brought down considerably and quantitative restrictions on imports have been by and large removed. For a discussion on India's economic reforms since 1991, see Joshi and Little (1996), among others.

(1) What has been the contribution of services to the growth in Indian manufacturing industries? Has the relative contribution of services to industrial growth increased in the post-reforms period?
(2) Has the growing use of services as input contributed to increases in productivity in Indian manufacturing industries?
(3) To what extent the fast growth in use of services in Indian industries is a consequence of the economic reforms, particularly trade reforms undertaken in the 1990s?

The rest of the paper is organized as follows. The next section discusses briefly the data sources for the study and the measurement of output and inputs of manufacturing industries. Section 3 presents estimates of a KLEMS production function for Indian manufacturing, using which a supply-side analysis of sources of growth in manufacturing is carried out for the period 1980-81 to 1999-2000 and separately for the 1980s and 1990s, based on the growth accounting framework. The principal aim is to assess the contribution of services to industrial growth. In Section 4, an analysis of the effect of services input on industrial productivity is undertaken. For this purpose, a multilateral total factor productivity index is constructed for 41 major industry groups (comprising the manufacturing sector) for the period 1980-81 to 1999-00, with and without services. To assess the effect of services input on productivity, the total factor productivity index is regressed on a set of explanatory variables including technology acquisition intensity and the ratio of services input to employment. Section 5 presents the results of a multiple regression analysis undertaken to explain inter-industrial and inter-temporal variations in the intensity of use of services in manufacturing industries. The purpose is to ascertain if the growing use of services in Indian industries in the 1990s had something to do with the economic reforms, particularly trade reforms. This analysis is based on data for 41 major industry groups for the period 1980-81 to 1999-2000.

2. Data Sources and Measurement of Output and Inputs

The study uses two data sets. One is at a more aggregated level, i.e., for 41 major industry groups (comprising the organized manufacturing sector) for the period 1980-81 to 1999-00. It was prepared for a research project undertaken at the ICRIER on the impact of tariff policy reform on Indian industries (Virmani, et al., 2003, 2004). The other data set is at a more disaggregated level, covering 148 three-digit level industries[4] for the period 1980-81 to 1997-98. Some details on the data sources and measurement of variables are given below.

2.1 Data Sources

For measuring output and inputs, data have been drawn mainly from the *Annual Survey of Industries* (ASI), published by the Central Statistical Organization (CSO), Government of India. The *Economic and Political Weekly* has created a systematic, electronic database using ASI results for the period 1973-74 to 1997-98 (hereafter, EPW database). Concordance has been worked out between the industrial classifications used till 1988-89 and that used thereafter (NIC-1970 and NIC-1987), and comparable series for various three- and two-digit industries have been prepared. ASI data at three-digit industry level according to NIC-1987 could be obtained for 1998-99 and 1999-00 from a special tabulation of ASI results, which was done by the CSO and made available to the ICRIER for a study on trade protection and its impact on industrial productivity (Das, 2003a, 2003b). The time series on value of output and inputs at nominal prices at the level of three-digit industries have been aggregated to obtain the series for the 41 industry groups (a list of industry groups is given in Annex I). The series at nominal prices have been deflated to obtain real output and input series.

For the purpose of deflating output and inputs, wholesale price indices have been used, taken from the official series on *Index Number of Wholesale Prices in India*. Construction of materials and energy price indices requires input-use weights, for which

[4] These industries together constitute almost the entire organized manufacturing sector.

the input-output matrix for 1993-94 prepared by the CSO has been used. A similar approach has been taken for constructing a deflator for services.

The EPW database mentioned above has been used to obtain data on output and inputs for 148 three-digit industries for the period 1980-81 to 1997-98. The time span for the disaggregated data set has not been extended beyond 1997-98 because ASI has changed its industrial classification after 1997-98. The measurement of output and input for this data set has been done more or less in the same manner as for the data-set for 41 industry groups. This is discussed further in Section 2.2.

The regression analysis presented in Section 4 uses variables representing technology acquisition and foreign direct investment as determinants of productivity along with export intensity of industries and the ratio of services input to output. Data on export intensity of industries, foreign direct investment and technology acquisition intensity have been taken from the Prowess database of the CMIE (Center for Monitoring Indian Economy, Mumbai). Export intensity is measured by the ratio of exports to sales. The share of foreign companies in total sales of the industries has been taken as the indicator of the level of foreign direct investment. An index of technology acquisition intensity inflow has been constructed using data on R&D expenditure, payment of royalty and technical fees for technology imports, and capital goods imports. The construction of the index has been done in two steps. First, the relevant ratios (e.g. R&D expenditure to sales) have been constructed for the 41 major industry groups from firm level data taken from the Prowess database of the CMIE. Next, applying the principal component analysis and taking the first principal component, the index has been formed. The index combines the three technology related variables using factor loadings as weights.

For the regression analysis presented in Section 5, industry-wise tariff rates and non-tariff barriers are used as explanatory variables. These have been taken from the data set prepared for the ICRIER research project on impact of tariff policy reforms (Virmani, et al, 2003, 2004) mentioned earlier. The time-series on tariff and non-tariff barriers on imports for the 41 industry groups have been compiled from several sources. The main data source on tariff rates and non-tariff barriers (percentage import coverage by quantitative restrictions) is the previously mentioned study on trade protection undertaken at the ICRIER (Das, 2003a). Since Das has not covered all three-digit industries, it has been necessary to use other sources. Tariff rates and non-tariff barriers at the level of industrial groups (66 sectors of Input-Output table) have been taken form Goldar and Saleem (1992), NCAER (2000) and Nouroz (2001). For some industry groups, it has been necessary to interpolate the tariff rates or import coverage ratios, as these are not available for all the years of the period under study. For some industries, the import coverage ratio is not available for years prior to 1988-89. For such industries, the figure for 1988-89 has been applied for all earlier years of the 1980s. This should not introduce any serious error in the data on non-tariff barriers, because quantitative restrictions covered a very high proportion of imports of manufactures throughout the decade.[5]

2.2 Measurement of output and inputs

Output: For each industry group and each three-digit industry, real gross output has been obtained by deflating the nominal figures by the wholesale price index for the group or industry.[6] The best deflator that could be formed from the wholesale price index series has been used.

Labor: Total number of persons engaged is taken as the measure of labor input. This includes working proprietors.

[5] For aggregate manufacturing, the proportion of imports covered by quantitative restrictions was about 90 per cent in 1988-89. Note further that in actual application in regression analysis, a dummy variable has been created to represent non-tariff barrier, taking 50 per cent as the cutoff level. Needless to say that the use of dummy variable in place of actual values makes the regression results less sensitive to errors in data on non-tariff barriers.

[6] Note here that, for deflating the output of 41 industry groups, the wholesale price index has been adjusted for changes in excise duty rate over time. Adjusting the wholesale price index for inter-temporal changes in excise duty rate applicable to the relevant product category yields in effect an index of producers' price which is obviously more relevant for deflation of output and value added.

Capital: Net fixed capital stock at constant prices is taken as the measure of capital input. The construction of the net fixed capital series has been done by the Perpetual Inventory method. The method of construction of fixed capital series is explained further in Annex II.

Materials input: The reported series on materials has been deflated to obtain materials input at constant prices. Following a common practice among productivity studies, a deflator for materials has been constructed with the help of an input-output (IO) table. The 1993-94 input-output table prepared by the CSO has been used for this purpose. The table has 115 IO sectors of which 66 belong to manufacturing. The deflator for each industry group is formed as a weighted average of price indices for various IO sectors (for each sector including agricultural and mining products, the best price series available from the official series on wholesale price indices has been used). For each IO sector or group of sectors corresponding to an industry group considered in the study, the column(s) in the absorption matrix gives the purchases of materials made by the industry group from various sectors including intra-industry transactions. This information is used for constructing weights.[7]

The 41 industry groups were mapped into the 66 sectors of the input-output table belonging to manufacturing for construction of materials price indices. To get the price indices for the three-digit industries, the price indices were first constructed for the above-mentioned 66 IO sectors and then the price index for each sector was applied for all the three-digit industries belonging to that sector.

Energy input: Energy input at constant prices is obtained in a manner similar to that for materials. For each industry group, a price index for energy is formed considering the

[7] A number of studies on productivity trends in Indian industries have constructed deflator for materials used in manufacturing in this manner. See, Rao (1996) and Goldar and Kumari (2003), among others.

relative expenditures on coal, petroleum products and electricity made by the constituent IO sectors, as given in the input-output table for 1993-94, and using the wholesale price indices for these three categories of energy inputs.

For the three-digit industries, a similar method has been applied. The price index for energy has been constructed for each of the 66 IO sectors engaged in manufacturing, and then the price index for each sector has been applied to the three-digit industries belonging to that sector.

Services: ASI does not provide data on services used by industrial enterprises. However, data are reported on materials, energy (coal, petroleum products, wood, electricity, gas, etc.) and total inputs. According to the definition of 'total input' in the ASI, it includes, besides the cost of material, power and fuel, the following cost items: (a) cost of contract and commission work done by others on materials supplied by the factory, (b) cost of materials consumed for repair and maintenance of factory's fixed assets including cost of repair and maintenance work done by others to the factory's fixed assets, and (c) inward freight and transport charges, postage and telephone charges, insurance charges, banking charges, etc. The difference between total inputs and the cost of materials and energy (hereafter referred to as 'other input cost') has been taken as a measure of services purchased by the industrial units. This is justified because a major part of 'other input cost' is likely to be on account of services procured from other agencies.[8] The series, so obtained, has been deflated to correct for price changes. For this purpose, a deflator for services has been constructed from the *National Accounts Statistics* (NAS). The input-output table for 1993-94 provides information on the purchases of services (transport, banking and insurance, etc.) made by the manufacturing industries in that year. For various services sectors, the NAS reports GDP at current and constant prices, which have

[8] According to information obtained from the CSO (private communication from Director, Industrial Statistics Wing, CSO), the cost of work done by other units on materials supplied by the factory constituted about 12 percent of 'other input cost' in 2001-02. Some important cost items under 'other input cost' are operating costs, non-operating costs, insurance charges, and cost of repair and maintenance of building, plant and machinery, and other fixed assets. Considering the definition of 'total input' in ASI and available

been used to compute implicit deflators. The input-output table indicates the weights to be used for combining them; these are the flows from the services sectors to the manufacturing industries. Thus, a weighted average of the implicit deflators of different services sectors has been taken and a deflator of services purchased has been formed for each of the 41 industry groups.

To obtain price index for services for three-digit industries, these have been computed for the 66 IO sectors engaged in manufacturing (applying the methodology described above), and then the index computed for a sector is applied to all three-digit industries belonging to that sector.

3. Contribution of Services to Industrial Growth

As mentioned earlier, the analysis of supply-side sources of growth of Indian manufacturing is based on a KLEMS production function estimated from panel data. The production function may be written as:

$$Q_{it} = f(K_{it}, L_{it}, E_{it}, M_{it}, S_{it}; A_{it}) \quad ...(1)$$

where Q denotes gross output, K capital, L labor, E energy (fuel and power), M materials, and S services. The subscripts i and t are for industry and time (year). The term A_{it} represents 'technology'. Through this term, inter-industrial and inter-temporal variations in total factor productivity are incorporated into the production function.

For empirically applying the above equation, the functional form needs to be specified. To keep the analysis simple, a Cobb-Douglas functional form has been chosen. The efficiency term A_{it} has been specified as $\exp(c_i) + \exp(\lambda t)$, where t denotes time. Accordingly, after logarithmic transformation, the equation to be estimated becomes:

information on important cost items included in total input other than materials and energy, it appears that services form a major part of 'other input cost'.

$$\ln(Q_{it}) = c_i + \lambda t + \alpha \ln(L_{it}) + \beta \ln(K_{it}) + \gamma \ln(M) + \delta \ln(E_{it}) + \nu \ln(S_{it}) + \varepsilon_{it} \quad ...(2)$$

where ε is the random error term.

The data set on output and inputs for 148 three-digit-level industries for 18 years, 1980-81 to 1997-98, described in Section 2 above, has been used for estimating the production function given in equation (2). The estimates are presented in Table 1. Estimation has been done by both the fixed-effects model and the random-effects model.

It is seen from Table 1 that the estimates obtained by the fixed-effects and the random-effects models are quite close to each other. Going by the p-value for Hausman test, the estimates obtained by the random-effects model should be preferred.

Table 1: Estimates of KLEMS Production Function, Indian Manufacturing

Dependent Variable: ln(*Q*) Period: 1980-81 to 1997-98

Explanatory Variables	**Fixed-Effects**		**Random-Effects**	
	Coefficients	t-Statistics	Coefficients	t-Statistics
ln(*K*)	0.048*	5.19	0.051*	5.95
ln(*L*)	0.038*	2.58	0.049*	4.21
ln(*E*)	0.098*	9.29	0.095*	10.41
ln(*M*)	0.672*	61.33	0.666*	67.97
ln(*S*)	0.128*	16.77	0.131*	17.71
t (time)	0.003*	3.10	0.003*	3.4
No. of observations	2655		2655	
Overall R^2	0.987		0.987	
Hausman statistics			8.57	
Wald Chi^2 (6)			58978.35	

Notation: *Q* = real value of gross output, *K* = capital input, *L* = labor, *E*= energy, *M*= materials, and *S*= services.

* statistically significant at one per cent level.

Note: (1) due to data gaps, a few observations have been left out. (2) The null hypothesis for the Hausman test is that the coefficients in the fixed-effects and random-effects specifications are not different systematically. A rejection of the null implies that the random effects are correlated with the other regressors, and hence the estimates from the random-effects specification are biased.

The estimated coefficients of all the inputs are statistically significant at one per cent level. The coefficients of inputs are positive and less than one, consistent with the underlying theory of producer behavior. The sum of the four coefficients is 0.984 in the case of the fixed-effects model and 0.992 in the case of the random-effects model. The hypothesis of constant returns to scale is not rejected by the estimates of the production function.

Analysis of sources of output growth in manufacturing is presented in Table 2. Separate analyses have been carried out for the periods 1980-81 to 1989-90 and 1989-90 to 1999-00, and for the entire period 1980-81 to 1999-00. The estimated coefficients of the KLEMS production function obtained by the random-effects model have been used for the decomposition of output growth (guided by p-value for Hausman test). The estimates of parameters α, β, γ, δ and ν give the elasticities of output with respect to labor, capital, materials, energy and services respectively. The contribution of each input to output growth is computed by multiplying the trend growth rate of the input[9] with the elasticity of output with respect to that input. Adding together the contributions of inputs, the growth rate of total input is obtained. The gap between the growth rate of output and the growth rate of total input gives the growth rate of total factor productivity.

The estimates of growth rate in real gross output and the five inputs for the two sub-periods and the entire period 1980-81 to 1999-00 are based on the output and input estimates for aggregate manufacturing for the period 1980-81 to 1999-00 made by Goldar (2004). The measures of output and input used in Goldar (2004) are the same as that used in this study.

[9] Exponential trend equations are fitted to the time-series on output and inputs to obtain the trend rates of growth for the period 1980-81 to 1999-00. To get the trend growth rates for sub-periods, the kinked exponential model is used. See Boyce (1986) for a discussion on this method of estimating sub-period growth rates.

Table 2: Source of Growth in Indian Manufacturing, 1980-81 to 1999-00

(per cent per annum)

	1980-81 to 1999-2000	1980-81 to 1989-1990	1989-90 to 1999-2000
Growth rate of output	7.63	7.21	8.12
Growth rates of inputs			
Capital	8.76	7.41	10.34
Labor	1.46	0.62	2.44
Energy	7.37	9.27	5.16
Materials	7.26	7.49	6.99
Services	7.52	0.42	15.78
Contribution of inputs to output growth			
Capital	0.45	0.38	0.53
Labor	0.07	0.03	0.12
Energy	0.70	0.88	0.49
Materials	4.84	4.99	4.66
Services	0.99	0.06	2.07
Growth rate of total input	7.04	6.33	7.86
Total factor productivity growth rate	0.59	0.88	0.26
Relative contribution of services to output growth (%)	13.0	0.8	25.5
Relative contribution of TFP growth to output growth (%)	7.7	12.2	3.2

From the growth decomposition analysis presented in Table 2, it is seen that the trend growth rate of real gross output of aggregate manufacturing was 7.21 per cent per annum during 1980-81 to 1989-90 and 8.12 per cent per annum during 1989-90 to 1999-00. The growth rate of total input was 6.33 per cent per annum during 1980-81 to 1989-90 and 7.86 per cent per annum during 1989-90 to 1999-00. Thus, the growth rate in total factor productivity (TFP) [10] was about 0.9 per cent per annum during 1980-81 to 1989-90 and lower at about 0.3 per cent per annum during 1989-90 to 1999-00. For the entire period, 1980-81 to 1999-00, the growth rate of output was 7.63 per cent per annum and

[10] Note here that these estimates of total factor productivity are based on elasticities derived from the estimated production function, and hence not strictly comparable with the TFP estimates that use income shares of factors as weights.

the growth rate of total input, 7.04 per cent per annum. The growth rate of TFP in this period was about 0.6 per cent per annum.

Real value of services used in manufacturing grew at the rate of about 0.4 per cent per annum in the 1980s and the growth rate increased sharply to about 16 per cent per annum in the 1990s. The contribution of services to output growth was a meager 0.06 per cent per annum during the 1980s, which increased substantially to 2.07 per cent per annum during the 1990s. The relative contribution of services to output growth was about one per cent in the 1980s and it increased to about 25 per cent in the 1990s.[11] Thus, the results indicate that increased use of services in industrial firms made a significant contribution to industrial growth in India in the 1990s.

4. Impact of Services on Productivity in Manufacturing

To study the effect of increased use of services on manufacturing productivity, a Multilateral TFP Index has been constructed. The index may be written as:

$$TFP_{bc} = \left(\frac{Q_b}{Q_c}\right)\prod_i \left(\frac{X_{zi}}{X_{bi}}\right)^{(S_{bi}+S_{zi})/2} \prod_i \left(\frac{X_{ci}}{X_{zi}}\right)^{(S_{ci}+S_{zi})/2} \quad (i = K, L, E, M, S) \quad ...(3)$$

The index varies across industries and over time. It expresses the productivity level in industry-year b as a ratio to the productivity level in industry-year c. Q denotes real value of gross output. X_{bi} is the i'th input (K capital input, L labor, E energy input, M materials, and S services) for industry-year b, and X_{ci} is that for industry-year c. X_{zi} is the geometric average of i'th input across all observations. S_{bi} and S_{ci} are the income

[11] This finding remains unchanged even if average income shares of inputs are used for the growth accounting instead of the elasticities obtained form the estimated production function as done in Table 2. It needs to be noted, however, that a part of 'other input cost' is not expenditure on services. It includes payment for materials purchased by the factory for repair and maintenance of its plant and equipment, payment of land lease etc. The implication is that if income shares are used as weights and expenditure on materials, land lease etc are separated out from 'other input cost', then the estimated contribution of services to growth of manufacturing output in the 1990s would be less than 25 per cent, but probably not much less.

shares of i'th input for industry-year b and c respectively. S_{zi} is the arithmetic average of income share of i'th input across all observations.

The Multilateral Total Factor Productivity Index (MTFPI) has been computed for 41 industry groups for 20 years, 1980-81 to 1999-00, from the aggregate level panel data set mentioned earlier.[12] Based on the MTFPI, Table 3 presents the trend growth rate in total factor productivity in Indian manufacturing for the periods 1980-81 to 1989-90 and 1990-91 to 1999-00, and for the entire period 1980-81 to 1999-00. To arrive at a summary estimate of TFP for the manufacturing sector, a weighted average of MTFPI across industries has been taken for each year, using value-added weights. The trends growth rates shown in the table are for the average index so computed.

An interesting question to be examined in this context is whether the inclusion of services as an input make a significant difference to the estimates of growth in total factor productivity. Therefore, an alternate multilateral total factor productivity index has been formed by considering only four inputs, namely labor, capital, materials and energy, and leaving out services[13]. This index is denoted by MTFPI*. Table 3 presents, for different periods, a comparison of trend growth rates in TFP in manufacturing based on MTFPI and MTFPI*.

Table 3: Trend growth rate in TFP in manufacturing based on multilateral total factor productivity index

(per cent per annum)

Period	Trend Growth rate based on MTFPI	Trend Growth rate based on MTFPI* (index excluding services)
1980-81 to 1989-90	1.3	0.5
1990-91 to 1999-00	0.5	1.1
1980-81 to 1999-00	0.8	0.7

[12] We have chosen textiles (excluding carpet making and readymade garments) in 1980-81 as the base for computing the multilateral TFP index. Our output-input data starts from 1980-81, and in that year textiles topped the list in terms of value added. It accounted for about 19 percent of gross value added in manufacturing (registered). This is the rationale for choosing textiles in 1980-81 as the base for making productivity comparisons.

[13] The productivity is estimated using KLEM production function.

The trend growth rate in MTFPI (average across industries) is found to be 1.3 per cent per annum for the period 1980-81 to 1989-90 and lower at 0.5 per cent per annum for the period 1990-91 to 1999-00. For the entire period 1980-81 to 1999-00, the trend growth rate in the index is 0.8 per cent per annum. By comparison, the trend growth rate in MTFPI* (index without services) is 0.7 per cent per annum for the period 1980-81 to 1999-00. For the two sub-periods, the trend growth rates are 0.5 and 1.1 per cent per annum respectively. It is interesting to observe that while the trend growth in MTFPI* is lower than that in MTFPI for the 1980s, the opposite is true for the 1990s. This may be explained by the fact that the growth in services input in manufacturing was slower than that in other inputs in the1980s, whereas in the 1990s, services input grew faster than other inputs (see Table 2). Evidently, the estimate of productivity growth for the post-reforms period is over-stated when use of services in manufacturing is not taken into account.

When growth rates in MTFPI and MTFPI* (index without services) are compared for individual industrial groups for the 1980s, the growth rate in MTFPI is found to be relatively higher in 38 cases out of 41. By contrast, for the 1990s, the growth rate in MTFPI is found to be relatively lower than that of MTFPI* in 35 cases out of 41. In 13 cases, the growth rate in MTFPI falls short of that in MTFPI* by about one percentage point per annum or more. Evidently, when service input is not taken into account, among inputs causes the multilateral total factor productivity index over-estimates productivity growth in Indian manufacturing industries in the post-reform period.

To assess the impact of increased use of services on total factor productivity in manufacturing, the following equation has been estimated:

$$\ln(MTFPI)_{it} = \phi_0 + \phi_1 \ln(S/Q)_{it} + \phi_2 \ln(TECH)_{i,t-1} + \phi_3 \ln(FS)_{i,t-1} + \phi_4 \ln(XI)_{i,t-1} + \xi_{it} \quad ...(4)$$

In this equation, MTFPI denotes the multilateral TFP index (five-input based; varying across industries and over time; textiles in 1980-81 being taken as 1.0) and ξ is the random error term. S denotes the real value of services used. For the purpose of normalization, it has been divided by output. If the use of services has a favorable effect on productivity, this should show up in a positive coefficient of *S*/Q. Three other factors, which are expected to influence industrial productivity, have been included in the regression equation. TECH represents technology acquisition intensity. It is based on R&D intensity, technology import intensity and capital goods import intensity. As mentioned earlier, these three ratios have been computed separately for the 41 industries for different years, and then an index has been formed by applying the principal component analysis. FS denotes foreign share. It is measured by the ratio of the sales of foreign firms to total industry sales. XI denotes export intensity. It is measured by value of exports as ratio to sales. For TECH, FS and XI, we hypothesize a positive relationship with productivity. These variables have been included in the equation with one-year lag to take care of any problem of simultaneity that might arise between industrial productivity and these explanatory variables.

Since data on TECH, FS and XI could be obtained only for the 1990s, the regression equation has been estimated using data for the period 1990-91 to 1999-00. As noted earlier, the use of services in manufacturing grew rapidly in the 1990s. Thus, for assessing the impact of services on industrial productivity, an analysis based on the data for the 1990s is more appropriate. The regression results are presented in Table 4. Since panel data are used, fixed and random-effects model have been estimated. Based on the *p-value* of Hausman statistics, Random effects model is preferred.

From the regression results presented in Table 4, it is seen that the coefficients of technology acquisition (TECH), foreign direct investment (FS) and export intensity (XI) variables are positive as expected. The coefficient of TECH is statistically significant indicating that technological improvements lead to higher productivity. The coefficient of XI is not statistically significant, but the t-ratio of the coefficient is more than one. This is suggestive of a favorable effect of increased export intensity on industrial productivity.

Table 4: Effect of Services on Productivity in Indian Manufacturing, 1990-91 to 1999-00, Regression Results

Dependent Variable: ln(multilateral total factor productivity index)

Explanatory Variables	Fixed-Effects		Random-Effects	
	Coefficients	t-Statistics	Coefficients	t-Statistics
ln(services/output)	0.0214**	2.48	0.0256**	2.95
ln(TECH)	0.0075#	1.85	0.0080*	1.99
ln (FS)	0.0003	0.24	0.0007	0.56
ln (XI)	0.0068	1.34	0.0069	1.39
Constant			0.1121**	3.06
No. of observations	410		410	
Overall R^2	0.15		0.17	
Hausman statistics			5.54	
Wald Chi 2 (4)			16.73	

** statistically significant at one per cent level. * statistically significant at five per cent level.
# statistically significant at ten per cent level

Notation: TECH= index of technology acquisition intensity (based on R&D, technology imports and capital goods imports); FS= foreign share (indicator of foreign direct investment); XI = export intensity.

The coefficient of services variable is positive and statistically significant at one per cent level. The equation was re-estimated after dropping some of the other explanatory variables, and in all cases, the coefficient of the services variable was found to be statistically significant at one per cent level. It seems reasonable therefore to interpret the regression results as suggestive of a positive relationship between services input and industrial productivity. Accordingly, it seems that the growing use of services in manufacturing in the post-reforms period might have contributed to better productivity performance.

5. Have Trade Reforms Caused Increased Use of Services in Manufacturing?

To examine the reasons for higher use of services in the manufacturing sector in the post reforms period, we estimate the impact of the factors discussed earlier in Section 1, i.e., higher competition, higher relative cost of using in-house services and development of services sector in the post reforms period. For the analysis, we use aggregated data set for 41 industry groups for the years 1980-81 to 1999-2000.

It has been noted above that in the post-reform period there was a marked acceleration in the growth rate of services used in Indian manufacturing. It should be pointed out in this connection that this acceleration in growth of services used was almost across-the-board. Since competition can drive industrial firms to increase the use of services procured from outside with a view to gaining competitiveness, the observed rapid increase in the use of services in manufacturing in the 1990s may be connected with the trade reforms. To examine the impact of trade reforms on the use of services in the manufacturing sector, the following equation has been estimated:

$$\ln(S/Q)_{it} = \theta_0 + \theta_1 \ln(W/P)_{it} + \theta_2 TRF_{it} + \theta_3 NTB_{it} + \theta_4 DUM + \zeta_{it} \quad ....(5)$$

Here, S/Q, i.e., service use intensity (value of services used as a ratio to the value of output, both at constant prices) is taken as the dependent variable. ζ is the random error term. W/P is the ratio of nominal wage rate to the price index of services. A fast increase in wage rate in relation to the increase in price index of services would create a situation conducive to splintering because the industrial firms will find procurement of services from outside more economic than in-house provision. Accordingly, the coefficient of this variable is expected to be positive.

Tariff rate adjusted for changes in real effective exchange rate[14] (denoted by TRF) and percentage of imports covered by non-tariff barriers (denoted by NTB) are included

[14] Tariff rate has been adjusted for changes in real effective exchange rate because the effect of lowering of tariff may be offset partly by depreciation in the real effective exchange rate.

among the explanatory variables.[15] Inasmuch as lowering of tariff and non-tariff barriers on manufactured imports intensifies competition and hence induces the domestic industrial firms to improve their competitiveness by increasing use of services procured from outside, a negative coefficient of these variables is expected.

Apart from these, there are other variables that would influence the intensity of use of services in the manufacturing sector. Some important examples are the growth of the services sector and changes in market structure due to industrial policy reforms. While these factors are important, due to of lack of data it is difficult to include them as specific explanatory variables in the regression equation. The best that could be done was to introduce a dummy variable for the 1990s (denoted by DUM). The dummy variable is expected to capture the effect of a number of variables including the growth of services sector in the 1990s and various economic policy changes made in this decade, especially those that helped in the development of the services sector. It seems reasonable to expect a positive coefficient for this variable.

The results of multiple regression analysis are reported in Table 5. These are based on panel data for 41 industry groups for 20 years, 1980-81 to 1999-00. Since panel data are used for the analysis, panel data estimation techniques have been applied. Estimates of both the fixed-effects and random-effects model are presented in the table. The *p-value* of Hausman statistics indicates that the fixed-effects model should be preferred.

[15] Since both tariff rates and non-tariff barriers were lowered in the 1990s, these two variables are correlated. Therefore, the regression results get affected when both variables are included in the regression. To tackle this problem, a dummy variable for non-tariff barrier has been used. It takes value one if the level of barrier is more than 50 per cent, zero otherwise.

Table 5: Factors determining Use of Services in Indian Manufacturing, 1980-81 to 1999-00, Regression Results

Dependent Variable: Log (Services/ manufacturing output)

Explanatory Variables	Fixed-Effects		Random-Effects	
	Coefficients	t-Statistics	Coefficients	t-Statistics
Tariff adjusted for changes in Real Effective Exchange Rate	-0.004**	-10.07	-0.004**	-10.07
Dummy for Non-tariff barriers (import coverage ratio)@	-0.126**	-4.47	-0.128**	-4.47
Log (Wage rate/ price index of services)	0.134*	1.96	0.180**	2.97
Dummy for the 1990s	0.109**	3.73	0.101**	3.47
Constant			-2.34**	-17.26
No. of observations	820		820	
Overall R^2	0.07		0.08	
Hausman statistics			50.78**	
Wald Chi 2 (4)			213.4	

** statistically significant at one per cent level. * statistically significant at five per cent level.
@ takes value one if NTB is more than 50%, zero otherwise.

Examining the results of regression analysis presented in Table 5, it is seen that the coefficients have the expected sign and are statistically significant at one per cent level in almost all cases. The results clearly indicate that lowering of tariff and non-tariff barriers had a favorable effect on the use of services in Indian manufacturing. In other words, the observed acceleration in the use of services in manufacturing in the 1990s is attributable in a significant measure to the trade reforms. The coefficients of the wage rate variable are positive as expected. The coefficient of the dummy variable for the 1990s is found to be positive, as expected. It may be inferred accordingly that the economic policy changes made in the 1990s and other developments in this decade created a condition favorable for increased use of services in manufacturing.

6. Conclusion

The paper examined the contribution of services to output growth and productivity in Indian manufacturing in the pre and post reform period. For this purpose, a KLEMS (Capital, Labor, Energy, Material and Services) production function was estimated, explicitly recognizing services as an input to production. Panel data for 148 industrial groups for the period 1980-81 to 1997-98 were used to estimate the production function.

The results brought out that the importance of services as an input to production in the manufacturing sector increased considerably in the 1990s as compared to 1980s. Use of services in manufacturing grew at an accelerated pace in the 1990s. The growth rate was about 16 per cent per annum. The contribution of services to growth of manufacturing output went up considerably, from about one per cent in the 1980s to about 25 per cent in the 1990s. The trade liberalization undertaken in the 1990s, which increased competition in the domestic market, were found to be responsible to a certain extent for the increase in the intensity of use of services in the manufacturing sector. It appears from the empirical results that the increasing use of services in manufacturing in the post-reforms period had a favourable effect on industrial productivity.

The acceleration in the growth of services sector in the Indian economy in 1990s, ahead of industry and agriculture, has raised the question of sustainability of India's overall growth rate. There is a view that due to slow growth rate of industry, the services sector might not be able to sustain its pace of growth as it will come to face constraints emerging from slow growth in domestic demand. However, the findings of the paper suggest that the use of services is growing rapidly in the industrial sector and the increased use of services is contributing to both output and productivity growth in the industrial sector. This points to the possibility that the Indian services sector might not only succeed in sustaining its own growth but might also help in improving the growth rate of industrial sector in the near future.

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Annex I: List of Industry groups considered for the analysis

Industry group	Description	Share in value added in triennium ending 1999-00 (%)
1	Food products	9.13
2	Beverages	1.46
3	Tobacco products	1.83
4	Textiles (except readymade garments and carpets)	8.60
5	Carpet weaving	0.77
6	Readymade garments	1.54
7	Furniture and fixtures wooden	0.03
8	Wood and wood products	0.47
9	Paper and paper products	1.52
10	Printing and publishing	1.37
11	Leather footwear	0.41
12	Leather and leather products	0.43
13	Rubber products	2.09
14	Plastic products	1.70
15	Petroleum and coal tar products	3.42
16	Inorganic and organic heavy chemicals	2.91
17	Fertilizers and pesticides	4.55
18	Paints, varnishes and lacquers	1.19
19	Drugs and medicines	4.71
20	Soaps, cosmetics, glycerine	1.49
21	Synthetic fibres, resin	5.13
22	Other chemicals	1.36
23	Structural clay products	0.62
24	Cement	2.51
25	Other non-metallic mineral products	3.12
26	Iron and steel basic metals	10.29
27	Non-ferrous basic metals	3.10
28	Hand tools, hardware	0.50
29	Miscellaneous metal products	1.95
30	Tractors, agricultural Implements	0.96
31	Non-electrical machinery except agricultural and office machinery	4.63
32	Office, computing machinery	0.13
33	Electrical industrial machinery	2.40
34	Other electrical machinery	4.72
35	Ships and boats	0.21
36	Rail equipment	0.35
37	Motor vehicles	4.76
38	Manufacturing of motor cycles, scooters, bicycles	1.35
39	Other transport equipment	0.38
40	Watches and clocks	0.19
41	Miscellaneous manufacturing industries	1.71

Annex II: Construction of Fixed Capital Stock Series

For each of the 41 industry groups, fixed capital stock series at 1981-82 prices have been constructed for the period 1980-81 to 1999-00. The steps in the construction of fixed capital series are as follows. (1) Implicit deflator for gross fixed capital formation for registered manufacturing is derived from the data on gross fixed capital formation in registered manufacturing at current and constant prices published in the *National Accounts Statistics* (NAS). The deflator series is constructed for the period 1971-72 to 1999-00. The base is shifted to 1981-82 so as to be consistent with the price series used for other inputs and output. (2) From ASI, the book value of fixed capital stock (at historical prices, net of depreciation) in 1980-81 is taken for each industry group. This is adjusted for price change by using the average value of the deflator for the previous 10 years (1971-72 to 1980-81). This provides the benchmark capital stock.[16] (3) Gross investment in fixed capital is computed for each year by subtracting book value of fixed assets in the previous year from that in the current year and adding to that figure the reported depreciation in fixed assets in the current year.[17] To obtain real gross investment, the gross fixed investment series at current prices is deflated by the price series mentioned above. (4) Real net investment in fixed assets is derived by subtracting depreciation of fixed capital from real gross investment in fixed assets. The rate of depreciation is taken as 5 per cent, which the same as assumed in Unel (2003). (5) Starting from the benchmark fixed capital stock and adding real net fixed investment for successive years, the net fixed capital stock series is constructed.

The capital stock estimates made for the 41 industry groups have been used to form such estimates for the three-digit industries. For each group, we compute for each year the ratio between of estimated value of new capital stock at 1981-82 prices and the reported fixed capital (book value) in ASI. This ratio is then applied to all three-digit industries that belong to that group.

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[16] Bulk of the assets existing in the benchmark year, 1980-81 (in terms of net book value) would have been bought in the previous ten years. This is the rationale for using the average value of the deflator for the previous ten years for making price adjustments. It may be pointed out in this connection that assets acquired in the previous five years would constitute a much bigger part of the net book value of assets than the assets acquired between the fifth and tenth year in the past. Thus, the use of a simple average of the fixed assets price series for the previous ten years for making price correction introduces an upward bias in the benchmark estimate of the capital stock. It should be noted, however, that the depreciation rate used by firms for accounting purposes (allowed by income tax authorities) is much higher than the true depreciation (taken here as five per cent). The implication is that the reported capital stock in ASI understates the true value of net fixed assets at historical prices. These two biases tend to cancel out each other to some extent.

[17] Let B_t denote the book value of fixed assets in year t and D_t the reported depreciation in that year. Then, the gross investment in year t, denoted by I_t, may be obtained as $I_t = B_t - B_{t-1} + D_t$. It should be noted here that the ASI reports book value of fixed assets net of cumulative depreciation.