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Contents

Annexures

Text Tables

Figures

Appendix Tables

List of Abbreviations Used in the Study

ASI:	Annual Survey of Industries
ATC:	Agreement on Textile and Clothing
BLS:	Bureau of Labour Statistics
C-D:	Cobb-Douglas production function
CES:	Constant Elasticity of Substitution Production Function
CHEM:	Chemical and chemical products
DD:	Double-deflation Method
DEA:	Data envelopment approach
E:	Per capita emoluments
EPPP:	Expenditure Purchasing Power Parity
EXIM Policy:	Export Import Policy
GAA:	Growth accounting approach
GATT:	General Agreement on Tariffs and Trade
GDCF:	Gross Domestic Capital Formation
GDP:	Gross Domestic Product
IN:	Total inputs used, at current prices
ISDB:	International Sectoral Database
K:	Real capital stock
K1:	Stock of real capital obtained by deflating stock of capital at current prices by the investment deflator
K1L:	Ratio of K1 to the number of employees
K2	Stock of real capital obtained by deflating stock of capital at current prices by the WPI of machine and tools
K2L	Ratio of K2 to the number of employees
KI:	Kendrick index
L:	Number of employees
LEATH:	Leather and leather products
METAL:	Metal and metal products
MFA:	Multi-Fibre Agreement
MFG:	Manufacturing sector
MFP:	Multifactor productivity
MRTP:	Monopolies and Restrictive Trade Practices
MTE:	Machinery and transport equipment
NDP:	Net domestic product
NIC:	National Industrial Classification
NLDP:	National Leather Development Programme
NV:	Net value-added at current prices
O:	Real Output (Gross)
OECD:	Organisation for Economic Cooperation and Development
OG:	Growth rate of real output (O)
OK1:	Capital productivity index (using K1)
OK2:	Capital productivity index (using K2)
OL:	Labour productivity index (based on gross real output)
OL*:	Labour productivity level (based on gross real output)
PFA:	Production function approach
SD:	Single-deflation method
SFP:	Single factor productivity

SI:	Solow index
SMAC:	Solow, Minhas, Arrow and Chenery Production Function
SMFG:	Selected industries
TEX:	Textiles and textile products
TFP:	Total factor productivity
TFPD:	Total factor productivity (with double-deflation method)
TFPD1:	Total factor productivity (with double-deflation method and capital stock series K1)
TFPD2:	Total factor productivity (with double-deflation method and capital stock series K2)
TFPG:	Total factor productivity Growth
TFPGD1:	Total factor productivity growth (using double deflation method and K1)
TFPGD2:	Total factor productivity growth (using double deflation method and K2)
TFPGS1:	Total factor productivity growth (using single deflation method and K1)
TFPGS2:	Total factor productivity growth (using single deflation method and K2)
TFPS:	Total factor productivity (with single-deflation method)
TFPS1:	Total factor productivity (with single-deflation method and capital stock series K1)
TFPS2:	Total factor productivity (with single-deflation method and capital stock series K2)
TL:	Tanslog production function
TLI:	Translog index
TP:	Total productivity
TP1:	Total productivity (using K1)
TP2:	Total productivity (using K2)
TPG:	Total productivity growth
TPG1:	Total productivity growth (using K1)
TPG2:	Total productivity growth (using K2)
ULC:	Unit Labour Cost
UNDP:	United Nations Development Programme
UVR:	Unit Value Ratio
V:	Real value-added
VDD:	Real value-added obtained by double deflation method
VDDG1:	Growth rate of real value-added obtained by double deflation method (using K1)
VDDG2:	Growth rate of real value-added obtained by double deflation method (using K2)
VDDK1:	Capital productivity index obtained using VSD and K1 series
VDDK2:	Capital productivity index obtained using VSD and K2 series
VDDL:	Labour productivity index based on real value added obtained by double deflation method
VDDL*:	Labour productivity level based on real value added obtained by double deflation method
VSD:	Real value-added obtained by single deflation method
VSDK1:	Capital productivity index obtained using VSD and K1 series
VSDK2:	Capital productivity index obtained using VSD and K2 series
VSDL:	Labour productivity index based on real value added obtained by single deflation method
VSDL*:	Labour productivity level based on real value added obtained by single deflation method
W:	Total emoluments
WPI:	Wholesale Price Index
Y:	Gross output at current prices

PRODUCTIVITY IN MAJOR MANUFACTURING INDUSTRIES IN INDIA: 1973-74 TO 1997-98

1. Introduction

For development economists and policy makers, movement of productivity has been a matter of both curiosity and concern. Cross-country disparities in real incomes, growth rates and standard of living have been attributed to differences in productivity performance. Productivity is one of the key determinants of cost and price-competitiveness of firms and industries of a nation. This in turn determines the competitive edge of the exports of these firms and industries in the global markets. Policy makers are interested in productivity movements for yet another reason. The conduct of monetary and exchange rate policies cannot be determined in isolation from the productivity performance of the economy.

Although historically productivity improvement has been regarded as a contributory factor to economic growth, the credit for popularising growth accounting exercises in empirical literature can be given to Solow (1957). The classical theory of growth emphasised the role of physical capital accumulation as a determinant of growth, which in turn depended on the sacrifice which people are willing to make in terms of their current consumption. Keynesian theory of output highlighted the role of effective demand factors in explaining the level of output. Harrod-Domar model emphasised the role of physical capital and savings in explaining growth rate. Solow (1957) provided the framework within which the growth emanating from an increased application of factor inputs could be separated from that due to the residual factors. This residual has been designated as productivity factor. After this pioneering contribution, numerous studies highlighting the role of productivity in the growth process have emerged. These have encompassed mainly two issues: (i) to what extent does productivity contribute to growth; and, (ii) whether growth rates of countries tend to converge. The former is important to determine whether or not the growth process is sustainable. It has been argued (Krugman, 1994) in the context of east-Asian countries that since their growth was driven by increased application of factor inputs, it was not a miracle. Sustainability of growth process driven by increased application of factor inputs can be threatened by either limited availability of factor inputs in the future or diminishing returns to factor inputs. The development of literature on 'endogenous growth theory' bears testimony to the seriousness with which productivity has been treated as an engine of growth in the recent years.

The measurement of both the levels of productivity and the growth rate of productivity assumes critical importance for the obvious reasons stated above. Despite this, more often than not, there is hardly any consensus among different researchers on the magnitudes of levels and the growth rates of productivity obtained. This makes comparisons of productivity a difficult task. With regard to cross-country comparisons of productivity, the differences in the product-mix, the quality of products and the methodological differences complicate the matter. Yet another problem in productivity measurement is that many studies have concentrated merely on productivity growth and not on the levels of productivity. As a result, the initial levels of productivity gaps remain unidentified and unmeasured. However, two limitations to estimation of productivity have been identified in the recent literature (Hulten, 2000). *First*, comparison of productivity over time may not be very useful if the product composition of national income undergoes a major change. It has been argued in the recent literature that, the 'new knowledge based economy' cannot be compared to the 'old tangible product based economy'. *Second*, productivity estimates may overstate economic performance by ignoring the environmental degradation which itself can limit the growth process in future.

This study is an attempt to update the estimates of productivity provided by the earlier studies and it also provides estimates of productivity by using alternative methodologies (single and double deflation) at industry levels. The industries have been selected on the basis of their contribution to India's export earnings and the availability of consistent time-series data. The time-span covered by this study is 1973-74 to 1997-98. The focus on industries with large contribution to manufactured exports is primarily because exports hold the key to managing the external sector of an economy. Export competitiveness depends critically on supply-side factors, such as, productivity and costs. While measures like 'devaluation' as a means of boosting exports have their limitations, increasing productivity and improving quality consciousness can provide a real boost to exports and make the firms and industries competitive. The manufacturing sector has figured prominently in India's development strategy and accounts for about three-fourths of India's export earnings (inclusive of software exports). Against this back drop, the present study makes a modest attempt to empirically estimate productivity in the major manufacturing industries and also for the manufacturing sector. The database and analysis pertains only to the factory sector.

The organisation of this study is as follows. In Section 2, we discuss the theoretical issues pertaining to the concepts and measurement of productivity and also provide a synoptic view of the major studies on productivity carried out in the 1980s and the 1990s for the Indian economy and the manufacturing sector of the Indian economy. In Section 3, we provide the methodological details of the study and an empirical background to the estimation of productivity indices. This section deals with the rationale behind the selection of industries, the details of the data used in the study, the relative positions of the selected industries and the growth rates of real gross output and real value-added in the industries included in this study. Section 4 forms the core of this study, wherein, we report the estimates of productivity for the selected industries, *viz*., textile, metal, machinery and transport equipment, chemical, and leather. Productivity estimates for these industries as a group and also for the entire manufacturing sector have also been reported in this section. *First*, we have reported the levels of labour productivity and capital intensities for the various industry groups. *Second*, we calculate the two single factor productivity (SFP) indices, *viz*., labour and capital productivity indices. *Third*, in view of the controversy about the 'separability of material inputs' in the Indian context [Rao 1996a, 1996b], we estimate the total productivity (TP) and the total factor productivity (TFP) indices, within the growth accounting framework. *Fourth*, we have estimated TFP indices with both single (TFPS) and double deflation (TFPD) methods. This we expect will shed some light on the Ahluwalia [1991] and Balakrishnan-Pushpangadan [1994] controversy and examine the impact of changing relative input-output prices on the measurement of productivity. In Section 5, we present the international comparisons of productivity estimates and in Section 6, the concluding observations emanating from this study.

2. Productivity and Efficiency: Concepts and Measurement

Productivity is defined as the ratio of output (or real value added) to input(s). The two most commonly used measures of productivity are single factor productivity (SFP) and multifactor productivity (MFP). When multiple inputs of heterogeneous nature are used in the production process, aggregation of these inputs requires use of price indices and entails computation of the productivity ratio or indices. Changes in relative prices of inputs as well as input requirements per unit of output can affect productivity. In brief, the concept of productivity combines relative price movements of inputs or the 'allocative efficiency' with the 'technical efficiency'.

Efficiency is usually defined as the deviation of the actual cost from the minimum achievable cost of production for a given level of output. Efficiency can be measured in several alternative ways. Estimation of the efficiency frontier function constitutes the main problem to be tackled in measurement of (in)efficiency. The two alternative approaches that have been adopted in the literature for the construction of efficient frontiers are: (i) mathematical programming approach or the Data Envelopment Approach (DEA); and (ii) the parametric approach. The main advantage of using the former approach is that it does not impose any functional form on the data. The problem with this approach is that it does not allow for any statistical noise in the data. The parametric approach employs econometric techniques and in this approach, the deviation of actual cost from the minimum cost is decomposed into two parts, viz., the statistical noise and inefficiency. The various alternatives within the parametric approach are as follows: (a) econometric frontier approach; (b) thick frontier approach; and, (c) distribution free approach. Each of these approaches involves arbitrary assumptions regarding the distribution of the noise and inefficiency components. In brief, the prime difficulty in using the econometric approach lies in separating the noise from the inefficiency.

As efficiency should get reflected in productivity measures, we considered productivity to be a good proxy for efficiency. Moreover, as many studies in the past have estimated productivity in Indian industries, a comparison with their findings necessitated estimation of productivity.

2.1 Single Factor Productivity (SFP) and Multifactor Productivity (MFP)

Productivity can be measured with respect to a single input or a combination of inputs. The partial or single factor productivity (or SFP) is defined as the ratio of the volume of output (or real value-added) to the quantity of the factor of production for which productivity is to be estimated. When the proportion in which the factors of production are combined (e.g., labour and capital) undergoes a change, partial measures of productivity provide a distorted view of the contribution made by the factors in changing the level of production. In a situation where capital-labour ratio follows an increasing trend, productivity of labour is overestimated and that of capital, underestimated. Despite this limitation, estimation of productivity of labour is regarded crucial from the welfare point of view, since it measures production per unit of labour employed. This explains why labour productivity is estimated and published regularly in most of the developed countries.

The concept of MFP tries to circumvent the problem encountered in interpretation of SFP estimates in the event of changing factor intensities. MFP is defined as the ratio of real output (or real value added) to a weighted sum of the inputs used in the production process. MFP is deemed to be the broadest measure of productivity and efficiency in resource use. It aims at decomposing changes in production due to changes in quantity of inputs used and changes in all the residual factors such as change in technology, capacity utilisation, quality of factors of production, learning by doing, *etc*. An increase in MFP, therefore, implies a decrease in unit cost of production. Since MFP incorporates all the residual factors, it has also been dubbed as an 'index of ignorance' [Abramovitz, 1956]**.** However, the concept of MFP scores over SFP, since all factors affecting the production process are captured in the former concept unlike that in the latter. Before embarking upon the empirical estimation of MFP growth we discuss the three choices which need to be made in the measurement of MFP.

2.2 Measurement of Multifactor Productivity: The Three Main Choices

The *first* choice relates to the numerator of MFP ratio. The choice here is between the use of data on 'real output' and 'real value-added'. If the latter is chosen then the *second* choice is between the use of 'single-deflation' and 'double-deflation' methods for measurement of real value-added. The *third* choice is between using the 'Growth Accounting Approach' and the 'Production Function Approach' for the measurement of MFP.

2.2.1 Measurement of Production: Gross Real Output *versus* Real Value-added

In the literature, a strong preference is exhibited for using real value-added as the measure of production. Norsworthy and Jang [1992] attribute this to the fact that the concept of value-added is useful in national income accounting as it avoids double counting of intermediate inputs. However, they favour the use of real output *vis-a-vis* real value-added. The use of value-added provides a distorted view of technology because the effect of changes in prices of purchased raw- material inputs is removed from the costs of production and technology. According to them, the aftermath of the energy crisis has revealed the shortcoming of using real value-added (V) *vis-a-vis* gross real output (O) for estimation of productivity. Rao [1996a, 1996b] has labelled the estimate of productivity based on gross output and real value-added as 'Total Productivity' (TP) and 'Total Factor Productivity' (TFP), respectively. We have also followed the same abbreviations for these two measures of MFP.

Depending on the coverage, studies on productivity can be classified into three major types, *viz*., macro, meso and micro level studies [Wagner and Ark, 1996]. Macro level studies deal with the entire economy, whereas, meso level studies pertain to a sector or an industry. Micro level studies are conducted at the firm level. The major macro and meso level studies carried out in the post-1980 period for India, arranged chronologically, have been listed in Table 1. It can be seen from Table 1 that the meso level studies conducted by Rao [1996a, 1996b] and by Pradhan and Barik [1998] have used data on gross output. In fact, the latter study encompasses only a part of India's manufacturing sector. Studies on productivity for the entire Indian economy, *viz*., Brahmananda [1982] and Mohanty [1992] have used Net Domestic Product (NDP). The national income accounts are prepared using the value-added approach and the real NDP is obtained by the single-deflation method. The remaining studies on productivity in India's manufacturing sector, undertaken prior to 1996, have used real value-added as the measure of output. In the Indian context, it was Rao [1996a] which first addressed the question of whether productivity should be measured by gross output or real value-added. As long as material inputs are separable from the other factors it does not matter as to which of the two above-mentioned measures of production is used for the measurement of productivity. If material inputs are not separable, TP should be preferred to TFP. The reason for this is that if firms reap economies of scale by combining material inputs with factor inputs, 'material input conversion efficiency' is included along with the 'efficiency in value-added' in the concept of TP. Nevertheless, measuring TFP is desirable on the grounds that it is the 'final measure of the value of production' [Rao, 1996a].

Table 1: Methodological Details of Productivity Studies India in India

Study [Year]	Measure of Output	Deflation Method	Estimation Approach	Functional Form of PF	Index Used in GA Approach
Brahmananda, P.R. [1982]	NDP	SD	GAA		KI
Goldar, B.N. [1986]	VSD	SD	GAA & PFA	C-D & SMAC	TLI, KI, & SI
Ahluwalia, I.J. [1991]	VSD	SD	GAA & PFA	C-D,TL & CES	TLI

Mohanty, D. [1992]	NDP	SD	PFA	C-D	-
Balakrishnan, P. and K. Pushpangadan [1994]	VDD	DD	GAA	-	TLI
ICICI Limited [1994]	VSD	SD	GAA	-	TLI, KI, & SI
Rao, J. M. [1996a]	O	-	GAA	-	TLI
Rao, J. M. [1996b]	O	-	GAA	-	TLI
Pradhan G. and K. Barik [1998]	O	-	GAA	-	TLI

Note: See the list of abbreviations.

In brief, it is only in the last few years that the productivity studies in India have considered the use of gross output over the real value-added as a measure of production. In the empirical exercise attempted in this study, we have estimated both TP indices and TFP indices to highlight the difference in productivity measurement on account of the use of different measures of production.

2.2.2 Measurement of Real Value-added: Single *versus* Double-Deflation Methods

If real value-added is used as a measure of output, nominal value-added needs to be converted into real value-added. This conversion can be done with either single (SD) or double deflation (DD) method. The details of SD and DD methods have been provided in Annexure I. In the case of the former, nominal value-added is deflated by the output price index, *i.e*., both nominal output and nominal material inputs are deflated by the output price index. This is referred to as the SD method. The other alternative is to deflate the nominal output by output price index and the nominal material inputs by the input price index, *i.e*., the DD method. If both the output and input prices change equiproportionately, then the ratio of input-output prices remains constant and in such a situation, the estimates of TFP growth obtained by both SD and DD methods will coincide. During the periods when the input price index increases (decreases) at a faster rate than the output price index, the estimate of real value-added obtained by using SD method will be lower (higher) than that obtained by using DD method. Bruno [1984] highlighted the role of increasing relative price of raw materials to output in explaining the productivity slowdown and argued that its effect on the estimation of productivity is analogous to that of Hicks-neutral technological regress. Goldar [1986] states that the use of single-deflation method based on product prices for estimation of real value-added may not be appropriate but due to the difficulty of compiling a materials price index required for double-deflation method, he used single-deflation method. Ahluwalia [1991] also addressed the problems associated with the use of the single-deflation approach in the context of measurement of productivity for petroleum and coal industries with the caveat that in the absence of official estimate of value-added in these sectors by the double-deflation method, productivity estimates for these industries need to be interpreted with caution. The study by Balakrishnan and Pushpangadan [1994] was the first of its kind to use the double-deflation method and to highlight the importance of changing relative prices in estimation of growth of TFP (henceforth, TFPG) in the context of Indian manufacturing sector. This study, carried out at the aggregate level for the manufacturing sector, refuted the claim made by Ahluwalia [1991] that there was a positive turnaround in TFPG in the Indian manufacturing sector in the 1980-81. It attributed this result to overestimation of productivity by the use of single-deflation method in the event of declining relative prices in the early 1980s.

2.2.3 Production Function *versus* Growth Accounting Approaches

The two main approaches for the estimation of growth in MFP, *viz*., the Production Function

Approach (PFA) and the Growth Accounting Approach (GAA) are elaborated below. Taking equation (1A) or (1B) as the starting point, we discuss each of these approaches so as to estimate the extent to which growth in output is caused by increased application of inputs and by productivity growth.

$$O = A(t) * f(X) \qquad (1A)$$

$$V = A(t) * f(X') \qquad (1B)$$

Notations used in equation (1) are as follows.

O : Single homogenous output.

V : Real Value Added.

A(t) : Index of technological change or of MFP.

f(X) : Functional form specifying the relationship between the output (O) and the input vector (X) which includes labour, capital and raw-materials.

f(X') : Functional form specifying the relationship between the output (O) and the input vector (X') which includes only factor inputs, *viz*., labour and capital.

2.2.3.1 Production Function Approach

Although the concept of production function essentially belongs in the area of microeconomics, the studies on productivity have used this concept at industry and economy-wide levels. PFA involves specification of the functional forms for A(t) and for f(X) or f(X'). The functional form which is most often used for A(t) is given by equation (2).

$$A(t)= A_0e^{\lambda t} \qquad (2)$$

Equation (2) implies that technological progress occurs at a constant rate λ. The modelling of technological progress as in equation (2) has received sharp criticism. To quote Norsworthy and Jang [1992], "Production economics has only begun to recognize the importance of technology. Until recently, technological changes and its productivity effects have been ignored or, perhaps worse, proxied by faceless time trends". Besides the specification of technological change, one needs to specify the functional forms f(X) or f(X') in the PFA. Three major forms of production functions which have been used in the empirical literature on productivity measurement are as follows: (i) Cobb-Douglas (C-D) production function; (ii) Constant Elasticity of Substitution (CES) production function; and, (iii) Transcendental Logarithmic (TL) production function. The most frequently used form of production function in empirical studies, *viz*., C-D production function, is given in equation (3). In this equation, V, L, K and t denote real value added, labour, capital and time, respectively. λ, α and β are constants and denote the rate of technical progress, partial elasticity of output w.r.t. labour and partial elasticity of output w.r.t. capital, respectively. Empirical estimates of this equation not only provide a measure of growth of TFP or the rate of technological change (λ) but also allow one to extract information on the returns to scale. If ($\alpha+\beta-1$) is not significantly different from zero, the condition of constant returns to scale holds true. If this magnitude is greater (lesser) than zero, it depicts the condition of increasing (decreasing) returns to scale. A functional form more flexible than both C-D and the CES functions, was developed by Chirstensen, Jorgenson and Lau [1971, 1973]. This functional form, known as the transcendental logarithmic or the translog production function (henceforth, TL), is stated in equation (4).

$$\log (V/L)_i = a + (\alpha+\beta-1)\log L_i + \beta\log(K_i/L_i) + \lambda t + \mu_i \qquad (3)$$

$$\log V_i = \alpha_0 + \alpha_L(\log L_i) + \alpha_K(\log K_i) + \alpha_t t + 1/2\beta_{LL}(\log L_i)^2 + 1/2\beta_{KK}(\log K_i)^2 + \beta_{LK}(\log L_i)(\log K_i) + \beta_{Lt}(\log L_i)t + \beta_{Kt}(\log K_i)t + 1/2\beta_{tt}t + e_i \quad (4)$$

TL function imposes a fewer *a priori* assumptions regarding technology used in the production process. Technology does not have to be of the Hicks-neutral type; it does not have to proceed at a constant rate; the elasticity of substitution need not be either unity (as in the case of C-D function) or constant (as in the CES function).

We tried empirical estimation of equation (3) but chose not to report them. This is because both capital intensity and employment of labour have risen over the years resulting in severe problems of multicollinearity and autocorrelation in the data set. In view of this, we did not consider the estimates of TFPG derived from C-D and CES production functions to be of much use. Due to the problem of the very few degrees of freedom, we refrained from using the translog production function stated in equation (4) for empirical estimation of TFPG in a time series framework. In other words, we estimated productivity using GAA not PFA.

2.2.3.2 Growth Accounting Approach

The crux of the growth accounting approach (GAA) is the separation of change in production on account of change in the quantity of factors of production from residual influences, *viz*., technological progress, learning by doing, managerial efficiency, *etc*. MFP growth proxies these residual influences. The origins of GAA can be traced back to Tinbergen [1942] and Solow [1957]. The three main indices - used in the GAA - are as follows: (i) Kendrick Index (KI); (ii) Solow Index (SI); and, (iii) Translog Index (TLI). We have used only the TLI for estimating productivity indices as these indices are considered to be superior to both KI and SI. We provide a brief description of the TLI below (for details on KI and SI, see Annexure II).

The TLI has been described by Alhluwalia [1991] in the following words: “The 'superlative' index of productivity change that is consistent with the 'flexible' production function can be applied to discrete data points. A 'flexible' functional form for which the Tornquist discrete approximation is exact, is the Translog (transcendental logarithmic) production function. It not only naturally accommodates the discrete time analysis, but also imposes fewer *a priori* restrictions on the underlying technology of production”. The discrete approximation of the translog production function in the form of TLI has been used in most of the recent studies on the measurement of productivity in the Indian industries (Table 1).

In equation (5), w and n denote the share of labour and raw materials in gross output at current prices, respectively, and N denotes the real material input. In equation (6), w’ denotes the share of labour in nominal value added. Symbol Δ indicates the first difference of the relevant variable. Notations of other variables have already been explained earlier.

$$\Delta TP_t / TP_t = \Delta O_t/O_t - [(w_t+w_{t-1})/2]\Delta L_t/L_t - [(n_t+n_{t-1})/2]\Delta N_t/N_t - [\{(1-(n_t+w_t)) + (1-(n_{t-1}+w_{t-1}))\}/2]\Delta K_t / K_t \quad (5)$$

$$\Delta TFP_t / TFP_t = \Delta V_t/V_t - [(w'_t+w'_{t-1})/2]\Delta L_t/L_t - [\{(1-w'_t)+(1-w'_{t-1})\}/2]\Delta K_t/K_t \quad (6)$$

Equations (5) and (6) are based on a more general neo-classical production function for which the elasticity of substitution need not be infinite, equal to unity or even constant. However, the technical change is assumed to be of Hicks-neutral type. Further, if factors are paid their marginal products, TPG measured by equation (5) provides us with the difference between the growth of real output and the rate of growth of factor and raw-material inputs. Equation (6) measures the difference between the rate of growth of real value-added and the rate of growth of factor inputs.

2.2.4 Production Function and Growth Accounting Approaches: A Comparison

It has been well documented in the literature [Rao,1996a] that both PFA and GAA assume a well-behaved production function, stability of the production function over time and cost minimisation, which is a sub-goal of profit maximisation. The widely accepted advantage of the production function approach is that the assumptions of constant returns to scale and perfect competition need not be imposed. The estimates of parameters of the production function directly provide information about the factor shares. Moreover, if flexible functional forms are used, returns to scale or homotheticity property of production functions can be directly tested for. In this sense, the PFA scores over the GAA. One of the major disadvantages of using PFA is the problem of identification of production function due to the simultaneity in determination of input intensities and output levels. The problems of autocorrelation and multicollinearity encountered in the use of PFA vitiate the empirical estimates obtained by this approach. Massaging the data in order to take care of these statistical problems render it difficult to interpret the empirical results. The assumption of 'well-behaved' production function takes away flexibility and the ability of TL production function to approximate a non-homothetic production structure. The limitation of GAA is that, if the share of capital is treated as a residual (see weights assigned to capital stock in equations (5) and (6)), it implies the assumption of constant returns to scale. Moreover, if output elasticities are proxied by the observed factor shares, it implies the assumption of a competitive market structure.

3. Coverage of the Study and the Stylised Facts

This section provides information on the industries selected for the estimation of productivity in India's manufacturing sector and on the relative importance of the selected industries in manufacturing. As a prelude to the estimation of productivity, we present estimates of growth of real gross output and real value added (using both SD and DD methods) in this section.

3.1 Selection of Industries

It is rather unambiguous that other things remaining the same, an increase in productivity can improve the price competitiveness of exports due to its cost-reduction effects. At the outset, therefore, it is useful to examine India's export performance to show the relative contribution of various industries to total exports. This can form an objective criterion for the selection of industries for productivity analysis (Table 2).

Table 2: Major Items of India's Exports as a Percentage of Total Exports
(Total Exports in million US $)

Export Item/Year	**1970-71**	**1980-81**	**1990-91**	**1992-93**	**1993-94**	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**
Primary Products	**42.4**	**36.8**	**24.0**	**21.0**	**22.1**	**19.7**	**22.8**	**23.8**	**21.9**	**20.6**
Agriculture & allied products	31.7	30.7	19.4	17.6	18.7	16.0	19.1	20.4	19.5	18.5
Ores & minerals	10.7	6.2	4.6	3.4	3.4	3.8	3.7	3.5	2.4	2.1
Manufactured Goods	**50.3**	**55.8**	**72.9**	**76.1**	**75.6**	**76.8**	**73.9**	**73.5**	**76.7**	**78.7**
Textile fabrics & Manufactures	9.5 (18.8)	13.9 (24.9)	21.0 (28.8)	23.3 (30.6)	21.3 (28.2)	24.0 (31.3)	22.6 (30.6)	23.5 (31.9)	24.7 (32.2)	25.4 (32.2)
Engineering goods	12.9 (25.6)	12.3 (22.1)	11.9 (16.3)	13.3 (17.4)	13.6 (18.0)	13.3 (17.4)	13.8 (18.7)	14.6 (19.9)	15.0 (19.6)	13.0 (16.5)
Chemicals & allied products	1.9 (3.8)	3.3 (6.0)	6.5 (8.9)	7.4 (9.8)	8.2 (10.8)	7.4 (9.7)	7.4 (10.0)	8.1 (11.0)	10.5 (13.7)	10.0 (12.7)
Leather & Manufactures	5.2 (10.4)	5.8 (10.4)	8.0 (11.0)	10.8 (14.3)	5.8 (7.7)	6.1 (8.0)	5.4 (7.4)	4.7 (6.4)	4.7 (6.1)	4.8 (6.1)
Memo-item:	**29.4 (58.6)**	**35.4 (63.3)**	**47.3 (64.9)**	**54.8 (72.1)**	**48.9 (64.7)**	**50.8 (66.3)**	**49.2 (66.7)**	**50.9 (69.2)**	**54.9 (71.5)**	**53.2 (67.5)**
TOTAL EXPORTS	**2,031.O**	**8,486.0**	**18,143.0**	**18,537.0**	**22,238.0**	**26,331.0**	**31,797.0**	**33,106.0**	**35,006.0**	**33,659.0**

Sources: Economic Survey, Ministry of Finance, Government of India, New Delhi (various issues)
Report on Currency and Finance, Reserve Bank of India, Mumbai (various issues)
Annual Report, Reserve Bank of India, Mumbai (various issues)

Note: (i) Figures in parentheses are expressed as percentage of exports of Manufactured Goods.
(ii) Engineering goods comprise of Machinery and Transport Equipment, Metal Manufactures including iron and steel, Electronic Goods, Computer Software and Project Goods.
(iii) Memo-item refers to the items listed below the Manufactured Goods.

In 1970-71, manufactured goods accounted for almost half of India's export earnings and during the 1990s the share of the manufacturing sector (inclusive of software and project goods) in total export earnings increased to more than three-fourths of the total exports. In the category of exports of manufactures, the performance of a few industries is noteworthy both in terms of their shares and the dominant influence they exert on the behaviour of the total exports. The shares of 'textile fabrics & manufactures' and 'chemical & allied products' have registered sharp increases in the last three decades. The share of 'engineering goods' has been more or less stagnant, whereas, the share of 'leather and manufactures' increased until early 1990s and witnessed a decline, thereafter. The share of memo items as a group recorded an increase in the total manufactured goods from 58.6 per cent in 1970-71 to 67.5 per cent in 1998-99 after reaching a peak of 72.1 per cent in 1992-93.

Five industries have been selected for the estimation of productivity in this study, on the basis of their contribution to India's export earnings (Table 3) and the availability/comparability of data needed for productivity analysis. The reason for choosing 1973-74 as the initial year of the study is that a major change in the classification of industries was introduced in this year. For the years 1973-74 to 1988-89, Annual Survey of Industries (ASI) followed the National Industrial Classification (NIC)-1970. Since 1989-90, the NIC-1987 has been in vogue.

We have aggregated industries at two-digit level of classification for textile, metal and machinery and transport equipment industries. No such aggregation was required for chemical and leather industries. Details of classification codes of the industries included in this study have been provided in Annexure III. Apart from the industries mentioned in serial numbers 1 to 5 in Table 3, we have estimated productivity for these selected industries as a group (selected industries) and also for the total manufacturing sector. The analysis includes only the registered components of the various industries/manufacturing sector.

Table 3: Industries Selected for Measurement of Productivity

Sr. No.	Industry (Abbreviation Used in the Study)
1.	Textiles and textile products (TEX)
2.	Metal and metal products (METAL)
3.	Machinery and transport equipment (MTE)
4.	Chemical and chemical products (CHEM)
5.	Leather and leather products (LEATH)
6 = 1 to 5	Selected industries (SMFG)
7	Manufacturing sector (MFG)

Note: (i) Abbreviations mentioned in the brackets have been used in the various tables and figures in this study. Industry groups mentioned against serial number 1 to 6 will be henceforth referred to, as textile, metal, machinery and transport equipment, chemical, leather and selected industries, respectively.

(ii) Engineering goods exports are inclusive of software and project exports as well. However, due to the non-availability of data in the required details, we could not include software and project exports in the empirical investigation carried out in this study.

3.2 Data Sources and Data Details

Data sources used in this study are as follows: (1) *Summary Results for Factory Sector*, Annual Survey of Industries (ASI), Central Statistical Organisation, Government of India, New Delhi, (various issues); (2) *Technical Note to the Eighth Five Year Plan (1992-1997)*, Planning Commission, Government of India, New Delhi,1995; (3) *Economic Survey*, Ministry of Finance, Government of India, New Delhi (various issues); (4) *Report on Currency and Finance*, Reserve Bank of India, Mumbai (various issues); (5) *Annual Report*, Reserve Bank of India, Mumbai (various issues); (6) *Reserve Bank of India Bulletin*, Reserve Bank of India, Mumbai (various issues); (7) *National Account Statistics*, Central Statistical Organisation, Government of India (various issues); and, (8) *Handbook of Statistics on Indian Economy*, 1999, Reserve Bank of India, Mumbai**.**

In this study we have used the data (from ASI) on the following variables: (i) number of employees; (ii) fixed capital (i.e., the depreciated book value of fixed assets owned by the factory on the closing day of the accounting year); (iii) depreciation; (iv) total emoluments; (v) fuels and materials consumed; (vi) total inputs; (vii) gross output; (viii) net value-added; and, (ix) gross capital formation. As the data used in this study pertain only to the factory sector, the analysis and conclusions emanating from this study are valid only for the factory sector.

Using the data on fixed capital at book value, gross capital formation, depreciation, Wholesale Price Index (WPI) for machine tools and investment deflator index series, we have computed two series on real capital stock, viz., K1 and K2. Details of these have been given in Annexure IV. As mentioned in the previous section, we have attempted measurement of productivity using the DD method also. This required compilation of the price indices of inputs for each of these industries. We have used data source (2), wherein, the technological coefficient matrix for 1983-84, updated to 1991-92 prices, has been provided. The information on commodity sectors included in this input-output transactions matrix, which broadly corresponds to the industries selected by us, has been presented in Annexure V. Annexure VI explains the procedure for compiling the input price indices. Industry-wise input price indices have been compiled and used for the measurement of productivity for the first time in this study and the relative (input-output) price indices have been reported in Table A1.

3.3 Relative Positions of the Various Industries in India's Manufacturing Sector

It can be seen from Table 4 that the selected industries in this study accounted for an average of 55.9 per cent of employees (L) in the organised manufacturing sector during the period 1973-1980. This figure registered a decline over the years and stood at 52.7 per cent during 1995-98. The average share of total emoluments (W) of these industries also decreased from 67.1 per cent (1973-80) to 57.0 per cent (1995-98). During this period, the decline in the average share of real capital (K) was of the order of about 3 percentage points. Average shares of inputs (IN), gross output (Y) and net value added (V), all at current prices, also witnessed decreases across the years. In brief, it can be said that the relative importance of these industries in the organised manufacturing sector witnessed a decline over the years. However, these industries still covered about 50 per cent or more of the organised manufacturing sector in terms of labour employed, emoluments, capital stock, inputs used, gross output and net value added.

Although the textile industry provided the maximum employment, machinery and transport equipment industry had the highest share of the total emoluments in the recent years. Metal industry accounted for the highest amount of fixed capital. Textile industry accounted for as high as 18.6 per cent of the net value-added of the manufacturing sector during 1973-80. This came down sharply to 9.2 per cent during 1995-98. The variations in the share of net value-added for other selected industries were not as pronounced as in the case of textile industry.

Table 4: Average Shares of Employment, Emoluments, Real Capital Stock, Inputs, Gross Nominal Output and Nominal Net Value-added of Various Industries in India's Manufacturing Sector

(As a percentage of Manufacturing Sector)

Average Shares in Manufacturing Sector						
Textiles andTextiles Products (TEX)						
Period	**L**	**W**	**K**	**IN**	**Y**	**NV**
1973-1980	23.9	22.9	10.2	16.7	16.9	18.6
1980-1985	20.8	18.9	8.8	13.0	13.1	14.0
1985-1990	19.1	15.8	8.3	11.2	11.2	11.4
1990-1995	17.8	14.5	8.0	11.7	11.5	11.2
1995-1998	18.2	12.5	9.4	11.8	11.2	9.2
Metal and Metal Products (METAL)						
Period	**L**	**W**	**K**	**IN**	**Y**	**NV**
1973-1980	10.1	13.8	19.3	13.0	13.1	12.8
1980-1985	10.3	13.4	17.3	14.5	14.2	12.9
1985-1990	10.4	12.5	15.3	14.5	14.1	12.3
1990-1995	10.0	11.8	17.4	14.6	14.0	11.4
1995-1998	9.8	12.0	16.1	13.2	13.2	12.9
Machinery andTransport Equipment (MTE)						
Period	**L**	**W**	**K**	**IN**	**Y**	**NV**
1973-1980	15.3	21.2	11.5	15.1	16.2	20.1
1980-1985	16.0	22.7	11.4	15.4	16.7	21.7
1985-1990	16.6	22.4	11.6	16.1	16.9	20.7
1990-1995	16.0	21.9	10.6	16.5	16.9	19.6
1995-1998	15.6	21.4	10.7	17.4	17.7	19.6
Chemicals and Chemical Products (CHEM)						
Period	**L**	**W**	**K**	**IN**	**Y**	**NV**
1973-1980	5.8	8.6	13.3	12.5	12.6	12.7
1980-1985	6.3	9.3	12.8	13.2	13.2	12.3
1985-1990	7.1	9.8	12.9	13.2	13.2	12.5
1990-1995	7.2	10.2	13.4	12.7	13.1	14.0
1995-1998	7.8	10.2	15.0	13.1	13.7	15.8
Leather andLeather Products (LEATH)						
Period	**L**	**W**	**K**	**IN**	**Y**	**NV**
1973-1980	0.7	0.6	0.2	1.0	0.9	0.6
1980-1985	0.8	0.6	0.3	0.9	0.8	0.6
1985-1990	1.1	0.7	0.3	1.0	0.9	0.6
1990-1995	1.3	0.9	0.4	1.1	1.1	0.9
1995-1998	1.3	0.8	0.4	1.0	0.9	0.7
Selected Industries (SMFG)						
Period	**L**	**W**	**K**	**IN**	**Y**	**NV**
1973-1980	55.9	67.1	54.5	58.2	59.7	64.7
1980-1985	54.3	65.0	50.6	57.0	58.0	61.4
1985-1990	54.2	61.1	48.3	56.0	56.3	57.5
1990-1995	52.3	59.3	49.8	56.6	56.6	57.2
1995-1998	52.7	57.0	51.5	56.5	56.7	58.1

Note: Period 1973-80 indicates financial years 1973-74 to 1979-80. Similar practice has been used for the other time-periods, as well. Average shares of L, W, IN, Y and NV have been calculated from the ASI data. Though the estimates of absolute K1differ from K2, the share of K1 and K2 for individual industries in relation to total K1 and K2 for manufacturing sector are the same and have been denoted by ‘K’ in this table. For calculation of real capital stock series K1 and K2, see Annexure IV.

It is interesting to note that though the organised sector of textile industry has shrunk compared to other industries in terms of share in all the parameters mentioned in Table 4, the contribution of this industry as a whole to exports has registered a phenomenal increase over the time-span of the study (Table 2). Engineering goods industry – which includes metal and machinery and transport equipment industries contributed about 25 per cent of manufactured exports in 1970-71. The corresponding figure was at its lowest in 1990-91 (16.3 per cent) and even in 1998-99 its share is almost the same (16.5 per cent). As mentioned earlier, the data on exports of engineering goods also include the exports of computer software and project goods, which have grown rapidly in the recent years. This means that the contribution of metal and machinery and transport equipment to India's export earnings was even lower than 16.5 per cent in 1998-99. In other words, export performance of metal and machinery and transport equipment industries does not compare very well in relation to textile industry. One of the reasons could be that these industries were supposed to be import substituting industries rather than export-oriented industries. The relative importance of chemical industry in manufacturing sector has improved over the years. During the period of the study, this industry recorded an impressive increase in its contribution to manufactured exports. The significant contribution of leather industry to manufactured exports (Table 2) cannot be overlooked.

3.4 Capital Intensity and Per Capita Emoluments in Indian Industries

A comparative view of the various industries in terms of the capital intensities (K1L) and the per capita emoluments has been provided in Table 5 and Figures 1A and 1B. Capital intensities have been relatively lower in textile, machinery and transport equipment and leather industries as compared with the metal and chemical industries. Capital intensities (Figure 1A) increased sharply in textile and machinery and transport equipment industries during the latter half of the 1980s and this trend continued in the nineties as well.

In metal, chemical and leather industries, capital intensities did rise during 1980s, but the jump was pronounced in nineties. Selected industries and the total manufacturing sector also witnessed sharp increases in capital intensities since the mid-1980s. It is also worth noting that capital intensities for the selected industries as a group were consistently lower than the corresponding figures for the total manufacturing sector. This was true for all the sub-periods mentioned in Table 5.

Table 5: Average Capital Intensity (K1L) and Per Capita Emoluments (E) in Indian Industries

(Rupees)

	Average Real Capital Stock (at 1981-82 constant prices) per Employee (K1L)						
Period	TEX	METAL	MTE	CHEM	LEATH	SMFG	MFG
1973-1980	27134	121120	47924	146940	17307	62118	63806
1980-1985	30696	122180	51206	146121	23486	67389	72447
1985-1990	42125	142141	67552	175934	25936	86321	96839
1990-1995	57928	222306	84539	240361	34931	121825	127925
1995-1998	87281	276322	116497	325038	49251	165475	168987

Average Annual Per Capita Emoluments (E)							
Period	TEX	METAL	MTE	CHEM	LEATH	SMFG	MFG
1973-1980	5407	7702	7840	8385	4973	6791	5644
1980-1985	9377	13611	14693	15163	8340	12419	10397
1985-1990	15268	22065	24931	25406	12302	20795	18473
1990-1995	24881	36515	41885	43816	19630	34752	30761
1995-1998	33388	59440	66924	63826	28697	52521	48536

Note: K1L is the capital intensity, i.e., stock of capital stock (at 1981-82 prices) per employee. Per capita emoluments (E) have been obtained as ratio of nominal emoluments (W) to the number of employees (L). These ratios have been expressed in terms of rupees per employee. See Annexure IV for the compilation of 'K1' series. In this table, we have not provided capital intensity based on the real capital stock K2, since the ranking of capital intensity based on K2 is exactly the same as that obtained by using K1.

A rise in per capita emoluments has taken place more evenly than capital intensities, across the sub-periods. It may be also be noted that unlike the capital intensities, per capita emoluments in selected industries (as a group) have been consistently higher as compared with the corresponding figures for the manufacturing sector. Textile and leather industries consistently recorded lower per capita emoluments than those witnessed for other selected industries and also for the total manufacturing sector. These industries also happen to be the traditional industries with the lowest capital intensities. Among the selected industries, chemical (leather) industry had the highest (lowest) per capita emoluments. It is interesting to note that chemical (leather) industry had the highest (lowest) capital intensity. The correlation coefficient between the capital intensity and per capita emoluments was about 0.52 for the industries selected in this study, indicating that there is a direct association between the capital intensity and the per capita emoluments.

3.5 Trend Growth Rates of Selected Variables in Indian Industries

Rates of growth in employment, real capital stock, capital intensities, total emoluments and per capita emoluments across the industries have been estimated as semi-logarithmic trends (Table 6).

Table 6: Trend Growth Rates of Selected Variables in Indian Industries (1973-74 to 1997-98)

Industry Group	**Trend Growth Rates (per cent per annum)**						
	L	**K1**	**K2**	**K1L**	**K2L**	**W**	**E**
Textiles and textile Products (TEX)	-	5.6	7.0	5.5	6.8	9.9	9.8
Metal and metal products (METAL)	1.6	5.7	7.1	4.0	5.4	12.3	10.5
Machinery and transport equipment (MTE)	1.9	6.2	7.6	4.3	5.6	13.3	11.2
Chemical and chemical products (CHEM)	3.3	7.0	8.4	3.6	4.9	14.4	10.8
Leather and leather products (LEATH)	5.4	10.7	12.1	5.0	6.3	14.9	9.0
Selected Industries (SMFG)	1.4	6.1	7.5	4.7	6.0	12.3	10.8
Manufacturing Sector (MFG)	1.8	6.6	8.0	4.8	6.1	13.2	11.3

Note: See the list of abbreviations.

The trend rate of growth of employment for the total manufacturing sector was about 1.8 per cent per annum, whereas, it was 1.4 per cent per annum for the selected industries. Textile industry pulled down the rate of employment of the selected industries, as it did not witness any growth in employment during the period under investigation. As against this, leather and chemical industries recorded the highest growth in employment.

The rates of growth of capital stock ‘K1’ were lower than that of ‘K2’ by about 1.4 per cent per annum for all industries. We consider the former series of capital stock to be more appropriate as compared with the latter because the gross domestic capital formation (GDCF) deflator index is more comprehensive in comparison with the WPI for machine and machine tools. We have used the latter index also to compile the real capital stock series (K2) in order to compare our findings on productivity with the findings of other studies. The rate of growth of real capital stock turned out to be highest for leather and chemical industries and lowest for textile and metal industries. Machinery and transport equipment industry witnessed the trend growth of real capital stock similar to those obtained for the selected industries and for the entire manufacturing sector. The rates of growth in real capital stock for all the industries included in this study outpaced the rate of growth in employment in respective industries, thereby, resulting in rising capital-labour ratios (rising trends in capital intensities) in all industries. Textiles and leather industries recorded highest growth in capital intensity over the period of the study. However, in the case of the former, employment witnessed a declining trend, whereas, the latter industry recorded the highest growth in employment.

The rate of growth in total emoluments across industries varied between 9.9 per cent per annum (textiles industry) and 14.9 per cent per annum (leather industry). However, the rate of growth of per capita emoluments (i.e., the difference between the rates of growth of total emoluments and the number of employees) varied between 9.0 to 11.3 per cent per annum. Growth in per capita emoluments in leather and textile industries turned out to be lowest (9.0 and 9.8 per cent per annum). The trend inflation rate (as measured by the Consumer Price Index, CPI, for industrial workers) during this period was 8.6 per cent per annum. This implies that the rate of growth of real per capita emoluments in the industries investigated ranged between 0.4 per cent per annum and 2.7 per cent per annum.

3.6 Relative Price Movements, Real Output and Real Value-added in Indian Industries

We have deflated gross output at current prices (Y) by the WPI for the respective industries in order to obtain the estimates of the real gross output (O), needed for estimating total productivity growth (TPG). The estimates of real value-added, requireded for computing total factor productivity growth (TFPG), have been obtained both by single (VSD) and double deflation methods (VDD). The movements in the ratio of input prices to output prices (henceforth, relative prices) explain the differences between the estimates of VSD and VDD. We, therefore, provide a synoptic view of the movements in relative prices for the various industry groups in Figure 2, before providing the estimates of real output and real value added. Figure 2 is based on the data provided in Table A1.

During the 1970s there was no discernible trend in the relative prices for the various industry groups. The period thereafter, witnessed divergent trends in relative prices across industry groups. During the 1980s, relative prices moved more or less in tandem with each other in textiles, machinery and transport equipment industries and in the manufacturing sector as a whole. In chemical industry the relative prices witnessed a steady increase and peaked in 1990-91**.** Thereafter, relative prices continued to decrease and this trend got reversed only after the mid-nineties. For leather industry, we observe fluctuations in relative price index over the years. In the case of metal industry, relative prices were more or less stable until 1987-88. Thereafter, relative prices declined in this industry due to the fact that the output prices increased at a faster rate than the input prices. After 1990-91, the decline in relative price in this industry was reversed. In view of the fluctuations in relative prices of various industries, it is logical to expect differences in estimates of productivity obtained by single and double deflation methods.

Table 7: Trend Growth Rates of Real Output, Real Inputs and Real Value-added in Indian Industries, 1973-74 to 1997-98

Industry Group	Trend Growth Rates in (per cent per annum)				
	O	N1	VSD	N2	VDD
Textiles & textile Products (TEX)	6.4	1.7	4.7	3.0	7.7
Metal & metal products (METAL)	6.8	1.2	5.6	-1.9	3.7
Machinery & transport equipment (MTE)	8.3	1.2	7.1	1.7	8.8
Chemical & chemical products (CHEM)	9.1	-0.1	9.2	4.5	13.7
Leather & leather products (LEATH)	8.2	-0.9	9.1	3.6	12.7
Selected Manufacturing (SMFG)	7.7	0.9	6.8	2.3	9.1
Manufacturing Sector (MFG)	7.8	0.6	7.2	1.8	9.0

Note: N1 and N2 measure real inputs. The former is obtained by deflating the value of inputs by the output price, as is the case in the SD method. The latter is obtained by deflating value of inputs by input price, which is done in the DD method.

It can be seen from Table 7 that the trend rates of growth of O were higher than the trend rates of growth of VSD, barring the leather and chemical industries. Growth rate of N1 is the difference between the trend rates of growth of 'O' and 'VSD' (where, real input, N1 is defined as the value of nominal inputs deflated by output price index). The trend growth rates of N2, *i.e.*, the nominal value of inputs deflated by input price index, for different industries have also been reported in Table 7. Trend rates of growth in real value-added by SD method (VSD) are lower, barring the metal industry, as compared with the respective rates obtained by the double deflation method (VDD). This implies that relative price index for industries, except the metal industry, witnessed a rising trend. This has implications for the measurement of total factor productivity growth (TFPG). It has already been explained that in a situation where relative price index records an increasing trend, TFPG measured by SD method will be lower than the TFPG measured by the DD method.

Textile and metal industries pulled down the rates of growth of O and VSD for the selected industries. These two industries, besides machinery and transport equipment industry, pulled down growth rate of VDD for selected industries. As against this, chemical and leather industries were the best performers in terms of both production and value addition.

4. Productivity in Selected Industry Groups in India: 1973-74 to 1997-98

Very often the choice between measures of single and multifactor productivity is regarded as a matter of 'measurability' versus that of 'theoretical appropriateness'. Of the various productivity measures, labour productivity is the oldest and most widely used. The wide usage of labour productivity is due to the fact that it can be used as a proxy for the amount of goods available for consumption per labourer. Hence, increase in labour productivity is very often regarded as an end in itself and in such a situation the role of capital stock gets reduced merely to that of enabling labour productivity to rise. Labour productivity has also been viewed as a superior indicator of the long-term technical progress (or welfare) as compared to per capita real GDP, since the latter ignores the importance of working hours per person/employment rates in the growth process [Maddison, 1987].

Indices of productivity can, at best, enable comparison of the movements of productivity and not the initial productivity gap. Comparisons of productivity, therefore, become more meaningful only if the information on *absolute levels* of productivity complements the estimates of *growth rates* of productivity. In view of this, we have calculated both the levels and indices of various measures of SFP, which have been discussed in sub-section 4.1. In sub-section 4.2, we present the estimates of multifactor productivity indices, *viz*., TP and TFP indices.

4.1 Single Factor Productivity in Selected Industry Groups

In Table 8, we provide the details of various SFP measures, which we have computed in this study. Of these, the first three indicate the *levels* of labour productivity. The remaining ones are *indices* of labour and capital productivity. In this sub-section, our focus is on the level and movement of labour productivity, though the indices of productivity of capital have also been reported. In many of the industrialised countries, labour productivity is calculated as the real value added per man-hour. This leads to a downward adjustment in estimates of productivity in industries (countries) where a higher number of hours are put in by an employee *vis-a-vis* other industries (countries). In general, the number of hours worked per employee tends to be higher in private sector where incentive schemes prevail and labour unions are not very powerful. However, most of the studies on India's manufacturing sector have used the data on number of employees or workers for estimation of labour productivity. We have also used the data on number of employees in the estimation of productivity.

Table 8: Details of Single Factor Productivity Measures Computed in this Study

Sr. No.	Measure of Output	Input	Productivity Measure (Notation)	Level/ Index
1	O	L	Labour productivity (OL*)	Level
2	VSD	L	Labour productivity (VSDL*)	Level
3	VDD	L	Labour productivity (VDDL*)	Level
4	O	L	Labour Productivity (OL)	Index
5	O	K1	Capital productivity (OK1)	Index
6	O	K2	Capital productivity (OK2)	Index
7	VSD	L	Labour productivity (VSDL)	Index
8	VDD	L	Labour productivity (VDDL)	Index
9	VSD	K1	Capital productivity (VSDK1)	Index
10	VSD	K2	Capital productivity (VSDK2)	Index
11	VDD	K1	Capital productivity (VDDK1)	Index
12	VDD	K2	Capital productivity (VDDK2)	Index

Note: See list of abbreviation for the abbreviations used in this Table. Annexure IV details the procedure used for estimation of K1 and K2 series.

4.1.1 Levels of Labour Productivity

In Figure 3.1, 3.2 and 3.3 (data in Table A2), we indicate the annual averages of real output per employee (OL*), real value added per employee (VSDL*), arrived at by using SD method and real value added per employee (VDDL*), arrived at by using DD method, respectively. These are expressed in lakhs of rupees, at 1981-82 prices.

The following observation can be made by a scrutiny of Figures 3.1 to 3.3. *First*, whatever be the measure of labour productivity, an increasing trend in labour productivity is witnessed in the case of most of the industry groups, across the five sub-periods of the study. *Second*, labour productivity has been consistently higher (except during 1973-80, if measured by VDDL*) for the selected industries as a group as compared with that for the manufacturing sector. *Third*, labour productivity measured by OL*, VSDL* and VDDL*, increased consistently for machinery and transport equipment and chemical industries across the five sub-periods. *Fourth*, a predominant role in increasing labour productivity in selected industries and in manufacturing sector has been played by the chemical industry. *Last*, the metal industry was a problematic industry with stagnant and low levels of labour productivity until mid-eighties, as judged by the VDDL* criterion.

4.1.2 Movements in Partial Productivity and Capital Intensity Indices

Figures 4.1- 4.7 plot yearly movements in labour productivity indices (OL), capital productivity indices (OK1 and OK2) and capital intensities (K1L and K2L) for the various industries/industry groups. Numerical estimates of these indices have been provided in Tables A3 to A10. Trend growth rates of above-mentioned partial productivity indices, *inter alia*, have been reported in Table 9 and yearly movements in these indices have been provided in Figures 4.1 to 4.7. The following observations emerge from scrutiny of Table 9 and Figures 4.1 to 4.7.

First, OL depicted a rising trend in all industries (Table 9). *Second*, in textiles and metal industries (Figures 4.1 and 4.2), OL increased sharply during 1984-85 to 1994-95. Rising OL was accompanied by increasing capital intensities in these two industries (Figure 1A and Table A3). . Thereafter, fluctuations in OL in these industries can be seen. *Third*, in machinery and transport equipment industry, OL increased consistently since the turn of 1980s, followed by a slackening growth of OL in the early nineties (Figure 4.3). Similar trend can be seen for capital intensity in this industry. *Fourth*, chemical industry registered a rising trend in OL during the 1980s (Figure 4.4). The rise was pronounced during the period 1988-89 to 1990-91. OL in this industry increased rather slowly thereafter, until 1996-97. Capital intensity in this industry was stagnant up to the mid-1980s and accelerated thereafter, barring the year 1991-92. *Fifth*, in leather industry, OL showed a rather low rate of growth though the capital intensity registered a sharp increase since 1989-90 (Figure 4.5). *Lastly*, OL and capital intensities increased consistently in selected industries and in manufacturing sector since the 1980s (Figures 4.6 and 4.7).

We regressed labour productivity index (OL) on capital intensity index (K1L) for the various industry groups so as to ascertain whether the former is explained by the latter. We found that for all the industries/industry groups K1L explained OL, t-statistics were significant in all the cases and the adjusted R^2 was above 0.85. In brief, it can be said that capital intensity has facilitated increase in labour productivity. We have already noted a significant correlation between capital intensity and per capita emoluments across industries.

As regards the trend growth rates of OL (estimates provided in Table 9), we observe the following. *First*, trend growth rates of OL were highest in machinery and transport equipment (6.3 per cent per annum) and textile (6.2 per cent per annum). *Second*, chemical and metal industries witnessed trend rates of growth of OL of 5.1 and 5.6 per cent per annum, respectively. *Third*, leather industry recorded the lowest (2.7 per cent per annum) trend rate of growth of OL. *Fourth*, trend rate of growth of OL for the manufacturing sector (5.9 per cent per annum) was marginally lower than that witnessed by the selected industries (6.3 per cent per annum).

As mentioned earlier, increasing capital intensity results in underestimation of capital productivity and overestimation of labour productivity. Capital intensity increased in all industries, which can be verified by the positive growth rates of K1L and K2L. Growth rate of OL was much higher than the growth rate of OK1 and OK2, for all industries. Trend growth rates of OL were higher than of capital productivity, for all the industries. This is expected in a situation of increasing capital intensity.

Table 9: Trend Growth Rates of Single Factor Productivity in the Various Manufacturing Industries in India, 1973-74 to 1997-98

(per cent per annum)

Industry Group	Trend Rates of Growth* of										
	OL	OK1	OK2	K1L	K2L	VSDL	VDDL	VSDK1	VSDK2	VDDK1	VDDK2
Textiles and textile Products (TEX)	6.2	0.7	-0.6	5.5	6.8	4.5	7.5	-0.9	-2.2	2.0	0.7
Metal and metal products (METAL)	5.1	1.1	-0.2	4.0	5.4	3.9	2.0	-	-1.4	-2.0	-3.2
Machinery and transport equipment (MTE)	6.3	1.9	0.6	4.3	5.6	5.1	6.8	0.8	-0.5	2.4	1.1
Chemical and chemical products (CHEM)	5.6	1.9	0.7	3.6	4.9	5.7	10.1	2.0	0.7	6.2	4.9
Leather and leather products (LEATH)	2.7	-2.2	-3.4	5.0	6.3	3.5	7.0	-1.4	-2.6	-	-
Selected Industries (SMFG)	6.3	1.5	0.2	4.7	6.0	5.3	7.6	0.6	-0.7	2.7	1.4
Manufacturing Sector (MFG)	5.9	1.1	-0.2	4.8	6.1	5.4	7.2	0.5	-0.7	2.2	1.0

Note: See list of abbreviations.

* Trend growth rates have been calculated using semi-log trend equations.

In Tables A3-A9, we have provided estimates of labour productivity indices (VSDL and VDDL) and capital productivity indices (VSDK1, VSDK2, VDDK1 and VDDK2). These indices (excluding VSDK2 and VDDK2) have been plotted in Figures 5.1 to 5.7. Since the movements in VSDK1 (VDDK1) imitate those in VSDK2 (VDDK2), we have not plotted VSDK2 and VDDK2 series in these figures. We observe the following after a scrutiny of these figures.

In the textile industry three distinct phases can be seen. The first phase was observed during 1973-74 to 1982-83, the second during 1983-84 to 1993-94 and the third during 1994-95 to 1997-98 (Figure 5.1). In the first phase, the trend growth rates of OL, VSDL and VDDL were 4.4, 2.0 and 4.7 per cent per annum, respectively. Acceleration in growth rate of labour productivity took place during the second phase and the corresponding figures rose to 8.2, 7.3 and 9.9 per cent per annum, respectively. In the third phase we see a deceleration in growth rates of labour productivity and the above-mentioned rates declined to 3.1, -4.6 and –6.0 per cent per annum.

In metal industry both VSDL and VDDL (Figure 5.2) moved closely until 1987-88. Thereafter, the divergence between VSDL and VDDL in this industry is evident, especially before 1990-91. It is pertinent to note that this industry was dominated by the public sector and the output and prices in this industry were, by and large, administered, especially in the pre-1991 period. In this industry, acceleration in growth of labour productivity took place in the early nineties. Trend growth rates in OL, VSDL and VDDL accelerated from 4.7, 2.1 and –1.7 (1973-74 to 1991-92) to 6.9, 12.8 and 17.2 per cent per annum (1992-93 to 1997-98), respectively.

In machinery and transport equipment industry (Figures 5.3) the turnaround in labour productivity growth rate seems to have taken place at the turn of the eighties itself. In this industry, three phases of labour productivity growth can be seen. The years 1979-80 and 1991-92 can be treated as cut-off years for the three sub-periods. Growth rates of labour productivity in this industry accelerated in the second and the third sub-periods as compared to the first and the second sub-periods, respectively. The trend rates of growth in OL, VSDL and VDDL in the first (second) period were 4.5 (7.0), 2,4 (5.6) and 3.4 (8.1) per cent per annum, respectively. Growth rates in these variants of labour productivity further accelerated in the third sub-period.

Growth rates of labour productivity in chemical industry were rather low during the seventies and these accelerated in the post 1979-80 period (Figures 5.4). The trend growth rates of OL, VSDL and VDDL during the seventies were 2.9, -0.5 and 2.8 per cent per annum, respectively. The corresponding figures were 6.3, 8.2 and 11.5 per cent per annum, respectively, for the period 1980-81 to 1997-98.

In leather industry (Figure 5.5), VDDL movements have been quite erratic as compared to those in VSDL. In leather industry, the time-span of the study can be divided into two sub-periods, from the point of view of the performance of growth of labour productivity. These two sub-periods are pre-1990-91 years and the period thereafter. However, acceleration in trend growth rates was significant only in the case of OL and VDDL in this industry. If the effect of relative prices is removed, during the earlier half of the 1980s and 1990s, substantial improvement in labour productivity seems to have taken place in this industry.

Acceleration in growth rates of OL, VSDL and VDDL can be observed in the case of selected industries and also for manufacturing sector during the period 1980-81 to 1997-98 as compared with the pre-1980-81 period (Figure 5.6 and 5.7). Trend growth rates of these variants of labour productivity in selected industries (manufacturing sector) were 4.9 (4.2), 1.9 (1.9) and 2.7 (2.8) per cent per annum, respectively, during the pre-1980-81 period. These accelerated to 6.7 (6.2), 6.7 (6.3) and 8.6 (8.1) per cent per annum, respectively, in the period thereafter.

As regards the trend growth rates in partial productivity measures (for the entire time-span of the study), the following observations can be made after a scrutiny of Table 9. First, labour productivity has risen at a higher rate than capital productivity. Second, capital productivity growth rates estimated by capital stock series K1 are higher than those estimated by K2. Third, estimates of trend growth rates of OL are higher than growth rates of VSDL for all industry groups, barring chemical and leather industries. This implies that real inputs (valued at output prices) per employee have risen at a lower rate than real output in the case of all industries, except in chemical and leather industries. Fourth, growth rates of VDDL are higher than those obtained by VSDL for all industry groups except for metal industry. This has been caused by a faster rate of inflation in input prices *vis-à-vis* the output prices in all the industries included in this study (except for the metal industry) and in the manufacturing sector.

4.2 Multifactor Productivity Indices for the Selected Industries

The details of various multifactor productivity indices, which we have computed in this study, have been provided in Table 10. We have used translog index set out in equation (5) for estimating growth rates of total productivity indices (TP1 and TP2). Growth rates of total factor productivity indices (TFPS1, TFPS2, TFPD1 and TFPD2) were calculated using equation (6). These growth rates were then used to obtain the productivity indices by setting 1973-74 as the base year.

Table 10: Details of Multifactor Productivity Indices Computed

Sr. No.	Measure of Output	Inputs	Productivity Index
1	O	L, K1, N	Total productivity (TP1)
2	O	L, K2, N	Total productivity (TP2)
3	VSD	L, K1	Total Factor productivity (TFPS1)
4	VSD	L, K2	Total Factor productivity (TFPS2)
5	VDD	L, K1	Total Factor productivity (TFPD1)
6	VDD	L, K2	Total Factor productivity (TFPD2)

Note: See the list of abbreviations.

Two sets of numbers are of interest in an inter-industry growth-accounting exercise. *First*, the rates of growth of multifactor productivity across industries and *second*, the contributions of multifactor productivity in explaining the growth of output/real value added. Table 11 and Figures 6.1 to 6.7 provide us with the information related to the first set of numbers.

Table 11: Trend Growth Rates of Productivity in Various Industries in India, 1973-74 to 1997-98

(per cent per annum)

Industry Group	Trend Rates of Growth*					
	TP1	TP2	TFPS1	TFPS2	TFPD1	TFPD2
Textiles and textile Products (TEX)	1.17	1.05	2.25	1.83	5.25	4.81
Metal and metal products (METAL)	-	-	1.58	0.96	-	-
Machinery and transport equipment (MTE)	1.09	0.89	2.79	2.16	4.41	3.77
Chemical and chemical products (CHEM)	1.96	1.75	3.15	2.33	7.40	6.54
Leather and leather products (LEATH)	0.56	0.46	0.90	-	4.27	3.71
Selected Industries (SMFG)	1.12	0.95	2.71	2.09	4.90	4.27
Manufacturing Sector (MFG)	0.99	0.82	2.61	1.95	4.37	3.69

Note: See the list of abbreviations.

* Trend growth rates have been calculated using semi-log trend equations.

A scrutiny of Table 11 allows us to make the following observations. *First*, the trend growth rates of productivity indices compiled with K1 as the measure of capital stock (*viz*., TP1, TFPS1, TFPD1) are marginally higher than the trend rates of growth of productivity estimated with K2 capital stock series (*viz*., TP2, TFPS2 and TFPD2), for all industry groups. This is due to the fact that the trend rates of growth of K1 have been less than those of K2 (Table 6). *Second*, whatever be the measure of MFP considered, the rates of growth of productivity for manufacturing sector have been marginally lower as compared with the corresponding figures for the selected industries. *Third*, trend growth rates in TP1 (TP2) have been lower than trend growth rates in TFPS1 (TFPS2). *Fourth*, trend rates of growth in TFPS1 (TFPS2) have been lower than those of TFPD1 (TFPD2), except for metal industry. This has been on account of rising relative prices in all the industries, except in the metal industry. *Last*, the ranking of the industries remains unchanged irrespective of whether we use the criterion of trend growth rate of TP1or TP2 or TFPD1 or TFPD2. It undergoes a change if the criteria of trend growth rates of TFPS1 and TFPS2 are used. Despite these differences in rankings, chemical industry emerges as the best performer. Leather and metal industries turn out to be poor performers, judged by the growth rates of all the variants of MFP mentioned above.

Estimates of TP1 and TP2 - measured on the Y-axis (right side) in Figures 6.1 to 6.7 - have been provided in Table A11, whereas, estimates of TFPS1, TFPS2, TFPD1 and TFPD2 - measured on the Y-axis (left side) in Figures 6.1 to 6.7 - have been provided in Table A12. Though the trend rates of growth of various measures of productivity have differed, the movements in these indices have been more or less in similar direction, with the exception of metal industry.

4.2.1 Textile Industry

For textile industry (Figure 6.1), we observe a rising trend in TP1, TP2, TFPS1, TFPS2, TFPD1 and TFPD2 until 1993-94. Thereafter, productivity has declined in this industry. We have already seen that there was a significant deceleration in labour productivity in this industry in the post 1993-94 period. It is also interesting to note the co-movements in TP and TFPD indices. The textile industry is one of the largest industries in India and accounted for about 9.2 per cent of nominal value added by the organised manufacturing sector during the period 1995-96 to 1997-98 (Table 4). This industry provides employment to over 20 million people (Economic Survey, 1996-97, Government of India). Several policy measures have been announced by the Government to make this industry internationally competitive. The major policy measures include the Textile Policy Statement of March 1981, which aimed at modernisation and export-orientation of textile industry. This industry was delicensed in August 1991. The Textile Control Order 1986 was repealed in December 1992 and replaced by the Textile (Development and Regulation) Order 1992 which was subsequently replaced by Textile (Development and Regulation) Order 1993. Under the revised order, the provision of licence/registration certificate in respect of textile industry including powerloom, was abolished. Changes were also made in EXIM policy with effect from April 1, 1993. Under this policy, import of capital goods was allowed at a concessional tariff of 15 per cent, with an export obligation of four times the value of the machinery. The Government announced a new Export Entitlement Distribution policy 1994-96 (quota policy) on September 4, 1993 for export of various textile items to the countries where such exports are covered under the bilateral trade agreements. As a result of the successful conclusion of Uruguay round of GATT talks in held in December 1993, it has been agreed to phase out Multi-Fiber Agreement (MFA) within 10 years. In accordance with the requirement of Agreement on Textile and Clothing (ATC), a new long-term quota policy for 1997-99 has been announced in October 1996. This is to ensure greater transparency and higher unit value realisation for exports under quota items.

Since the textile industry has been provider of employment to a substantial labour force in India and that this industry depended to a large extent on unskilled labour, industrial unrest has been quite common in this industry. Despite the fact that the labour unions were quite active in this industry, employment in this industry has declined over the years. Decline in employment in this industry was rather sharp in the mid-eighties, which took place after a major strike in this industry in the early eighties. In fact, this is the only industry among the selected industries, which did not witness any growth of employment. Though the textile industry performed relatively better than the other industry groups, especially during the eighties, it is being viewed as a sunset industry in the nineties. This is in accordance with the decline in productivity in this industry in the post 1993-94 period.

4.2.2 Metal Industry

Multifactor productivity performance in metal industry displays three distinct phases (Figure 6.2). In this industry, TP1 and TP2 do not show any trend during 1973-74 to 1988-89. A sharp fall in productivity indices in metal industry is displayed in the subsequent two/three years followed by an upward trend during the nineties. TP1 (TP2) in this industry declined at an average annual growth rate of 0.5 per cent per annum during 1985-86 to 1989-90. However, it registered a growth of 2.8 (2.7) per cent during 1991-92 to 1997-98. TFPS1 and TFPS2 registered positive trend growth rates during the period of the study. However, the growth rates of TFPD1 and TFPD2 were not significantly different from zero. TFPS1, TFPS2, TFPD1 and TFPD2 hardly displayed any trend until the late eighties. Thereafter, we observe sharp fluctuations in these indices. It is also worth noting that this is one of the industries in which productivity has continued to rise consistently in the nineties.

In the post-Independence period, the new undertakings in a vast segment of metal industry were to be undertaken by the public sector. Iron and steel industry was one of the core industries which was de-reserved in 1991 (*vide* the Industrial Policy Statement of July 1991). Besides this, a substantial upward revision in iron and steel prices (37.44 per cent) was effected in 1991-92, as against a general increase of 9.74 per cent in manufactured prices. The pricing and distribution of iron and steel were deregulated with effect from January, 1992 and increases in prices fixed by the integrated steel plants were effected so as to neutralise increases in input cost of this industry. Import duties on steel items were reduced by 20 per cent in 1991-92 along with the deregulation of iron and steel industry. This was to moderate the rise in market prices of iron and steel. In the subsequent years also the import duties on items of steel have been reduced apart from removing all quantitative restrictions on these imports. In brief, reduction in tariff and non-tariff controls over imports of iron and steel industry, the process of liberalisation seems to have positively affected this industry. Metal industry is also one of the larger industries in India’s manufacturing sector, its contribution to the nominal value added being similar to that of textile industry in the recent years.

4.2.3 Machinery and Transport Industry

Machinery and transport equipment industry is the largest among the selected industries, as per the criterion of nominal value added. It accounted for about one-fifth of the nominal value added in India’s organised manufacturing sector over the period of the study. Productivity growth in this industry has exhibited an upward trend - albeit with fluctuations- since 1979-80 (Figure 6.3). We have already seen that labour productivity also accelerated in this industry at the turn of the eighties.

The Industrial Policy Statement of 1980 had many proposals for reducing procedural hurdles, such as, regularisation of installed capacities (in excess of licensed capacities) in 34 industries, incentives for export promotion, simplification of licensing procedures, improved access to financial assistance, etc. The year 1982 was declared as 'Productivity Year' in recognition of the need for improved performance of the Indian industries. Further liberalisation in industrial policy took place with the announcement of a spate of policy measures. The hallmark of this liberalisation was delicensing of 25 broad categories of industries, which included machinery and transport equipment industry. Broad-banding, capacity re-endorsement, expansion of capacity, loosening of controls over the MRTP companies, etc., were some of the other ingredients of 1985-86 policy statement. The liberalisation measures initiated in this policy statement were carried forward more vigorously in the nineties.

4.2.4 Chemical Industry

In the case of chemical industry (Figure 6.4), the increasing trend in productivity indices continued during the entire decade of 1980s. However, in the nineties deceleration in productivity growth took place in this industry,.

In chemical industry, a number of policy initiatives have been undertaken in the recent years. In 1993, delicensing was effected for most of the bulk drugs and automatic approval of foreign equity up to 51 per cent in most drugs and formulations was granted. Modifications of the Drugs Policy were undertaken in 1990-91 and further modifications were carried out in 1994. The number and the span of drugs under price controls were drastically reduced in 1994. Chemical industry in India did rather well during the 1980s. However, as a signatory to the GATT, India was required to enact legislation which would require adherence of the Indian firms to both product and process patents. The threat of introduction of product patenting could be one of the factors constraining the potential growth and productivity in this industry.

4.2.5 Leather Industry

Leather industry is the smallest of the selected industries in terms of the employment generated, stock of real capital, nominal value added (Table 6). However, its contribution to exports (Table 2) has been much higher as compared with its relative position in India's manufacturing sector. Leather industry recorded output growth of about 8.2 per cent per annum, during the period 1973-74 to 1997-98. Growth rates of employment (5.4 per cent per annum) and real capital stock have been the highest among the selected industries. There has been marginal growth in TP1, TP2, TFPS1 and TFPS2 indices in this industry, though TFPD1 and TFPD2 indices indicate positive growth rates of 4.3 per cent and 3.7 per cent, respectively (Figure 6.5). In other words, though leather industry has performed well in terms of growth of output and contribution to exports, its record has not been impressive as regards growth of multifactor productivity.

Since 1970s, there has been a steady s change in the leather industry. On the export front, there has been a gradual switch in production from semi-finished hides and skins to finished leather and leather manufactures. During the early nineties, leather manufactures accounted for about 70 per cent of leather exports. This was partly due to duty-free imports of raw-hides and skins and easing of norms for importing machinery and other inputs. Exports of raw-hides and skins has been banned. Manufacture of finished leather was delicensed with effect from April, 1993. The domestic manufacture of components for shoe industry is being encouraged through measures like promoting joint ventures and duty rationalisation on inputs required for the manufacture of such components. For the integrated development of this industry, the Government is implementing the National Leather Development Programme (NLDP) with the assistance of the United Nations Development Programme (UNDP). Besides this, a programme of technological upgradation has been launched through selected institutions/agencies in the country. The Council for Leather Exports has launched an image building programme (Leather Blitz) in the US market for boosting the exports of value-added leather products. A large raw material base of hides and skins available in India is the main strength of the industry. In other words, the competitive edge of Indian leather products in the global markets seems to emanate from advantages in terms of availability of raw-materials rather than efficiency in resource utilisation.

4.2.6 Selected Industries and manufacturing Sector

Selected manufacturing industries accounted for about 58 per cent of the nominal value added and 53 per cent of employment provided by India's manufacturing sector, during the period 1995-96 to 1997-98. During the period 1973-74 to 1997-98, trend growth rates of output, employment and real capital stock (K1) in these industries were of the order of 7.7, 1.4 and 6.1 per cent per annum, respectively. Productivity indices in this industry group exhibited an increasing trend since 1980-81 (Figure 6.6). Though there was no turnaround in TP1 and TP2 indices for this group of industries, TFP indices of all varieties indicated 1980-81 to be the year of turnaround. As already mentioned, rate of growth of productivity in selected industries as a group was marginally higher than that witnessed by the manufacturing sector as a whole. Manufacturing sector (Figure 6.7) displayed trends similar to those witnessed by selected industries. This is on account of the wide coverage of selected industry group in the manufacturing sector.

4.3 Correlation between Various Multifactor Productivity Indices

In Table 12, we have reported the correlation coefficients between the following six pairs of productivity indices, *viz*., TP1 & TFPS1, TP2 & TFPS2, TFPS1 & TFPD1, TFPS2 & TFPD2, TP1 & TFPD1 and TP2 & TFPD2. We have not reported the correlation coefficients between TP1 & TP2, TFPS1 & TFPS2 and TFPD1 & TFPD2, as these are expected to have a value of approximately equal to unity due to systematic difference between K1 and K2 series.

Table 12: Correlation Coefficients between Various Productivity Indices

Industry Group	TP1 & TFPS1	TP2 & TFPS2	TFPS1 & TFPD1	TFPS2 & TFPD2	TP1 & TFPD1	TP2 & TFPD2
Textiles and Textiles Products	0.911	0.882	0.944	0.919	0.988	0.989
Metal and Metal Products	0.721	0.696	0.559	0.570	0.851	0.872
Machinery and Transport Equipment	0.963	0.943	0.984	0.974	0.981	0.980
Chemical and Chemical Products	0.931	0.883	0.935	0.887	0.998	0.998
Leather and leather products	0.700	0.646	0.715	0.667	0.997	0.995
Selected Manufacturing	0.956	0.927	0.985	0.968	0.981	0.981
Manufacturing Sector	0.964	0.945	0.981	0.968	0.993	0.994

It can be seen from the above table that for all industries, correlation coefficients between TP1 & TFPS1 are above 0.91, except for metal and leather industries. For these industries also the correlation coefficients are as high as 0.70 or more. Similar observations can be made for the correlation coefficients between TP2 & TFPS2, TFPS1 & TFPD1 and TFPS2 and TFPD2. It is quite interesting to find that the correlation coefficients between TP1 & TFPD1 and TP2 & TFPD2 are higher than 0.85 for all industry groups including metal and leather industries. In Table 11, we have noted that the rates of growth of productivity as measured by TP, TFPS and TFPD indices differ widely. The magnitudes of correlation coefficients reveal that TP & TFPD indices have higher correlation in all industries, than those obtained for the pairs of TP & TFPS and TFPS & TFPD indices.

4.4 Productivity Growth of Indian Manufacturing Sector: Empirical Evidence in Literature

We provide a synoptic view of the growth rates of productivity obtained by a few recent studies on productivity in India's manufacturing sector (Table 13). Estimates of productivity presented in the above table are not strictly comparable, as they pertain to different time-periods and have not been obtained using the same methodology.

Table 13 : Alternative Estimates of Trend Growth Rates of Total Factor Productivity

(per cent per annum)

Study (Year)	Period	TFPG (SD)	TFPG (DD)
Ahluwalia (1985)	1959-60 to 1979-80	-0.6	-
Ahluwalia (1991)	1959-60 to 1985-86	-0.4	-
Brahmananda (1982)	1950-51 to 1980-81	-0.2	-
Balakrishnan and Pushpangadan (1994)	1970-71 to 1988-89	0.5	3.1
Majumdar (1996)@	1950-51 to1992-93	1.7@@	
Mohan.Rao (1996a)	1973-74 to 1992-93	1.3 (2.0*)	2.2
Pradhan, G. and K. Barik (1998)	1963-64 to 1992-93	0.6**	
Present Study	1973-74 to 1997-98	1.95** (0.8**)	3.7

@ Estimates of efficiency in this study have used Data Envelopment Approach (DEA).

@@ Though the study spans over the period 1950-51 to 1992-93, we report the estimates for the sub-period 1973-74 to 1992-93.

* Growth rate of TFPG have been obtained indirectly from the estimates of TPG.

** Estimate of TFPGS2 (TPG2).

The estimates of productivity growth obtained by double deflation method are higher than those obtained with single deflation method, for the given time-periods. This in turn implies that relative prices have risen over the period of time. Moreover, all the studies that include the post-1985-86 period report positive growth rates of productivity. This implies a better productivity performance of the Indian manufacturing sector in the post-1985 period. It is also worth noting that the growth rate of productivity obtained using the data envelopment approach (DEA) are close to the estimate of productivity growth obtained by the single deflation method in this study.

4.5 Contribution of Productivity to Growth in Indian Industries

Economists have shown keen interest in the sources of growth. Expansion of economic activity driven by productivity improvements is regarded as sustainable. In the context of recent international developments, it has been argued that since the growth of the East-Asian economies was primarily due to factor accumulation and not the outcome of productivity growth, it is inappropriate to treat their growth performance as miraculous (Krugman, 1994).

Table 14: Contribution of Productivity to Growth in Various Industries in India, 1973-74 to 1997-98

Industry Group	Trend Growth Rates (per cent per annum)			Ratios of Productivity Growth Rates to Growth Rates of Output or Real Value Added (percentages)					
	O	VSD	VDD	TPG1/ OG	TPG2/ OG	TFPGS1/ VSDG	TFPGS2/ VSDG	TFPGD1/ VDDG	TFPGD2 VDDG
Textiles and textile Products (TEX)	6.4	4.7	7.7	18.3	16.4	47.9	38.9	68.2	62.
Metal and metal products (METAL)	6.8	5.6	3.7	-	-	28.2	17.1	-	
Machinery and transport equipment (MTE)	8.3	7.1	8.8	13.1	10.7	39.3	30.4	50.1	42.
Chemical and chemical products (CHEM)	9.1	9.2	13.7	21.5	19.2	34.2	25.3	54.0	47.
Leather and leather products (LEATH)	8.2	9.1	12.7	6.8	5.6	9.9	-	33.6	29.

Selected Industries (SMFG)	7.7	6.8	9.1	14.5	12.3	39.9	30.7	53.8	46
Manufacturing Sector (MFG)	7.8	7.2	9.0	12.7	10.5	36.3	27.1	48.6	41

Note: See the list of abbreviations.

In Table 14, we have presented the ratios of growth rates of TPG1 and TPG2 to growth rate of real output (OG), which measure the contribution of productivity to the growth of output. During the span of the study, the contribution of TPG1 to the total output was rather low for selected industries as a group (14.5 per cent) and also for the manufacturing sector (12.7 per cent). Highest contributions of productivity to growth of output were registered for chemical (21.5 per cent) and textile (18.3 per cent) industries. In metal industry, the contribution of total productivity to growth of real output was insignificant. The contribution of TPG1 to growth of output in machinery and transport equipment was of the order of 13.1 per cent. The respective figure for leather industry was 6.8 per cent. Contributions of TPG2 to the growth of output for various industries/industry groups were marginally lower than the corresponding figures for TPG1.

The contribution of growth of productivity, measured by TFPGS1, to the growth of VSDG1, gives us much higher figures than the ratios of TPG1 (TPG2) to OG. The ranking of the industries, as per the criterion of contribution of productivity to growth, also undergoes a change. In other words, measurement of productivity and the contribution of productivity to growth is sensitive to whether we use the real output or real value added as a measure of production. This implies that material inputs cannot be treated as separable from factor inputs in production process. Moreover, the estimates of productivity and contribution of productivity to growth display a high sensitivity to the choice of deflation method, i.e., if we compare the ratio of TFPGD1 (TFPGD2) to VDDG1 (VDDG2), with the corresponding figures used in the single deflation method.

5. International Comparisons of Productivity: Approaches and Problems

Liberalisation in international flow of goods, services and factors of production has resulted in aggressive competition in global markets. The survival in the global markets has made it necessary to improve productivity and produce high quality goods at competitive prices. This has led to a renewed interest in cross-country studies on competitiveness and on international comparisons of productivity.

The concept of competitiveness is a much broader concept than those of cost-competitiveness and productivity. Porter [1990] highlighted the two major sources of competitiveness, *viz.*, efficiency in use of resources (or productivity, which leads to cost-competitiveness) and product differentiation. He further emphasised that through product differentiation, it is possible to neutralise cost disadvantage and that this has been the strategy pursued by the industrialised countries. The concept of competitiveness encompasses the relative costs at which products are produced (comparative advantage) and sold. In an open economy, the prices at which goods are sold are determined by prices of factor and intermediate inputs, profit margins and exchange rates. Movements in any of these variables influence the competitiveness of a product in the global markets. Other qualitative determinants of competitiveness include customisation of the products and after-sales services [Wagner and Ark, 1996]. In general, it is observed that countries which have been competitive at the global level are those which have improved productivity and lowered cost levels (Ark, 1996). Mere product differentiation is not of much use. In fact, improvement in productivity extends the scope for manoeuvring competitiveness.

The three main approaches used in cross-country comparisons of productivity are: (a) comparisons of *levels* of productivity; (b) comparisons of *growth rates* of productivity; and, (c) productivity case studies [Wagner and Ark, 1996]. Macro and meso studies generally resort to (a) and/or (b). It needs to be mentioned that studies that compare only growth rates of productivity are not of much use. Comparisons of productivity levels are necessary, as only these can reveal the 'initial magnitudes' of productivity differences across countries.

It needs to be mentioned that the international comparisons of levels of competitiveness and productivity have mainly focussed on labour productivity and unit labour costs. The concept of cost-competitiveness is often proxied by unit labour costs (ULCs). Unit labour costs are defined as the ratio of 'labour costs' to 'labour productivity'. These comparisons are bilateral in nature.

The ULCs are expressed in a common currency and hence, the exchange rate becomes another determinant of cost-competitiveness. Since the prices of commodities are rarely the same across countries, nominal output of the countries is converted into real output by using prices prevailing in the respective countries. This conversion is usually done by using the unit value ratios (UVRs) or expenditure purchasing power parities (EPPPs). It has been observed that the use of UVRs and EPPPs can yield significant differences in productivity and competitiveness estimates. It also needs to be added here that this methodology enables only bilateral comparisons and the estimates of competitiveness or productivity so obtained, very often do not satisfy transitivity property required for multilateral comparisons.

At present the following data sets on productivity are published on a regular basis. These are: (i) Indices on labour productivity growth for 12 countries; (ii) Multifactor productivity series for France, Germany and the United States; (iii) Employee compensation, capital stock, investment, output, etc. (as a part of International Sectoral Database, ISDB, for 14 OECD countries; and, (iv) STAN database covering the various aspects of manufacturing sector for 21 OECD countries. The first two series are published by the US Bureau of Labour Statistics (BLS). The data for these two series are available since 1950 and 1956, respectively. Data series (iii) and (iv) are published by the OECD. ISDB data series starts from 1960, whereas, the STAN database is available for the period 1970 onwards. Research papers, which have often made extensive use of the above-mentioned series, are another source of information on international comparisons of productivity and cost competitiveness. It is worth noting that due to the methodological problems, the BLS has avoided international comparisons of productivity [Ark, 1996b].

In Table 15, we reproduce one of the most recently available empirical evidence on the comparative levels of labour productivity across countries. It can be seen that the level of labour productivity in India was exceptionally low during the benchmark year as compared to the corresponding levels for the developed countries. This indicates the extent of productivity gap. With this data set it is not difficult to understand as to why merely the comparisons of growth rate in productivity are inadequate. Even a country like Korea had the labour productivity level, which was almost one-fourth of that witnessed by the United States. None of the countries had labour productivity level that was greater than that in the United States. France, Ireland, Japan, the

Netherlands and the United States had productivity levels higher than that in Germany. All these countries and Germany witnessed higher labour productivity as compared to the United Kingdom.

Table 15: Comparative Levels of Value Added per Person Employed in Manufacturing, 1987, as a % of the US, West Germany and the UK

Country	United States = 100	West Germany = 100	United Kingdom = 100
India	7.2	10.3	13.5
East Germany	22.5	32.0	41.9
Czechoslovakia	23.9	34.0	44.6
Portugal	24.5	34.9	45.7
Korea	26.3	37.5	49.1
Brazil	30.7	43.7	57.3
Spain	46.4	66.2	86.7
United Kingdom	53.6	88.7	100.0
West Germany	70.2	100.0	112.7
France	71.2	109.3	133.0
Ireland	73.4	104.6	137.0
Japan	76.4	108.9	142.7
Netherlands	83.5	118.7	155.6
United States	100.0	142.5	186.7

Source: Wagner and Ark [1996, p.7].

The reliability of studies using the 'industry of origin' approach hinges on the accuracy of the conversion factor to express output and productivity into a common currency. Finding such a conversion factor is fraught with numerous difficulties. The reliable comparison of productivity levels across countries depends on two components, *viz*., comparable indicators of output and inputs for each country, and a conversion factor to convert output values to a common currency unit. Exchange rate is not an appropriate conversion factor for the latter, as it is heavily influenced by speculative capital flows and does not indicate real price differences across countries [Ark, 1996a].

In Table 16 and 17, we report the growth rates of labour productivity and TFP, respectively, in the five major industrialised nations. Growth rates of TFP for selected East Asian economies have been reported in Table 18.

Table 16. Annual Compound Growth Rates of Value Added per Hour Worked in Manufacturing and in the Total Economy, 1950-1994

Country	**Total Economy**			**Manufacturing**		
	1950-73	**1973-87**	**1987-94**	**1950-73**	**1973-87**	**1987-94**
Germany (Fed. Rep.)	6.0	2.5	3.2	6.9	2.7	2.8
France	5.0	3.1	1.7	5.7	3.5	3.4
Japan	7.7	3.0	2.6	9.4	4.8	4.1

United Kingdom	3.1	2.4	1.9	4.2	3.2	4.9
United States	2.7	1.1	1.0	2.8	2.5	2.3

Source: Wagner and Ark [1996, p.1].

It can be seen from Table 16 that the rates of growth of labour productivity for all the developed countries mentioned in this table are less than that witnessed by the Indian manufacturing sector for a similar period (5.1 per cent per annum, see Table 9). However, the level of labour productivity differs so vastly (Table 15) that even if labour productivity continues to grow at this rate in India, the convergence to the international productivity levels in manufacturing sector seems to be a difficult proposition in the near future.

Table 17: Growth Rates of TFP in Selected Developed Countries

Country	**Total Economy**			**Manufacturing**	
	1950-73	**1973-87**	**1987-93**	**1973-87**	**1987-93**
Germany	2.5	1.0	1.0	1.1	1.5
France	3.8	1.3	1.4	2.1	2.7
Japan	4.6	1.1	0.8	3.8	1.4
United Kingdom	2.5	1.0	1.5	1.7	2.9
United States	1.5	-0.2	0.6	0.8	0.3

Source: Ark [1996b; p. 21]

Table 18: Growth Rates of TFP in Selected East-Asian Economies

Country--->	**Hong Kong**	**Singapore**	**South Korea**	**Taiwan**
Growth rate of TFP (period of the study)	3.9 (1971-76)	-0.9 (1970-80)	5.3 (1970-75)	0.1 (1970-80)
	2.2 (1976-81)		-0.7 (1975-80)	
	0.9 (1981-86)	-1.1 (1980-90)	5.1 (1980-85)	2.8 (1980-90)
	2.4 (1986-91)		0.8 (1985-90)	
	2.3 (1966-90)	0.2 (1966-90)	1.7 (1966-90)	2.1 (1966-90)

Note: Figures for Hong Kong are for the total economy and for manufacturing sector for the other countries.

Source: Adapted from Young [1995].

Our estimates of growth rates of TFPS1 and TFPS2 for the manufacturing sector in India (2.6 and 2.0 per cent per annum, respectively, for the period 1973-74 to 1997-98) show that in terms of growth rate of TFP, India's performance seems to be quite comparable with the developed countries. We also do not find India to be a poor performer vis-à-vis the East-Asian economies. This fact has also been corroborated by a recent study [Hulten,1999].

6. Summary and Conclusions

The role of productivity as a source of growth and competitive performance of nations hardly needs elaboration. In fact, efforts to explain the growth process have led to the emergence of a new area in development economics, *viz*., endogenous growth theory.

In this study, we have reported the levels and growth rates of labour productivity, capital productivity and also capital intensities. In view of the controversy about the 'separability of material inputs', we have estimated the total productivity (TP) and the total factor productivity (TFP) indices within the growth accounting framework. We have used the translog index for this purpose, whose superiority over the rival productivity indices has been amply demonstrated in the literature. Computation of productivity indices entailed the data on real output and real value-added as alternative proxies for production levels. We have, therefore, estimated the real value added and the TFP indices by both single and double deflation methods. These productivity indices have been calculated using the two alternative series of capital stock, *viz*., K1 and K2. We preferred the use of capital stock series (K1) derived by using investment deflator rather than K2 series obtained by using WPI for machine and tools, as the former price index is stated to be a more comprehensive measure than the latter. We also consider TP indices as superior to TFP indices in measuring the overall efficiency in production process. Since TFP indices have additional information content, such as, movement of input-output prices, implications for welfare, etc., we have also calculated these indices.

The main findings of the study, some of which are based on capital stock series K1, are summarised below.

- Labour productivity for the selected manufacturing industries, as a group, has been higher than that for the manufacturing sector as a whole. Whatever be the measure of labour productivity, an increasing trend in labour productivity has been witnessed in the case of most of the industry groups across the five sub-periods of the study. The leading performers were chemical, machinery and transport equipment and textile industries, if both the levels and the growth rates of labour productivity are considered. Labour productivity has risen at a higher rate than capital productivity.
- The international comparisons of labour productivity indicate that Indian industry has witnessed higher growth rates of labour productivity as compared with some of the industrialised countries. However, the level of labour productivity in India is abysmally low and its convergence to the international standards seems to be a difficult proposition in the near future. This indicates the extent of the productivity gap.
- The rates of growth of TP, TFP (single deflation method) and TFP (double deflation method) in manufacturing sector were 1.0 per cent, 2.6 per cent and 4.4 per cent per annum, respectively, during the period 1973-74 to 1997-98. The rates of growth of multifactor productivity were higher for the selected manufacturing sector as compared with the manufacturing sector as a whole. Textile, machinery and transport equipment and chemical industries were the better performers, whereas, metal and leather industries were the worst performers. It is worthwhile to note that most of the studies conducted on the Indian experience corroborate the empirical findings of this study i.e., the Indian manufacturing sector has recorded positive rates of growth of productivity, particularly in the post -1985 period. Furthermore, in terms of total factor productivity, the manufacturing sector in India compares favourably with those of the East Asian economies.

- Industry level analysis of the behaviour of productivity reveals diverse implications for their prospective performance. Although the textile industry is viewed as a sunset industry, its performance has been resilient *vis-à-vis* other industries, despite the problems of industrial unrest. The decline in the labour force facing this industry could operate as a drag on the growth of output. For the metal industry, optimising the use of labour force in changing demand conditions is difficult due to the stringent labour laws governing the public sector undertakings. If labour costs become fixed costs for a long period of time, then adapting to the changing demand conditions is bound to adversely affect the productivity performance. In spite of these constraints, productivity in the metal industry has responded favourably in the nineties to the structural changes in the industrial climate. As regards chemicals and machinery and transport equipment industries, they seem to have been adversely affected by the import liberalisation process, which has resulted in the input prices rising faster than the output prices. Leather industry presents a peculiar picture. Growth in output of this industry can be attributed solely to 'perspiration' rather than 'inspiration'. However, this industry has performed rather well in terms of its contribution to exports. Stricter environmental standards in competitor countries provide a competitive edge to the Indian leather industry.

For the Indian manufacturing sector, many challenges lie ahead. Increase in productivity is imperative in order to raise standards of living and also to make the Indian exports globally competitive. In the metal industry, labour unions have been quite active. In such a situation, optimising the level of labour input in accordance with the changing demand conditions is rather difficult. This could be one of the many reasons of low productivity in this industry. This is particularly true of public sector undertakings. We have already noted that the private sector was allowed to enter many areas of industry in the recent years and this accompanied by market related pricing has resulted in an increase in productivity.

We have also noticed that in all the industries, barring the metal industry, input prices have risen faster than output prices. Stabilisation of input prices, in a situation where output prices are getting stabilised due to import liberalisation, is necessary. With the pressure mounting on India to adhere to labour and environmental standards, Indian industries will have to prepare strategies for economising the use of inputs and curtailing costs so as to remain competitive in the global trading environment

Annexure I: Single and Double-deflation Methods

In this annexure, we detail the differences between the estimates of real value added obtained by using single and double deflation methods. See the list of abbreviations for the notations used.

Equation AI.1 defines the nominal value added for year 't' (NV_t) as the difference between the gross output at price in that year (P_tO_t) and the cost of raw-material used (Pn_tN_t).

$$NV_t = P_tO_t - Pn_tN_t \qquad \text{AI.1}$$

Nominal value added is converted into real value added (single deflation method) for year 't' (VSD_t) by deflating equation AI.1 by (P_t/P_o), i.e., the index of price for year 't' with respect to the base year 'o'. This is stated in equation AI.2.

$$VSD_t = (P_tO_t – Pn_tN_t)/ (P_t/P_o) = (P_oO_t - \Pi_tP_oN_t) \qquad \text{AI.2}$$

Nominal value added (stated in equation AI.1) is converted into real value added (double deflation method) for year 't' (VDD_t) by deflating the P_tO_t by (P_t/P_o), and Pn_tN_t by Pn_t/Pn_o. In other words, nominal gross output is converted into real gross output by using the output price deflator index, whereas, the nominal value of inputs is converted into real quantity of inputs by deflating it by the price deflator index for the material inputs. This is stated in equation AI.3.

$$VDD_t = [(P_tO_t)/ (P_t/P_o)] – [(Pn_tN_t)/(Pn_t/Pn_o)]= (P_oO_t - Pn_oN_t) \qquad \text{AI.3}$$

Setting $P_o, P_{no}= 1$ for the base year in equations AI.2 and AI.3, we get equations AI.4 and AI.5, respectively.

$$VSD_t = O_t - \Pi_tN_t \qquad \text{AI.4}$$

$$VDD_t = O_t - N_t \qquad \text{AI.5}$$

If Π_t is constant w.r.t. time, growth rate of VSD = growth rate of VDD.

If Π_t is rising w.r.t. time, growth rate of VSD < growth rate of VDD.

If Π_t is falling w.r.t. time, growth rate of VSD > growth rate of VDD.

Production function, i.e., dependence of real output on labour, capital and raw-material inputs has been described in equation AI.6. For simplicity in exposition, we have ignored the time subscript in equations AI.6, AI.7 and AI.8. Equation AI.7 links describes the relationship between the real value added obtained with single deflation method and the gross output.

$$O = f[L, K, N] \qquad \text{AI.6}$$

$$VSD = O - (P_n N / P) \qquad \text{AI.7}$$

If N is separable from L and K then, the real value added function can be written as equation AI.8.

$$VSD = g [L, K; \Pi] \qquad \text{AI.8}$$

However, if raw-materials are not separable from the factors of production, then it would be inappropriate to estimate the real value added function as dependent only on L and K.

Annexure II: Alternative Indices for Measuring Multifactor Productivity

In this annexure, we provide the details of the three major MFP indices, viz., the Kendrick Index (KI), the Solow Index (SI) and the Translog Index (TLI).

i) Kendrick Index

Kendrick index may be interpreted as the ratio of actual output to the output, which would have resulted from increased inputs alone, i.e., in absence of technological change. Kendrick index for TFP (A_t) for the time period 't' is stated in equation (AII.1).

$$A_t = O_t /(w_o L_t + r_o K_t) \qquad \text{(AII.1)}$$

In the above equation notations 'w_0'and 'r_0' denote the factor rewards to labour and capital, respectively, in the base year 'o'. Generally, income shares are used as weights to compute the ratio of output to a weighted combination of inputs and thereby measure A_t. A number of assumptions, implicit in use of these weights are as follows. *First*, factor rewards are equal to their marginal productivity. In other words, the applicability of marginal productivity theory of distribution is assumed. *Second*, technological change is of Hicks-neutral type. In the case of Hicks-neutral technical change the marginal rates of technical substitution remain unchanged and the technical progress increases the output attainable from a given bundle of inputs. The *third* assumption made in the empirical studies is that of constant returns to scale. In brief, the assumption of constant returns to scale combined with the applicability of marginal productivity theory yields the product exhaustion or the Euler's theorem, which means that entire output is exhausted by payment to labour and capital. Thus, in the base year A_0 will be equal to unity by definition. One of the major limitations of the Kendrick Index is that it is based on a linear production function (and hence, infinite elasiticity of substitution between the factors of production) and does not allow for the diminishing marginal productivity of factors of production.

ii). Solow Index

Solow (1957) used a linear homogenous Cobb-Douglas production function as stated in equation (AII.2), in order to obtain the TFPG. A variants of Equation (AII.2), converted into log-linear form is stated in equation (AII.3). Equation (AII.3) can also be written in the form of equation (AII.4), as the first difference in logarithms of a variable can be expressed as proportionate change in that variable.

$$O = A(t)\, K^{\beta}\, L^{1-\beta} \qquad \text{(AII.2)}$$

$$\Delta\log(O/L) = \Delta\log A(t) + \beta\, \Delta\log(K/L) \qquad \text{(AII.3)}$$

$$\Delta(O/L)/(O/L) = \Delta A(t)/A(t) + \beta\Delta(K/L)/(K/L) \qquad \text{(AII.4)}$$

Assuming that the marginal productivity theory of distribution holds true, we get the expression for β, which is stated in equation (AII.5) where 'i' denotes the real return to capital. Substituting (AII.5) in (AII.4) we get equation (AII.5).

$$\beta = i\, K/O \qquad \text{(AII.5)}$$

$$\Delta A(t)/A(t) = \Delta(O/L)/(O/L) - (i\, K/O)*\Delta(K/L)/(K/L) \qquad \text{(AII.6)}$$

Feeding the data on O, L, K and i, we get a numerical expression for the residual $\Delta A(t)/A(t)$ from equation (10). This term is designated as growth rate of TFP (TFPG). Growth rates of TFP are used to construct TFP indices across time. Indices of A(t) are also referred to as the Solow residuals or Solow index of technological progress or Solow TFP indices. The above discussion highlights the fact that all assumptions of the linearly homogenous C-D function, *viz*., disembodied Hicks-neutral technical progress and unitary elasticity of substitution are built into Solow (1957) residuals. Moreover, these residuals are obtained by invoking the assumption of the marginal productivity theory of distribution, as mentioned in equation (AII.5). Constant returns to scale and product exhaustion assumptions enter Solow's analysis *via* the combination of equation (AII.3) and (AII.6). The Solow concept of TFPG is unambiguous for infinitesimally small and continuous shifts in technology across time. Empirical estimates of productivity change are based on a discrete set of price and quantity data. A solution to this problem lies in using a flexible form of production function, which is twice differentiable.

Annexure III
Selected Industries and their National Industrial Classification (NIC) Codes

Industry (Code as per NIC-1970)	**Industry (Code as per NIC-1987)**
1. Textiles and textile products a) Manufacture of Cotton Textiles (23) b) Manufacture of Wool, Silk and Synthetic Fibres (24) c) Manufacture of Jute,Hemp and Mesta textiles (25) d) Manufacure of Textile Products (26)	***1. Textiles and textile products*** a) Manufacture of Cotton Textiles (23) b) Manufacture of Wool, Silk and Man-made Fibre Textiles (24) c) Manufacture of Jute and Other Vegetable Fibre Textiles, Except Cotton (25) d) Manufacure of Textile Products (26)
2. Metal and metal products a) Basic Metal and Alloys Industries (33) b) Manufacture of Metal Products and Parts except Machinery and Transport Equipment (34)	***2. Metal and metal products*** a) Basic Metal and Alloys Industries (33) b) Manufacture of Metal Products and Parts except Machinery and Transport Equipment (34)
3. Machinery and transport equipment a) Manufacture of Machinery, Machine Tools and Parts, except Electrical Machinery (35) b) Manufacture of Electrical Machinery, Apparatus, Appliances and Supplies and Parts (36) c) Manufacture of Transport Equipment and Parts (37)	***3. Machinery and transport equipment*** a) Manufacture of Machinery and Equipment Other Than Transport Equipment (35-36) b) Manufacture of Transport Equipment and Parts (37)
4. Chemical and chemical products a) Manufacture of Chemical and Chemical Products, except Products of Petroleum and Coal (31)	***4. Chemical and chemical products*** a) Manufacture of Basic Chemical and Chemical Products, except Products of Petroleum and Coal (30)
5. Leather and leather products a) Manufacture of Leather and Leather and Fur Products, except repair (29)	***5. Leather and leather products*** a) Manufacture of Leather and Products of Leather, Fur & Substitutes of Leather (29)

Source: ASI, Central Statistical Organisation, Department of Statistics, Government of India.

Annexure IV
Estimation of Capital Stock Series

The measurement of capital stock has been a controversial issue both in theoretical and in empirical contexts. There is no universally accepted method for its measurement and several methodologies are used in estimation of capital stock. We have used the Perpetual Inventory Accumulation Method (PIAM) for generating the series on capital stock. The PIAM requires the estimates of capital stock for a benchmark year and investment in the subsequent years. This method has been followed by other researchers as well (Ahluwalia [1991] and Balakrishnan and Pushpangadan [1994]). The time-series on capital stock at current prices, has been generated by using equations (AIV.1) and (AIV.2).

$$I_t = B_t - B_{t-1} + D_t \qquad \text{(AIV.1)}$$

$$K_t = K_0 + \sum_{i=1}^{t} I_i \qquad \text{(AIV.2)}$$

Notations used in these equations are as follows. I is the gross capital formation/investment, B is the book value of fixed capital, D is depreciation, K is the stock of capital at current prices. Subscript ‘t’ has been used to denote time. The gross investment figures were obtained using equation (AIV.1). Data on all the variables mentioned in this equation are available in ASI. We have taken the estimates of capital stock at current prices for 1964 (K_0) from Hashim and Dadi (1973) and have treated this year as the benchmark year. Gross capital stock for the subsequent years have been arrived at by adding the gross investment figures (from equation (AIV.1)) to the stock of capital of the previous year, as mentioned in equation (AIV.2).

The series on gross capital stock at current prices (K_t) has been converted into real capital stock series by using two alternative price indices, *viz*, Gross Domestic Capital Formation Deflator index and WPI for Machines and Machine tools, both with base 1981-82=100. The former real capital stock series has been referred to as K1 and the latter as K2, in this study.

Annexure V
List of Commodity Sectors as Classified in Input-Output Table (Code No.)

1. Textile, yarn, fabric & manufactures • Cotton textiles (24) • Wollen textiles (25) • Art silk and synthetic fibres (26) • Jute hemp mesta textiles (27) • Other textiles (28)
2. Manufacture of metals • Iron and steel (42) • Non-ferrous metals (43)
3. Machinery & transport equipment • Tractors and other agricultural machinery (44) • Machine tools (45) • Other non-electrical machines (46) • Electrical machinery (47) • Rail equipment (50) • Motor vehicles (51) • Other transport equipment (52)
4. Chemical & allied Products • Fertilisers (36) • Pesticides (37) • Other Chemicals (39)
5. Leather and Manufactures • Leather and leather products (31)

Note: Figures in brackets indicate the commodity sector number in the input-output table, 1991-92, in *A Technical Note to the Eighth Plan of India (1992-97)*, Perspective Planning Division, Planning Commission, Government of India, New Delhi, 1995.

Annexure VI
Compilation of Input Price Index

Input price index series for the various industry groups were compiled using the technological coefficients from the input-output table, 1991-92. This input-output table has been constructed by the Planning Commission (1995) using the inter-industry transactions matrix, 1983-84, provided by the Central Statistical Organisation (CSO), Department of Statistics, Ministry of Planning. The inter-industry table of 1983-84, which was originally constructed for 115 sectors, has been aggregated into 60 sectors and has been used in the Eighth Plan exercies. The 1983-84 inter-industry table has been updated to 1991-92 by the Planning Commission on the basis of input norms, commodity output, exports, imports, investment, public and private consumption, each at the prices prevailing in 1991-92.
The input price indices for the various industry groups were computed as a weighted average of the wholesale price indices of various inputs. It is for the first time that a group of 60 inputs has been used for estimating the relative input-output prices in the Indian manufacturing and used in the productivity study.

Table A1: Relative Price Indices for Selected Industry Groups in India

(Base 1981-82=100)

Year	TEX	METAL	MTE	CHEM	LEATH	SMFG	MFG
1973-74	88.3	100.3	99.9	100.6	96.6	94.4	95.1
1974-75	91.6	101.8	99.0	92.2	107.8	94.7	100.1
1975-76	97.9	102.2	96.1	91.6	102.1	97.0	103.1
1976-77	100.6	102.5	99.9	96.1	97.8	99.6	103.8
1977-78	94.3	104.2	101.2	99.5	101.9	98.1	105.7
1978-79	93.7	102.4	101.8	100.8	96.1	98.1	109.7
1979-80	92.3	99.0	99.8	103.3	88.7	97.1	102.1
1980-81	96.1	100.9	98.7	98.5	90.6	98.0	95.8
1981-82	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1982-83	100.2	100.9	101.0	100.9	105.3	100.7	103.5
1983-84	103.2	100.9	103.7	106.8	105.4	103.4	105.9
1984-85	105.4	99.5	106.1	111.2	106.5	105.2	107.4
1985-86	104.9	98.1	108.1	114.8	104.7	105.6	106.5
1986-87	108.8	99.6	106.1	116.6	105.3	107.0	107.7
1987-88	109.4	100.2	108.6	118.9	105.8	108.4	109.4
1988-89	108.6	95.3	108.4	124.6	99.4	107.6	110.6
1989-90	105.9	90.8	108.8	125.8	97.0	105.6	109.6
1990-91	108.1	88.6	103.8	135.4	89.5	105.5	106.6
1991-92	111.4	94.0	104.8	130.9	95.8	108.0	109.7
1992-93	113.1	95.7	105.8	129.1	105.8	109.2	110.8
1993-94	113.0	96.5	109.7	129.1	106.5	110.4	111.8
1994-95	111.4	96.6	109.3	128.5	106.6	109.9	110.5
1995-96	106.2	95.0	110.3	128.6	112.5	108.3	112.3
1996-97	106.8	97.1	111.1	132.2	116.4	109.9	113.4
1997-98	106.6	99.1	113.1	134.0	116.3	111.0	114.0

Note: See Annexure VI for methodology used for compilation of relative price indices

Table A2: Inter-industry Comparison of Levels of Labour Productivity

(RS. Lakhs, at 1981-82 prices)

Annual Average Real Output per employee (OL*)							
Period	TEX	METAL	MTE	CHEM	LEATH	SMFG	MFG
1973-80	0.49	1.07	0.83	1.72	1.02	0.81	0.78
1980-85	0.63	1.40	1.07	2.15	0.98	1.08	1.01
1985-90	0.93	1.75	1.54	2.99	1.16	1.55	1.47
1990-95	1.35	2.33	2.02	4.17	1.42	2.12	1.91
1995-98	1.49	3.00	2.94	4.98	1.80	2.66	2.40
Annual Average VSD per Employee (VSDL*)							
Period	TEX	METAL	MTE	CHEM	LEATH	SMFG	MFG
1973-80	0.12	0.23	0.23	0.38	0.14	0.19	0.17
1980-85	0.13	0.25	0.28	0.40	0.14	0.23	0.20
1985-90	0.18	0.29	0.35	0.54	0.15	0.30	0.28
1990-95	0.26	0.38	0.47	0.88	0.25	0.43	0.38
1995-98	0.24	0.57	0.65	1.15	0.27	0.56	0.48
Annual Average VDD per Employee (VDDL*)							
Period	TEX	METAL	MTE	CHEM	LEATH	SMFG	MFG
1973-80	0.09	0.24	0.22	0.35	0.12	0.18	0.19
1980-85	0.14	0.26	0.29	0.46	0.15	0.24	0.22
1985-90	0.23	0.24	0.44	0.93	0.18	0.39	0.37
1990-95	0.37	0.27	0.58	1.61	0.26	0.58	0.51
1995-98	0.36	0.32	0.64	1.69	0.32	0.62	0.56

Table A3: Indices of Capital Intensity in Indian Indust

Year	TEXTILE		METAL		MACHINERY etc.		CHEMICAL	
	K1L	K2L	K1L	K2L	K1L	K2L	K1L	K2L
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	85.3	83.6	87.6	85.8	92.6	90.8	91.3	89.4
1975-76	82.9	78.6	96.9	91.9	98.8	93.7	95.9	90.9
1976-77	87.2	86.2	104.2	103.1	108.3	107.1	95.0	93.9
1977-78	90.3	91.0	104.2	105.0	109.7	110.6	95.4	96.1
1978-79	90.4	92.3	100.3	102.4	128.6	131.3	98.4	100.4
1979-80	82.4	84.7	96.8	99.5	109.9	113.0	92.1	94.7
1980-81	88.9	93.8	96.0	101.3	108.6	114.6	94.0	99.2
1981-82	93.0	100.0	97.4	104.8	108.6	116.8	94.7	101.9
1982-83	98.1	111.2	99.5	112.8	112.1	127.2	90.5	102.6
1983-84	108.9	130.8	103.2	124.0	117.8	141.5	98.1	117.9
1984-85	111.0	138.0	101.0	125.6	123.8	153.9	97.1	120.7
1985-86	124.3	155.9	109.4	137.2	136.0	170.6	100.9	126.5
1986-87	126.8	163.0	109.0	140.2	141.4	181.8	110.3	141.9
1987-88	139.4	181.3	115.7	150.5	149.7	194.7	111.2	144.6
1988-89	148.2	184.2	120.4	149.6	159.6	198.4	115.1	143.1
1989-90	147.1	185.1	124.0	155.9	166.4	209.3	133.8	168.3
1990-91	162.2	196.6	157.2	190.5	171.8	208.1	153.6	186.1
1991-92	166.8	213.0	165.1	210.9	169.0	215.8	140.2	179.0
1992-93	180.3	224.1	175.0	217.5	186.6	231.9	146.0	181.4
1993-94	201.5	257.9	195.0	249.5	199.2	255.0	161.5	206.6
1994-95	232.2	286.4	212.3	261.8	215.9	266.3	179.2	221.0
1995-96	250.3	305.5	220.2	268.7	227.2	277.3	200.7	245.0
1996-97	284.7	353.7	214.1	265.9	262.3	325.8	202.5	251.6
1997-98	317.6	404.6	240.5	306.3	289.9	369.3	230.0	293.0

tries (Base: 1973-74=100)

LEATHER		SMFG		MANUFACTURING	
K1L	**K2L**	**K1L**	**K2L**	**K1L**	**K2L**
100.0	100.0	100.0	100.0	100.0	100.0
106.6	104.4	87.4	85.7	85.6	83.9
150.9	143.2	95.3	90.3	87.7	83.2
140.9	139.4	100.6	99.5	93.7	92.6
167.4	168.7	102.6	103.4	100.2	101.0
156.0	159.2	105.8	108.0	106.3	108.5
178.4	183.4	98.6	101.3	100.1	102.9
184.3	194.5	101.3	106.9	99.5	105.0
179.6	193.1	103.6	111.4	101.8	109.4
198.3	224.9	104.4	118.3	106.4	120.6
209.9	252.1	112.0	134.6	116.8	140.3
197.4	245.4	113.7	141.3	121.9	151.5
210.8	264.4	124.5	156.1	131.4	164.8
212.2	272.8	128.7	165.5	138.4	178.0
219.5	285.5	136.7	177.8	147.1	191.3
219.3	272.6	144.6	179.7	155.6	193.4
208.7	262.6	150.7	189.5	157.9	198.6
267.4	324.0	174.1	210.9	175.9	213.1
251.1	320.6	173.8	221.9	172.8	220.6
279.5	347.4	188.3	234.1	186.9	232.3
305.2	390.6	204.8	262.0	205.3	262.7
338.6	417.6	226.1	278.8	224.0	276.2
376.3	459.3	243.6	297.3	234.8	286.6
415.4	516.0	255.9	317.8	257.9	320.3
428.1	545.4	288.7	367.8	272.1	346.6

TTable A4. Partial Productivity Indices: Textiles and Textile Products (Base:1973-74 = 100)

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	103.7	96.3	106.5	121.5	124.0	112.9	115.2	124.8	127.3
1975-76	114.4	90.9	124.8	138.0	145.5	109.8	115.7	150.6	158.8
1976-77	122.5	90.9	137.2	140.5	142.0	104.3	105.4	157.4	159.2
1977-78	126.4	94.9	109.2	140.0	138.9	105.1	104.3	120.9	120.0
1978-79	133.5	110.7	127.9	147.7	144.7	122.5	120.0	141.5	138.6
1979-80	124.1	112.7	127.4	150.6	146.5	136.8	133.0	154.5	150.3
1980-81	137.3	115.5	149.1	154.6	146.5	130.0	123.2	167.9	159.1
1981-82	147.4	111.2	164.3	158.5	147.4	119.6	111.2	176.7	164.3
1982-83	149.1	102.4	152.4	152.0	134.0	104.5	92.1	155.5	137.1
1983-84	159.2	120.7	197.8	146.2	121.7	110.8	92.2	181.6	151.2
1984-85	166.9	118.1	209.2	150.4	121.0	106.4	85.6	188.5	151.7
1985-86	200.2	132.9	234.6	161.0	128.4	106.9	85.2	188.7	150.4
1986-87	211.0	154.4	296.3	166.4	129.4	121.7	94.7	233.7	181.8
1987-88	215.6	140.4	282.4	154.7	119.0	100.7	77.4	202.6	155.8
1988-89	235.9	152.7	301.9	159.2	128.0	103.0	82.9	203.7	163.9
1989-90	264.6	185.4	333.6	179.9	143.0	126.0	100.2	226.8	180.3
1990-91	288.6	209.3	395.7	177.9	146.8	129.0	106.5	243.9	201.3
1991-92	304.5	191.6	411.7	182.5	142.9	114.9	90.0	246.8	193.3
1992-93	320.5	190.4	435.8	177.7	143.0	105.6	84.9	241.7	194.4
1993-94	348.6	258.5	541.6	173.0	135.2	128.3	100.2	268.8	210.0
1994-95	365.6	261.4	537.1	157.4	127.6	112.6	91.3	231.3	187.5
1995-96	334.8	194.6	369.8	133.8	109.6	77.7	63.7	147.8	121.1
1996-97	344.9	218.0	411.5	121.1	97.5	76.6	61.6	144.5	116.4
1997-98	400.3	215.0	422.2	126.0	98.9	67.7	53.1	132.9	104.3

Table A5. Partial Productivity Indices: Metal & Metal Products (Base: 1973-74 = 100)

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	111.0	121.8	127.2	126.7	129.3	139.1	141.9	145.2	148.2
1975-76	109.6	111.5	118.4	113.1	119.2	115.0	121.3	122.1	128.7
1976-77	121.1	122.2	130.8	116.2	117.5	117.2	118.5	125.5	126.9
1977-78	121.1	106.9	122.5	116.2	115.3	102.6	101.8	117.6	116.7
1978-79	130.4	117.9	127.0	130.0	127.3	117.5	115.1	126.6	124.0
1979-80	130.1	108.3	103.1	134.4	130.8	111.9	108.8	106.5	103.5
1980-81	140.5	114.8	117.9	146.3	138.7	119.6	113.3	122.7	116.3

1981-82	153.5	133.8	132.8	157.6	146.5	137.3	127.7	136.3	126.8
1982-83	163.6	128.8	132.8	164.5	145.1	129.5	114.2	133.5	117.7
1983-84	154.5	136.7	140.4	149.7	124.6	132.5	110.3	136.0	113.2
1984-85	154.9	108.5	104.6	153.3	123.3	107.4	86.4	103.5	83.3
1985-86	167.6	129.7	117.7	153.3	122.2	118.6	94.6	107.6	85.8
1986-87	180.2	120.6	117.4	165.3	128.5	110.6	86.0	107.7	83.8
1987-88	187.7	132.0	131.9	162.2	124.8	114.1	87.7	114.0	87.7
1988-89	207.6	171.2	134.3	172.5	138.8	142.3	114.5	111.6	89.8
1989-90	221.3	158.0	76.9	178.5	141.9	127.5	101.3	62.0	49.3
1990-91	226.2	170.3	67.3	143.9	118.7	108.3	89.4	42.8	35.3
1991-92	244.0	138.7	80.3	147.8	115.7	84.0	65.8	48.6	38.1
1992-93	256.8	166.7	124.1	146.7	118.1	95.2	76.6	70.9	57.1
1993-94	264.4	208.8	173.0	135.6	106.0	107.1	83.7	88.8	69.4
1994-95	287.7	243.0	206.1	135.5	109.9	114.5	92.8	97.1	78.7
1995-96	317.7	253.9	197.3	144.3	118.2	115.3	94.5	89.6	73.4
1996-97	297.5	254.2	223.0	139.0	111.9	118.8	95.6	104.2	83.9
1997-98	375.2	340.6	326.5	156.0	122.5	141.7	111.2	135.8	106.6

A6. Partial Productivity Indices: Machinery and Transport Equipment (Base: 1973-7

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	99.4	100.5	98.3	107.3	109.5	108.5	110.7	106.1	108.3
1975-76	105.1	102.0	91.8	106.4	112.1	103.2	108.8	92.9	98.0
1976-77	124.2	118.6	118.5	114.7	116.0	109.5	110.7	109.4	110.6
1977-78	123.9	118.4	122.2	113.0	112.1	107.9	107.1	111.4	110.5
1978-79	129.3	119.7	124.9	100.5	98.4	93.1	91.2	97.1	95.1
1979-80	120.2	105.9	105.6	109.4	106.4	96.4	93.7	96.0	93.4
1980-81	132.9	114.2	110.0	122.4	116.0	105.1	99.6	101.3	96.0
1981-82	139.3	120.6	120.8	128.2	119.2	111.0	103.2	111.2	103.4
1982-83	149.7	136.2	140.1	133.5	117.7	121.5	107.1	125.0	110.2
1983-84	151.6	144.8	158.3	128.7	107.1	122.9	102.3	134.4	111.9
1984-85	162.8	160.6	183.4	131.5	105.8	129.8	104.4	148.2	119.2
1985-86	174.6	153.0	186.2	128.3	102.3	112.5	89.7	136.9	109.2
1986-87	190.6	163.7	192.0	134.7	104.8	115.7	90.0	135.8	105.6
1987-88	207.9	168.4	211.4	138.9	106.8	112.5	86.5	141.2	108.6
1988-89	224.2	173.2	219.7	140.5	113.0	108.5	87.3	137.7	110.7
1989-90	257.7	199.2	255.0	154.9	123.1	119.8	95.2	153.3	121.9
1990-91	259.0	215.1	272.2	150.8	124.5	125.2	103.3	158.5	130.8
1991-92	254.5	209.1	239.4	150.6	118.0	123.7	96.9	141.7	111.0
1992-93	272.9	214.8	254.6	146.3	117.7	115.1	92.6	136.4	109.8
1993-94	287.3	225.2	292.5	144.2	112.7	113.0	88.3	146.8	114.7

1994-95	337.2	273.6	349.5	156.2	126.6	126.7	102.7	161.8	131.2
1995-96	385.8	312.3	407.7	169.8	139.1	137.5	112.6	179.5	147.0
1996-97	391.2	315.1	418.7	149.1	120.1	120.1	96.7	159.6	128.5
1997-98	432.1	318.1	453.3	149.1	117.0	109.7	86.1	156.4	122.7

le A7. Partial Productivity Indices: Chemical & Chemical Products (Base: 1973-74 =

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	97.1	95.8	70.5	106.4	108.5	105.0	107.2	77.3	78.8
1975-76	98.3	85.7	57.0	102.5	108.1	89.4	94.2	59.4	62.6
1976-77	108.5	93.0	78.2	114.3	115.6	97.9	99.0	82.3	83.2
1977-78	113.8	94.6	91.3	119.3	118.4	99.2	98.4	95.7	95.0
1978-79	123.3	115.2	116.0	125.3	122.7	117.1	114.7	117.9	115.5
1979-80	114.9	95.0	104.5	124.7	121.3	103.1	100.3	113.5	110.4
1980-81	112.4	82.5	75.7	119.5	113.3	87.8	83.2	80.5	76.3
1981-82	128.0	92.8	91.2	135.2	125.7	98.0	91.1	96.2	89.5
1982-83	134.4	102.8	104.9	148.5	131.0	113.6	100.2	115.9	102.2
1983-84	144.5	121.5	147.2	147.2	122.5	123.8	103.0	150.0	124.9
1984-85	153.2	115.3	161.2	157.8	126.9	118.7	95.5	166.1	133.6
1985-86	158.1	117.7	179.4	156.8	125.0	116.7	93.1	177.9	141.8
1986-87	174.8	121.0	198.2	158.4	123.2	109.6	85.3	179.7	139.7
1987-88	177.5	132.5	218.1	159.6	122.7	119.2	91.6	196.1	150.8
1988-89	193.5	147.8	263.8	168.1	135.3	128.4	103.3	229.2	184.4
1989-90	232.2	171.1	315.5	173.6	138.0	127.9	101.7	235.9	187.5
1990-91	256.5	193.6	397.0	167.0	137.8	126.0	104.0	258.4	213.3
1991-92	255.6	188.0	372.5	182.3	142.8	134.1	105.0	265.7	208.1
1992-93	256.8	226.1	393.9	175.9	141.5	154.9	124.6	269.8	217.1
1993-94	265.1	264.3	433.7	164.2	128.3	163.7	127.9	268.6	209.9
1994-95	272.6	266.4	438.7	152.1	123.4	148.7	120.6	244.8	198.5
1995-96	295.3	321.9	502.3	147.1	120.5	160.4	131.4	250.3	205.1
1996-97	291.6	286.7	485.2	144.0	115.9	141.5	114.0	239.5	192.9
1997-98	349.4	280.7	550.3	151.9	119.2	122.1	95.8	239.3	187.8

ıble A8. Partial Productivity Indices: Leather & Leather Products (Base: 1973-74 = 1(

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	102.4	127.5	214.1	96.1	98.1	119.7	122.1	200.9	205.0

1975-76	131.9	112.0	162.7	87.4	92.1	74.2	78.2	107.8	113.6
1976-77	128.3	120.4	130.4	91.1	92.1	85.5	86.4	92.6	93.6
1977-78	121.1	117.5	165.1	72.3	71.8	70.2	69.7	98.6	97.9
1978-79	111.5	95.9	84.3	71.5	70.0	61.5	60.2	54.0	52.9
1979-80	125.3	101.3	4.8	70.3	68.3	56.8	55.2	2.7	2.6
1980-81	100.7	91.7	36.5	54.6	51.8	49.8	47.2	19.8	18.8
1981-82	112.0	97.5	123.1	62.3	58.0	54.3	50.5	68.6	63.8
1982-83	114.7	109.1	181.5	57.8	51.0	55.0	48.5	91.5	80.7
1983-84	112.8	133.7	210.0	53.8	44.8	63.7	53.0	100.1	83.3
1984-85	123.3	141.2	232.6	62.5	50.3	71.5	57.5	117.9	94.8
1985-86	123.4	115.3	186.8	58.5	46.7	54.7	43.6	88.6	70.6
1986-87	124.7	115.8	193.7	58.8	45.7	54.6	42.4	91.3	71.0
1987-88	152.0	139.1	238.3	69.3	53.3	63.4	48.7	108.6	83.5
1988-89	130.0	115.4	139.5	59.3	47.7	52.6	42.3	63.6	51.2
1989-90	135.0	130.2	133.6	64.7	51.4	62.4	49.6	64.0	50.9
1990-91	138.5	147.3	67.5	51.8	42.7	55.1	45.5	25.2	20.8
1991-92	143.1	175.3	176.3	57.0	44.6	69.8	54.7	70.2	55.0
1992-93	155.4	190.7	301.1	55.6	44.7	68.2	54.9	107.7	86.7
1993-94	191.1	284.1	438.5	62.6	48.9	93.1	72.7	143.7	112.3
1994-95	186.4	195.8	332.2	55.0	44.6	57.8	46.9	98.1	79.5
1995-96	182.2	195.7	395.3	48.4	39.7	52.0	42.6	105.1	86.1
1996-97	200.1	208.1	470.3	48.2	38.8	50.1	40.3	113.2	91.1
1997-98	236.5	251.5	560.4	55.2	43.4	58.8	46.1	130.9	102.7

Table A9. Partial Productivity Indices: Selected Manufacturing Industries (Base: 197

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	103.2	102.2	99.9	118.0	120.4	116.9	119.3	114.3	116.6
1975-76	110.9	97.7	96.9	116.5	122.8	102.5	108.1	101.7	107.2
1976-77	123.7	106.8	116.0	122.9	124.3	106.1	107.3	115.2	116.5
1977-78	125.4	105.8	114.0	122.2	121.2	103.1	102.3	111.0	110.2
1978-79	133.6	117.4	125.5	126.2	123.7	111.0	108.7	118.6	116.1
1979-80	128.4	108.6	112.0	130.2	126.7	110.2	107.2	113.6	110.5
1980-81	139.2	110.8	114.3	137.5	130.3	109.4	103.7	112.9	107.0
1981-82	153.1	119.1	130.1	147.9	137.5	115.0	106.9	125.7	116.9
1982-83	160.5	123.4	139.0	153.8	135.6	118.2	104.3	133.2	117.4
1983-84	164.8	138.1	168.5	147.1	122.4	123.3	102.6	150.4	125.2
1984-85	173.0	135.6	175.5	152.1	122.4	119.2	95.9	154.3	124.2
1985-86	192.8	143.8	193.4	154.9	123.5	115.6	92.1	155.4	123.9
1986-87	209.4	150.6	210.3	162.7	126.5	117.0	91.0	163.4	127.1
1987-88	220.5	156.3	227.2	161.3	124.0	114.3	87.9	166.2	127.8

1988-89	241.5	174.5	249.3	167.0	134.4	120.6	97.1	172.4	138.7
1989-90	267.9	192.1	267.3	177.8	141.3	127.5	101.4	177.4	141.0
1990-91	281.6	211.7	302.7	161.8	133.5	121.6	100.4	173.9	143.5
1991-92	291.3	200.4	296.4	167.6	131.3	115.3	90.3	170.5	133.6
1992-93	309.6	220.7	327.7	164.4	132.3	117.2	94.3	174.0	140.0
1993-94	322.0	259.6	385.3	157.2	122.9	126.8	99.1	188.2	147.1
1994-95	349.0	283.7	415.1	154.3	125.1	125.5	101.7	183.6	148.9
1995-96	366.2	301.5	429.6	150.3	123.2	123.8	101.4	176.4	144.5
1996-97	367.5	299.5	447.1	143.6	115.6	117.0	94.2	174.7	140.7
1997-98	432.3	315.4	509.4	149.8	117.5	109.3	85.8	176.5	138.5

Table A10. Partial Productivity Indices: Manufacturing Sector (Base: 1973-74 = 100)

Year	Productivity of Labour			Productivity of Capital					
	OL	VSDL	VDDL	OK1	OK2	VSDK1	VSDK2	VDDK1	VDDK2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	106.0	104.3	124.5	123.8	126.3	121.8	124.3	145.4	148.4
1975-76	113.4	102.5	134.6	129.3	136.3	116.8	123.1	153.4	161.7
1976-77	121.4	110.0	147.6	129.6	131.1	117.4	118.7	157.6	159.4
1977-78	126.8	112.0	159.3	126.6	125.6	111.8	110.9	158.9	157.7
1978-79	141.4	128.7	200.7	133.0	130.3	121.0	118.6	188.8	184.9
1979-80	130.9	114.9	146.7	130.7	127.1	114.8	111.7	146.5	142.5
1980-81	127.7	105.3	103.5	128.3	121.6	105.8	100.3	104.1	98.6
1981-82	145.7	121.6	144.6	143.2	133.2	119.5	111.1	142.1	132.1
1982-83	160.0	130.7	176.3	150.4	132.6	122.8	108.3	165.7	146.1
1983-84	167.5	152.3	215.9	143.4	119.4	130.4	108.5	184.8	153.8
1984-85	175.6	146.7	221.1	144.0	115.9	120.4	96.8	181.3	145.9
1985-86	198.7	162.5	240.0	151.2	120.6	123.7	98.6	182.7	145.6
1986-87	212.9	172.7	264.2	153.8	119.6	124.7	97.0	190.9	148.5
1987-88	219.7	170.7	276.3	149.4	114.9	116.1	89.3	187.9	144.4
1988-89	241.8	191.8	318.2	155.4	125.0	123.3	99.2	204.5	164.6
1989-90	258.5	205.3	332.0	163.7	130.2	130.0	103.4	210.3	167.2
1990-91	268.0	215.5	320.3	152.3	125.7	122.5	101.1	182.1	150.3
1991-92	276.2	213.8	349.8	159.9	125.2	123.7	96.9	202.5	158.6
1992-93	288.8	235.7	388.9	154.5	124.3	126.1	101.5	208.0	167.4
1993-94	309.3	271.3	446.3	150.7	117.7	132.2	103.3	217.4	169.9
1994-95	325.7	288.2	459.4	145.4	117.9	128.7	104.3	205.1	166.3
1995-96	350.4	307.7	511.7	149.2	122.3	131.0	107.4	218.0	178.6
1996-97	359.9	314.0	534.4	139.6	112.4	121.8	98.0	207.2	166.9
1997-98	396.9	316.8	565.3	145.9	114.5	116.4	91.4	207.8	163.1

Table A11. Total Productivity Indices for the Various Industries in India (Base:1973-74 =100)

Year	TEXTILE		METAL		MACHINERY etc.		CHEMICAL		LEATHER		SMFG		MANUFACTURING	
	TP1	TP2	TP1	TP2	TP1	TP2	TP1	TP2	TP1	TP2	TP1	TP2	TP1	TP2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	103.2	103.5	107.2	107.5	100.2	100.6	93.6	94.0	113.4	113.5	102.4	102.8	106.8	107.1
1975-76	107.5	108.2	103.1	103.9	97.6	98.5	90.1	91.1	104.1	104.4	102.4	103.2	108.5	109.3
1976-77	109.3	109.6	105.1	105.2	103.4	103.6	95.7	95.9	101.7	101.8	105.9	106.2	110.0	110.2
1977-78	104.5	104.6	103.6	103.5	104.1	104.0	98.4	98.4	103.9	103.8	104.1	104.0	111.1	111.0
1978-79	107.8	107.7	104.8	104.5	103.2	102.8	103.1	102.9	96.3	96.2	106.5	106.3	117.3	117.0
1979-80	108.3	108.1	100.7	100.3	100.5	100.0	102.0	101.6	89.9	89.7	104.8	104.5	109.0	108.6
1980-81	111.7	111.2	103.7	103.0	101.6	100.8	96.0	95.2	90.2	89.9	106.2	105.5	101.9	101.2
1981-82	113.8	113.0	105.2	104.2	104.1	102.9	99.1	98.0	99.3	98.9	109.3	108.3	108.3	107.3
1982-83	111.7	110.4	104.9	103.2	107.8	105.7	102.4	100.4	104.8	104.0	110.7	108.9	112.3	110.5
1983-84	118.4	116.4	106.5	104.0	111.4	108.2	110.1	106.9	108.1	106.6	115.5	112.7	117.4	114.6
1984-85	119.5	117.2	102.1	99.4	116.4	112.5	112.9	109.0	110.6	108.8	116.7	113.3	117.6	114.2
1985-86	121.2	118.7	103.4	100.4	114.0	110.0	115.2	111.0	105.2	103.4	117.3	113.8	118.3	114.7
1986-87	128.6	125.6	102.9	99.7	113.8	109.4	115.8	111.2	105.6	103.6	119.2	115.2	119.9	115.9
1987-88	126.5	123.5	105.1	101.7	116.6	111.9	120.1	115.2	109.2	107.0	121.3	117.1	121.0	116.8
1988-89	127.3	124.7	105.5	102.7	116.0	112.0	126.5	122.2	100.8	99.1	122.5	118.9	124.0	120.4
1989-90	129.8	127.0	99.4	96.6	119.6	115.3	129.7	125.0	100.6	98.9	122.2	118.5	124.6	120.8
1990-91	133.6	131.5	96.0	93.8	115.2	111.7	137.6	133.5	93.6	92.4	121.6	118.6	121.2	118.2
1991-92	134.1	131.0	97.6	94.7	117.3	112.8	135.2	130.0	102.4	100.3	123.3	119.3	124.4	120.3
1992-93	134.9	132.2	101.3	98.6	116.9	112.9	137.7	133.1	111.1	109.3	125.7	122.1	126.5	122.9
1993-94	140.3	137.0	102.7	99.6	120.3	115.6	137.8	132.3	119.3	116.8	128.0	123.8	129.2	124.9
1994-95	136.4	133.9	105.1	102.5	124.0	120.0	134.7	130.4	110.2	108.5	128.2	124.8	127.6	124.1
1995-96	123.0	120.1	114.8	112.2	127.8	123.8	137.6	133.6	113.7	112.1	126.6	123.4	130.1	126.8
1996-97	124.9	122.5	112.2	109.3	125.9	121.6	138.2	133.6	117.3	115.4	127.4	123.8	130.2	126.5
1997-98	123.2	120.5	115.8	112.3	126.6	121.8	134.5	129.3	120.8	118.5	127.9	123.8	130.0	125.8

Table A12. Total Factor Productivity Indices for Various Industries in India (Base:1973-74 =100)

Contd..

Year	TEXTILE				METAL				MACHINERY etc.			
	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	102.7	103.6	113.6	114.5	128.8	129.9	134.5	135.6	103.9	104.8	101.6	102.5
1975-76	97.9	99.7	134.3	136.8	112.5	115.2	119.5	122.3	102.4	104.8	92.2	94.4
1976-77	96.5	97.1	145.6	146.6	119.2	119.7	127.6	128.1	114.0	114.4	113.9	114.3
1977-78	99.6	99.7	114.6	114.7	104.2	103.8	119.5	119.0	113.0	112.4	116.7	116.0
1978-79	116.2	115.7	134.2	133.7	117.0	115.8	126.1	124.8	106.0	104.8	110.6	109.3
1979-80	123.0	122.2	139.0	138.1	109.3	107.9	104.0	102.6	101.0	99.5	100.7	99.2
1980-81	122.2	120.0	157.7	155.0	116.3	113.4	119.4	116.4	109.5	106.5	105.4	102.6
1981-82	115.6	112.7	170.8	166.5	134.5	129.8	133.6	128.9	115.6	111.4	115.8	111.7
1982-83	104.6	100.2	155.7	149.1	128.0	120.0	132.0	123.7	128.5	120.6	132.2	124.1
1983-84	119.3	112.3	195.5	184.0	133.3	121.2	136.9	124.5	133.4	121.8	145.8	133.1
1984-85	116.1	108.1	205.6	191.5	106.8	95.7	103.0	92.3	144.5	129.8	165.1	148.2
1985-86	126.1	117.2	222.6	206.8	123.4	110.2	112.0	100.0	131.4	117.4	160.0	143.0
1986-87	145.5	134.1	279.4	257.4	114.9	101.4	111.9	98.7	138.0	121.9	161.8	142.9
1987-88	128.6	118.0	258.6	237.5	122.4	107.5	122.4	107.4	138.1	121.4	173.4	152.3
1988-89	137.2	127.7	271.3	252.6	155.6	139.9	122.0	109.8	137.7	123.7	174.7	156.9
1989-90	167.1	154.9	300.7	278.7	141.0	125.9	68.6	61.3	155.0	138.3	198.4	177.1
1990-91	179.8	169.7	340.0	320.9	131.4	120.1	52.0	47.5	164.3	149.8	208.0	189.6
1991-92	162.5	149.5	349.0	321.2	103.9	92.0	60.2	53.2	161.3	142.6	184.7	163.3
1992-93	155.8	145.1	356.7	332.2	120.7	108.5	89.9	80.8	156.4	140.5	185.4	166.5
1993-94	199.7	183.2	418.5	383.9	141.6	125.0	117.4	103.7	157.8	139.3	205.0	181.0
1994-95	185.2	173.8	380.5	357.1	155.8	141.0	132.1	119.6	182.4	164.8	233.0	210.5
1995-96	132.1	124.7	251.1	237.0	158.8	144.7	123.4	112.4	201.5	183.3	263.0	239.2
1996-97	138.1	129.1	260.7	243.8	162.0	146.0	142.1	128.0	185.2	166.5	246.0	221.2
1997-98	128.0	118.0	251.4	231.7	200.1	177.0	191.8	169.7	175.5	155.3	250.0	221.2

Table A12. Total Factor Productivity Indices for Various Industries in India (Base:1973-74 =100)

Contd..

Year	TEXTILE				METAL				MACHINERY etc.			
	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	102.7	103.6	113.6	114.5	128.8	129.9	134.5	135.6	103.9	104.8	101.6	102.5
1975-76	97.9	99.7	134.3	136.8	112.5	115.2	119.5	122.3	102.4	104.8	92.2	94.4
1976-77	96.5	97.1	145.6	146.6	119.2	119.7	127.6	128.1	114.0	114.4	113.9	114.3
1977-78	99.6	99.7	114.6	114.7	104.2	103.8	119.5	119.0	113.0	112.4	116.7	116.0
1978-79	116.2	115.7	134.2	133.7	117.0	115.8	126.1	124.8	106.0	104.8	110.6	109.3
1979-80	123.0	122.2	139.0	138.1	109.3	107.9	104.0	102.6	101.0	99.5	100.7	99.2
1980-81	122.2	120.0	157.7	155.0	116.3	113.4	119.4	116.4	109.5	106.5	105.4	102.6
1981-82	115.6	112.7	170.8	166.5	134.5	129.8	133.6	128.9	115.6	111.4	115.8	111.7
1982-83	104.6	100.2	155.7	149.1	128.0	120.0	132.0	123.7	128.5	120.6	132.2	124.1
1983-84	119.3	112.3	195.5	184.0	133.3	121.2	136.9	124.5	133.4	121.8	145.8	133.1
1984-85	116.1	108.1	205.6	191.5	106.8	95.7	103.0	92.3	144.5	129.8	165.1	148.2
1985-86	126.1	117.2	222.6	206.8	123.4	110.2	112.0	100.0	131.4	117.4	160.0	143.0
1986-87	145.5	134.1	279.4	257.4	114.9	101.4	111.9	98.7	138.0	121.9	161.8	142.9
1987-88	128.6	118.0	258.6	237.5	122.4	107.5	122.4	107.4	138.1	121.4	173.4	152.3
1988-89	137.2	127.7	271.3	252.6	155.6	139.9	122.0	109.8	137.7	123.7	174.7	156.9
1989-90	167.1	154.9	300.7	278.7	141.0	125.9	68.6	61.3	155.0	138.3	198.4	177.1
1990-91	179.8	169.7	340.0	320.9	131.4	120.1	52.0	47.5	164.3	149.8	208.0	189.6
1991-92	162.5	149.5	349.0	321.2	103.9	92.0	60.2	53.2	161.3	142.6	184.7	163.3
1992-93	155.8	145.1	356.7	332.2	120.7	108.5	89.9	80.8	156.4	140.5	185.4	166.5
1993-94	199.7	183.2	418.5	383.9	141.6	125.0	117.4	103.7	157.8	139.3	205.0	181.0
1994-95	185.2	173.8	380.5	357.1	155.8	141.0	132.1	119.6	182.4	164.8	233.0	210.5
1995-96	132.1	124.7	251.1	237.0	158.8	144.7	123.4	112.4	201.5	183.3	263.0	239.2
1996-97	138.1	129.1	260.7	243.8	162.0	146.0	142.1	128.0	185.2	166.5	246.0	221.2
1997-98	128.0	118.0	251.4	231.7	200.1	177.0	191.8	169.7	175.5	155.3	250.0	221.2

Table A12. Total Factor Productivity Indices for Various Industries in India (Base:1973-74 =100)

Concluded

Year	CHEMICAL				LEATHER				SMFG				MANUFACTURING			
	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2	TFPS1	TFPS2	TFPD1	TFPD2
1973-74	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974-75	101.8	103.2	74.9	75.9	124.6	125.5	209.2	210.7	108.8	109.8	106.4	107.4	112.3	113.4	134.1	135.4
1975-76	88.1	91.2	58.6	60.7	94.0	96.0	136.4	139.4	100.0	102.4	99.1	101.6	109.1	111.9	143.3	147.0
1976-77	96.2	97.0	80.9	81.5	104.2	104.5	112.9	113.2	106.6	107.1	115.7	116.3	113.5	114.1	152.3	153.1
1977-78	97.6	97.2	94.1	93.8	94.6	94.1	132.9	132.2	104.7	104.3	112.7	112.3	111.8	111.4	159.0	158.3
1978-79	116.4	115.0	117.2	115.7	79.5	78.6	69.8	69.1	114.4	113.3	122.3	121.1	124.7	123.4	194.4	192.4
1979-80	100.3	98.5	110.4	108.5	79.1	78.1	3.8	3.7	109.6	108.2	113.1	111.6	114.8	113.2	146.6	144.5
1980-81	86.0	83.2	78.9	76.3	70.7	69.0	28.1	27.4	110.4	107.6	113.9	111.0	105.5	102.7	103.8	101.0
1981-82	96.3	92.0	94.6	90.4	75.9	73.5	95.9	92.8	117.3	113.3	128.2	123.8	120.5	116.1	143.2	138.1
1982-83	109.8	101.5	112.1	103.5	81.5	77.2	135.6	128.5	121.1	113.8	136.4	128.2	126.5	118.6	170.6	159.9
1983-84	123.1	109.5	149.1	132.7	97.4	89.9	153.0	141.2	131.0	119.7	159.8	146.0	140.3	127.6	198.9	180.8
1984-85	117.5	102.3	164.4	143.1	106.0	96.2	174.6	158.5	127.7	114.8	165.2	148.6	132.2	118.1	199.2	177.9
1985-86	117.3	101.5	178.7	154.7	84.0	75.9	136.0	123.0	129.8	116.2	174.5	156.3	141.0	125.4	208.2	185.1
1986-87	114.1	97.2	186.9	159.3	84.1	75.2	140.7	125.9	133.8	118.4	186.8	165.3	145.8	128.0	223.1	195.8
1987-88	124.4	105.3	204.6	173.2	99.5	88.6	170.6	151.9	134.9	118.8	196.2	172.7	139.8	122.0	226.1	197.3
1988-89	135.7	118.2	242.1	211.0	82.7	75.2	99.9	90.9	146.5	131.9	209.3	188.5	152.5	136.3	252.9	226.0
1989-90	142.1	122.9	262.1	226.6	95.6	86.5	98.1	88.7	157.7	141.1	219.4	196.3	161.8	143.6	261.7	232.3
1990-91	146.5	129.9	300.3	266.3	93.8	86.7	43.0	39.7	159.8	146.1	228.4	208.8	159.4	144.7	236.9	215.0
1991-92	151.5	129.6	300.1	256.7	116.2	103.9	116.8	104.5	151.4	134.2	223.8	198.4	159.9	140.5	261.6	230.0
1992-93	177.0	154.3	308.3	268.8	118.1	107.4	186.5	169.6	159.0	143.2	236.0	212.6	167.9	150.1	277.0	247.6
1993-94	191.7	163.5	314.6	268.3	165.7	147.7	255.7	228.0	177.5	156.9	263.4	232.9	181.9	159.6	299.2	262.4
1994-95	178.2	156.4	293.4	257.5	106.1	97.1	180.1	164.7	181.4	164.5	265.5	240.7	182.2	163.8	290.4	261.1
1995-96	196.8	174.1	307.1	271.8	99.2	91.4	200.4	184.6	183.3	167.3	261.2	238.4	188.4	170.6	313.3	283.7
1996-97	174.0	151.8	294.4	257.0	99.3	90.4	224.4	204.4	176.1	158.8	262.9	237.2	180.5	161.6	307.2	274.9

1997-98	154.4	132.1	302.7	259.0	117.7	105.6	262.3	235.2	170.1	151.6	276.0	244.8	175.7	154.6	313.5	275.9

Figure 1 A : Average Capital intensity (K1/L) of Indian Industries

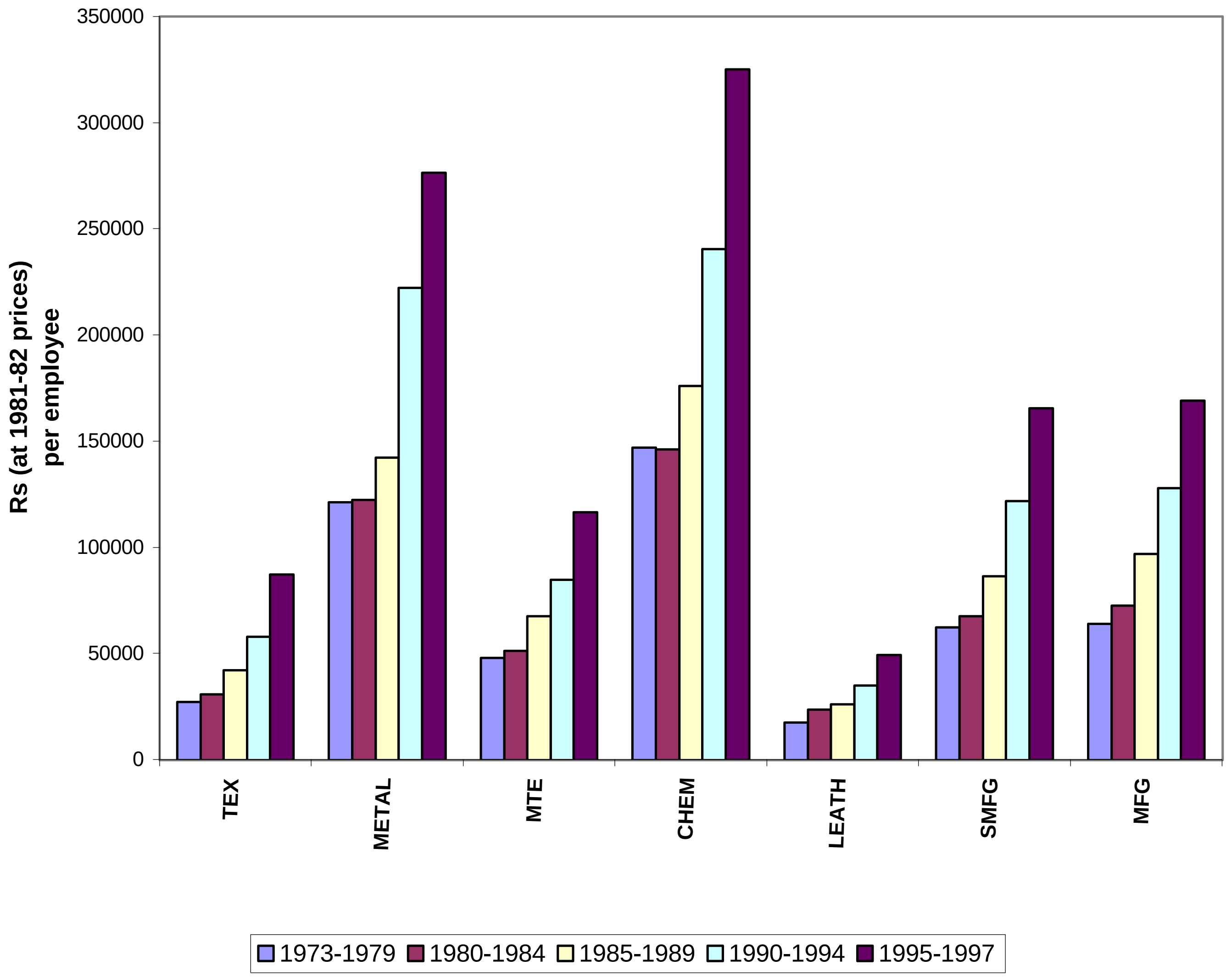


Figure 1 B : Average Per Capita Emoluments in Indian Industries

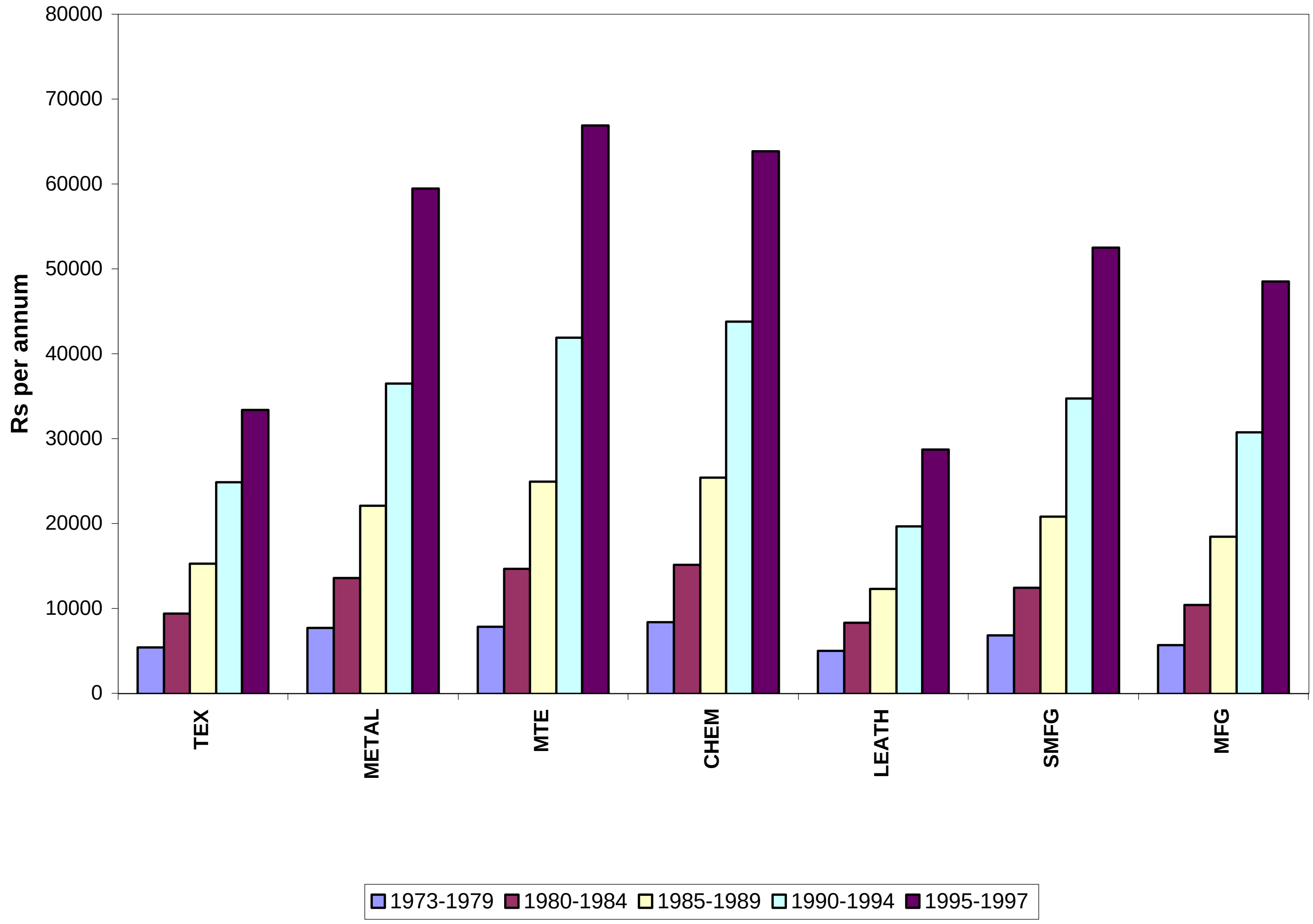
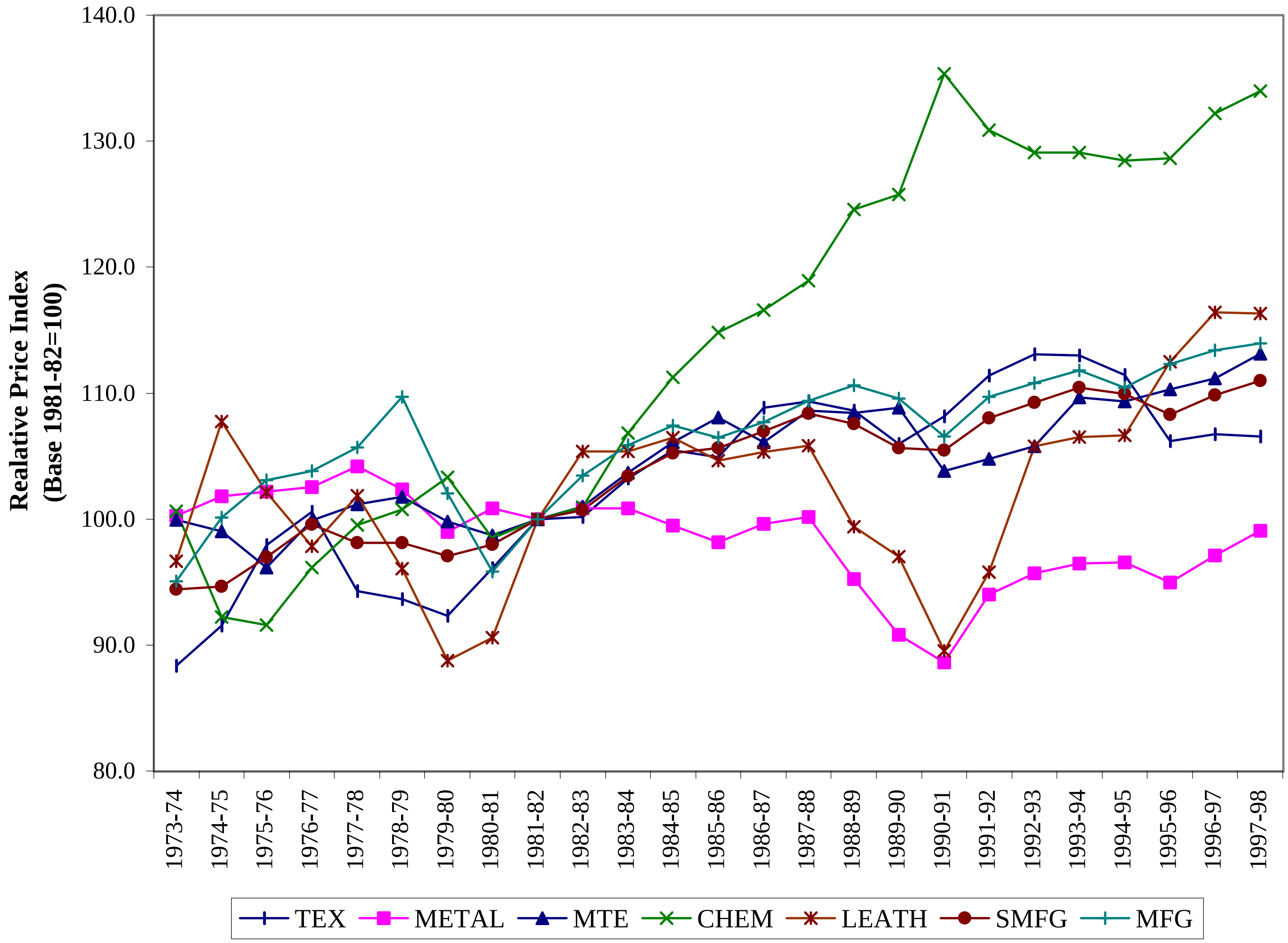


Figure 2: Relative Price Movements of Selected Industry Groups in India



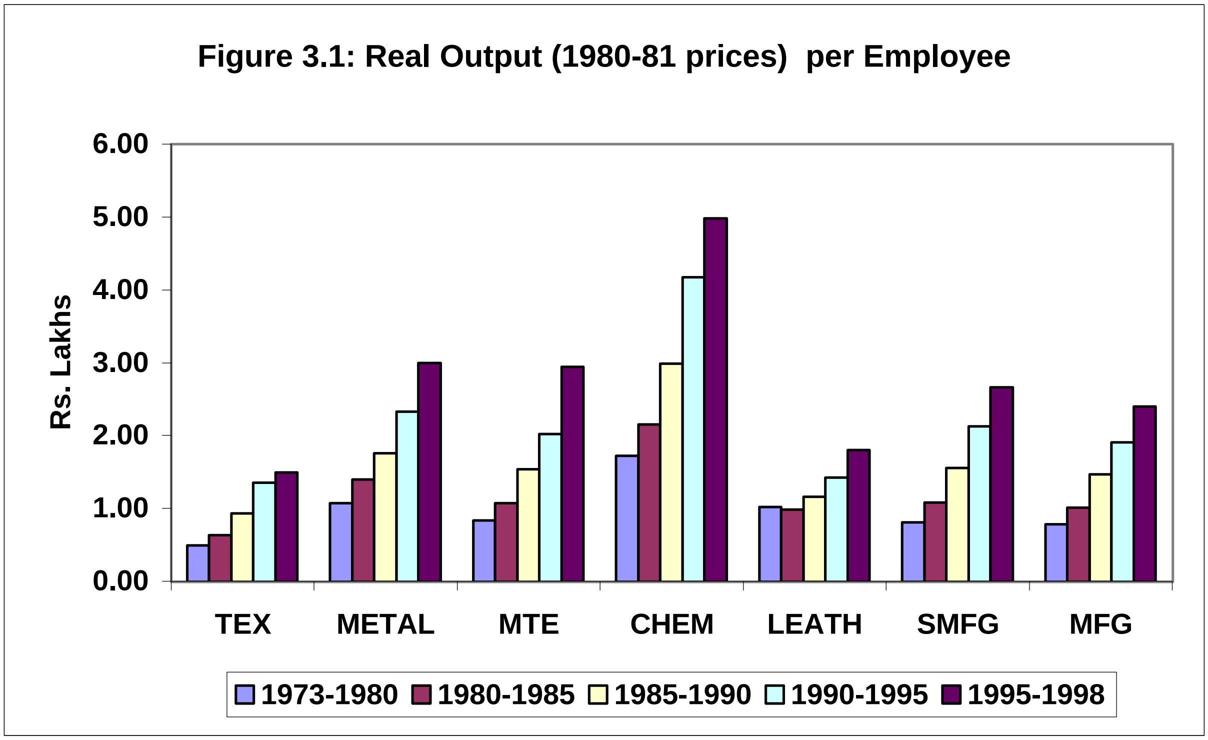


Figure 3.1: Real Output (1980-81 prices) per Employee
Rs. Lakhs
6.00
5.00
4.00
3.00
2.00
1.00
0.00
TEX
METAL
MTE
CHEM
LEATH
SMFG
MFG
1973-1980
1980-1985
1985-1990
1990-1995
1995-1998

Figure 3.2: VSD (1981-82 prices) per Employee

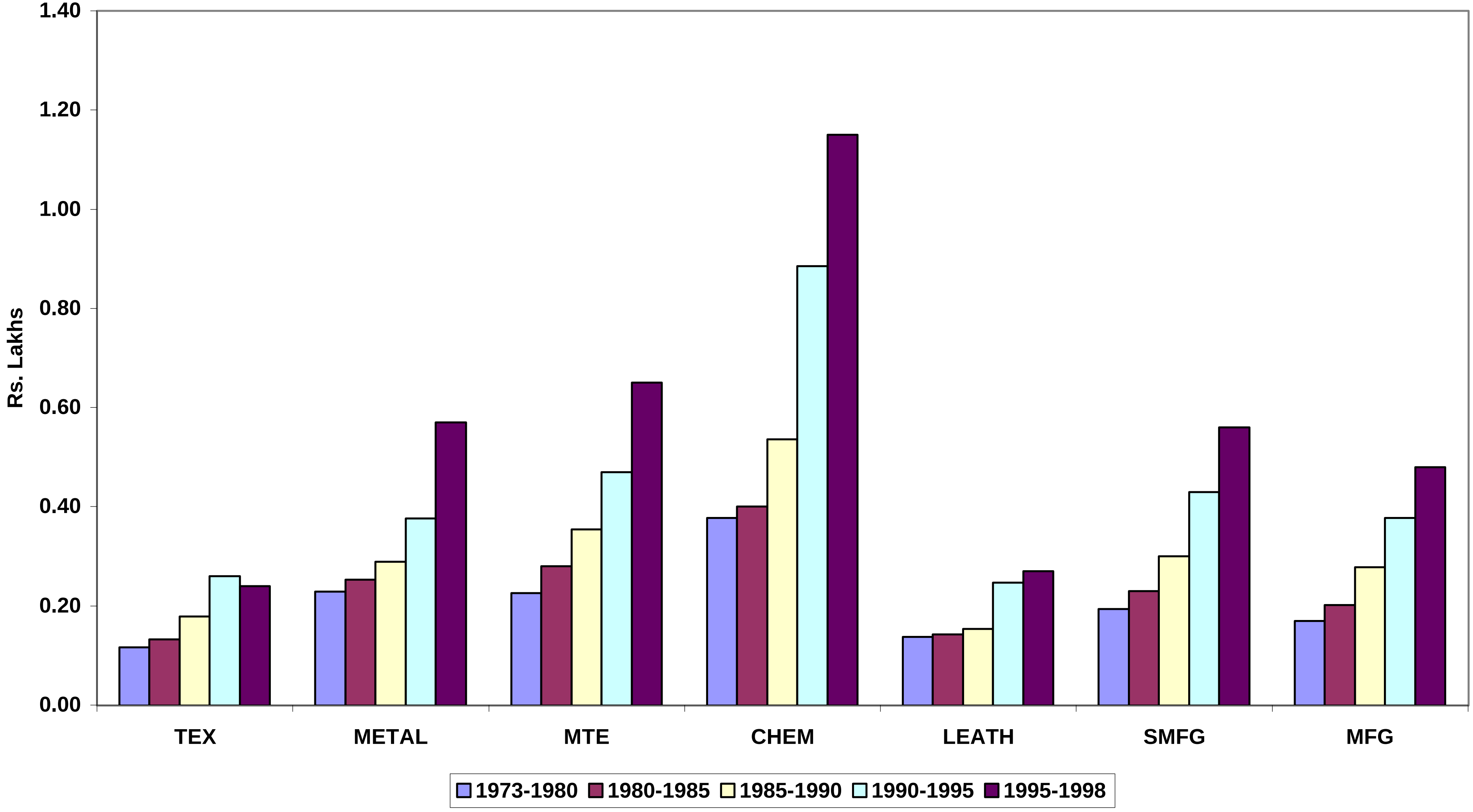


Figure 3.3: VDD (at 1981-82 prices) per Employee

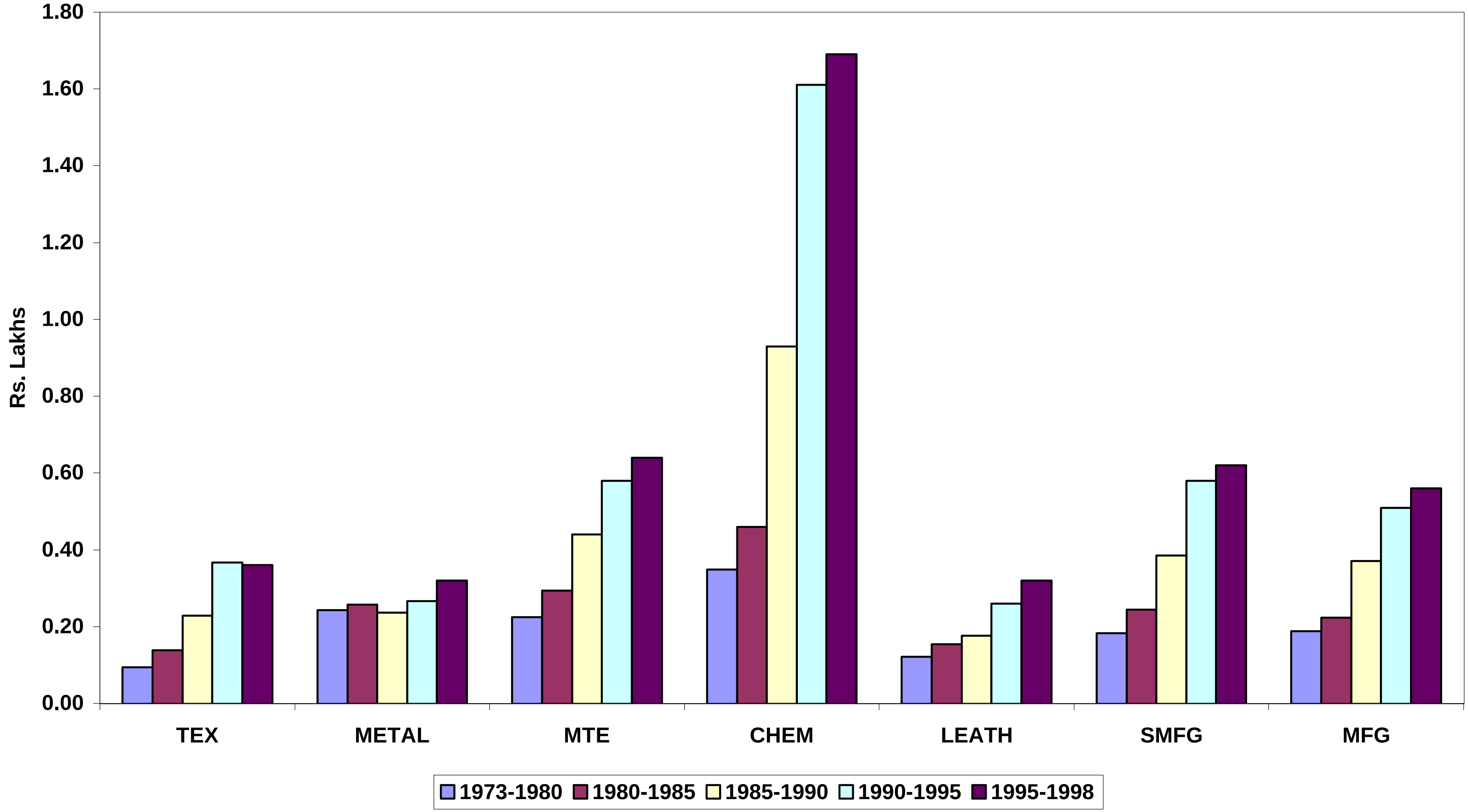


Figure 4.1 : Partial Productivity & Capital Intensity in Textiles & Textile Products (TEX)
(Based on Real Output)

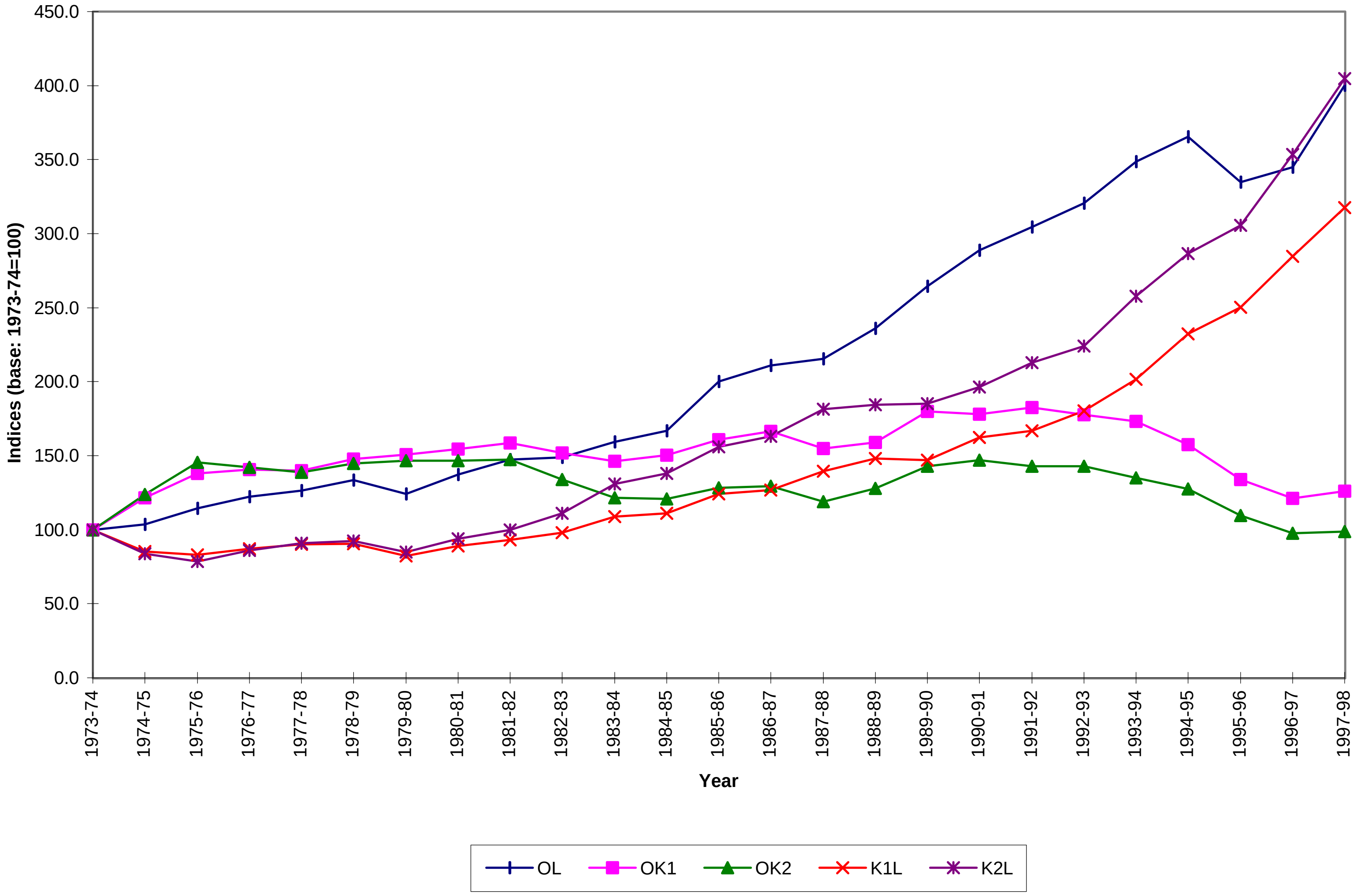


Figure 4.2: Partial Productivity & Capital Intensity in Metal & Metal Products (METAL)
(Based on Real Output)

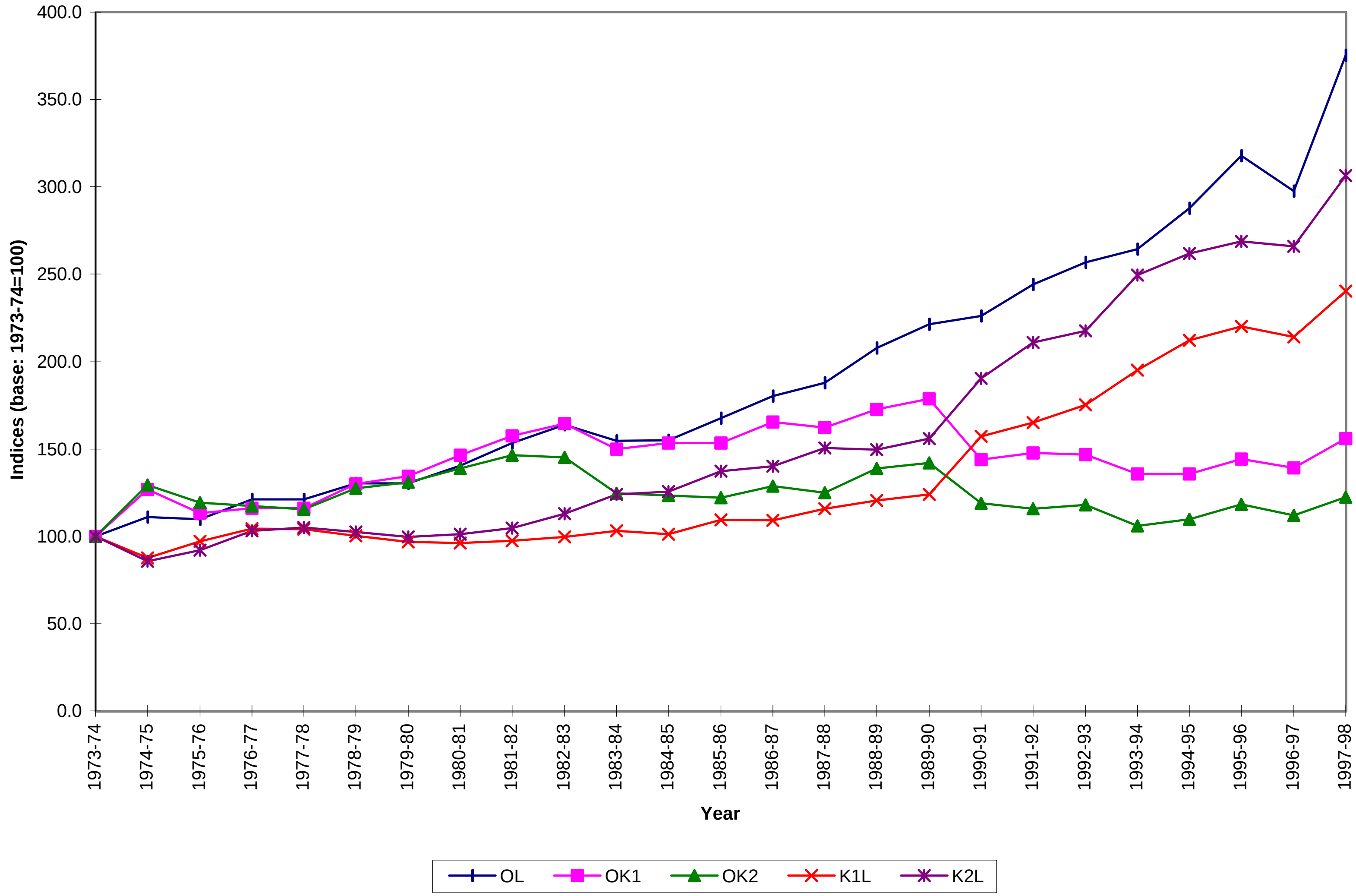


Figure 4.3: Partial Productivity & Capital Intensity in Machinery & Transport Equipment (MTE) (Based on Real Output)

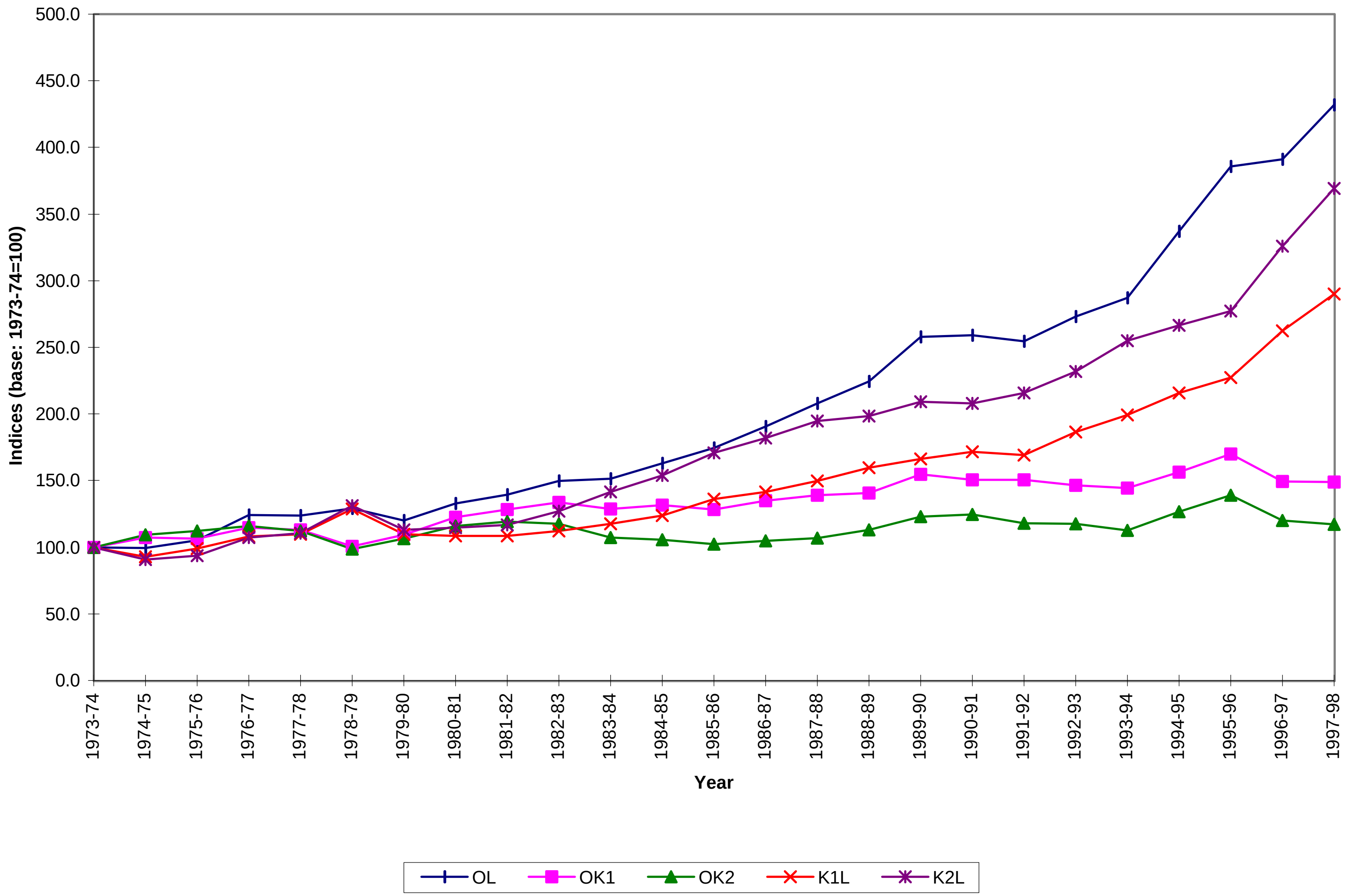


Figure 4.4: Partial Productivity & Capital Intensity in Chemicals & Chemical Products (CHEM) (Based on Real Output)

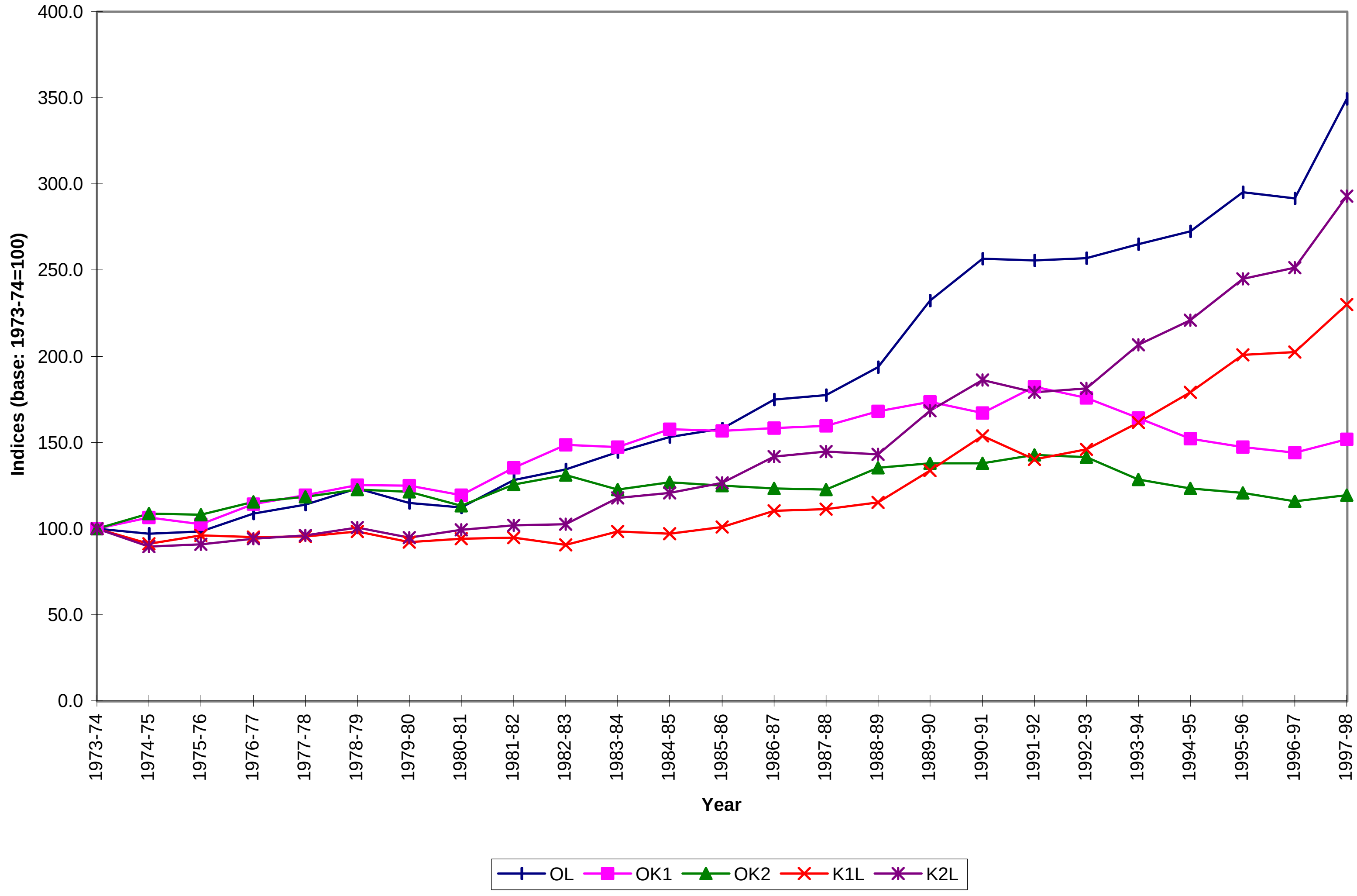


Figure 4.5: Partial Productivity & Capital Intensity in Leather & Leather Products (LEATH) (Based on Real Output)

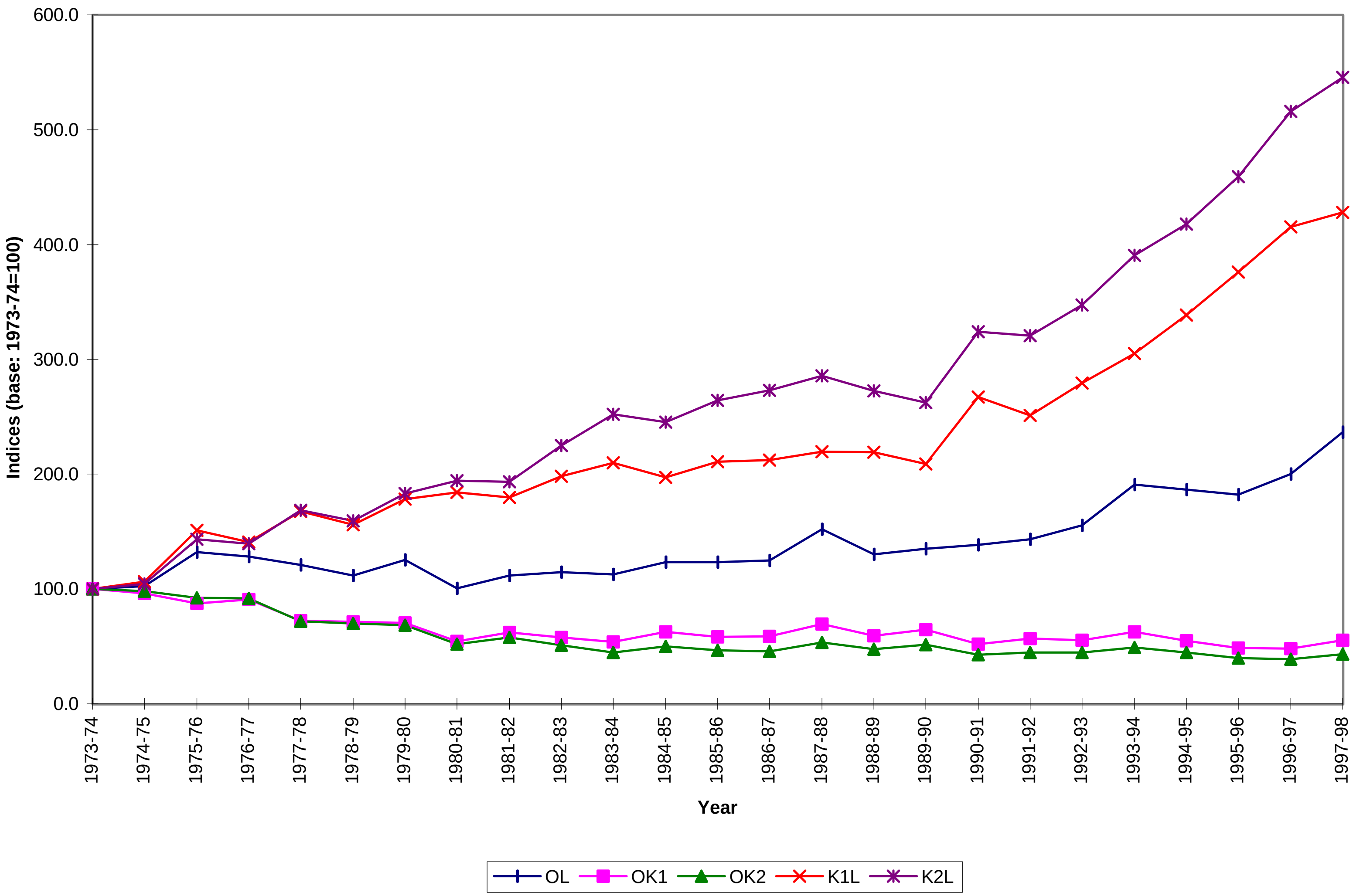


Figure 4.6: Partial Productivity & Capital Intensity in Selected Manufacturing (SMFG) (Based on Real Output)

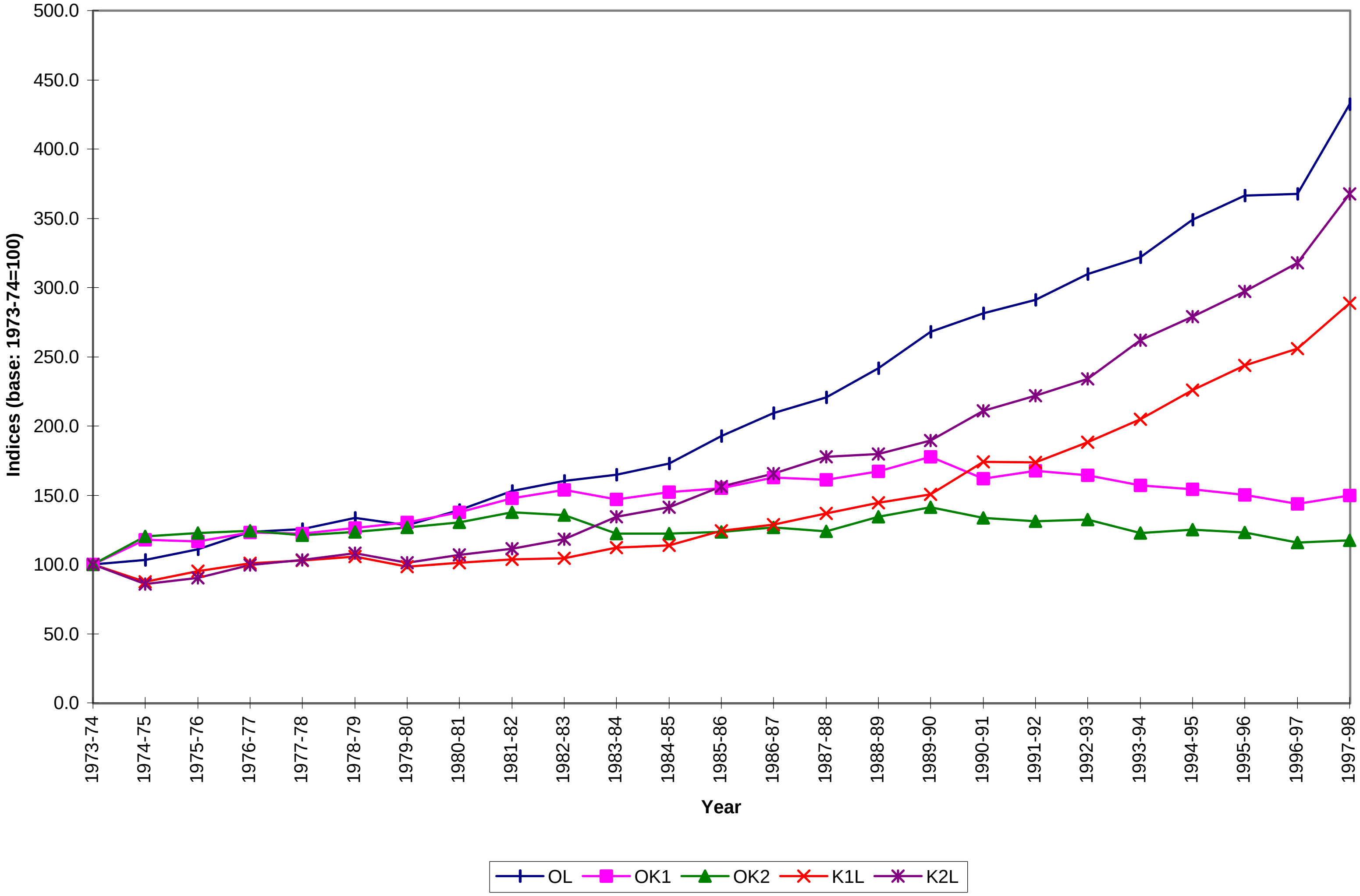


Figure 4.7: Partial Productivity & Capital Intensity in Manufacturing (MFG) (Based on Real Output)

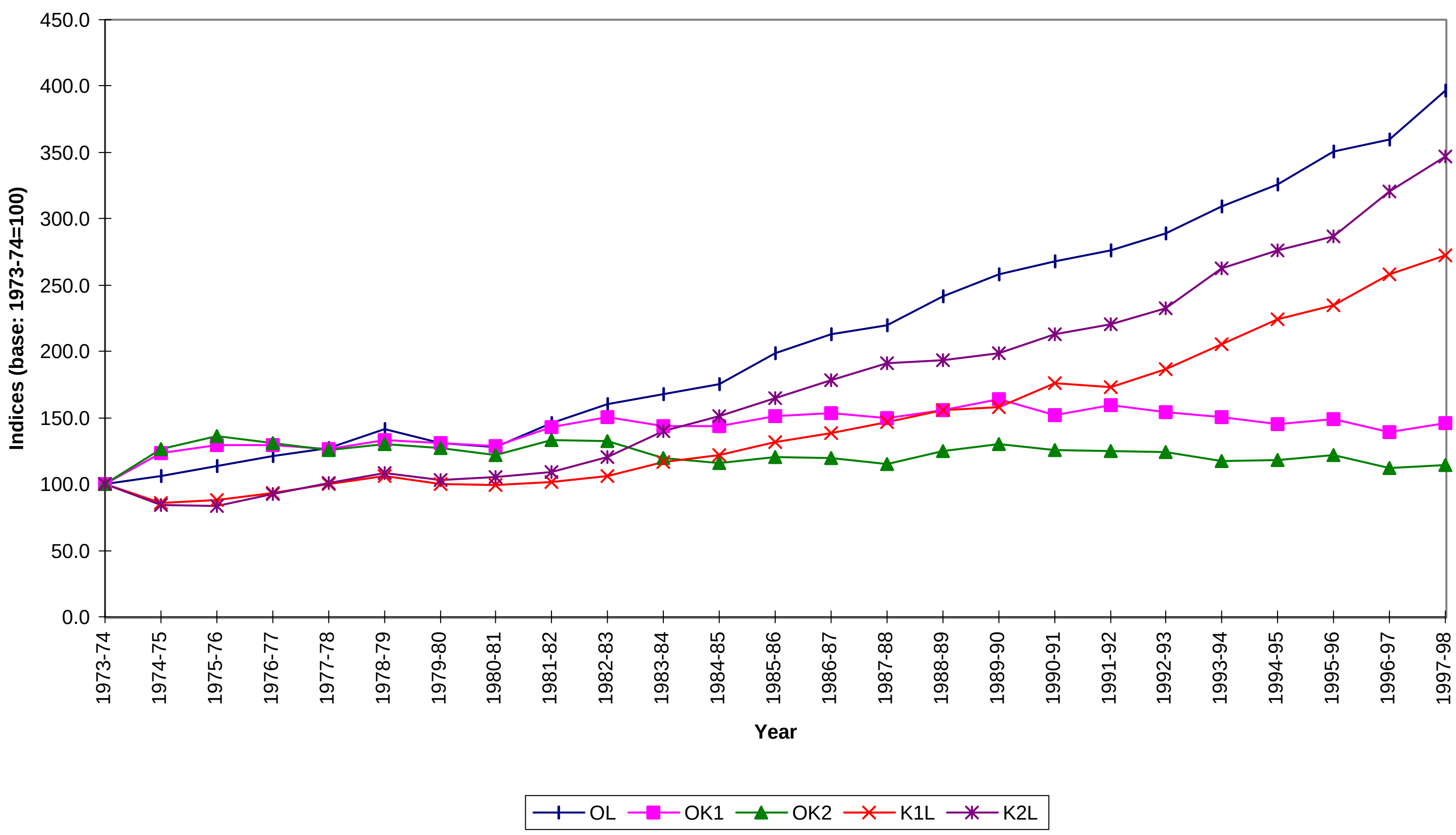


Figure 5.1: Partial Productivity Indices for Textiles & Textile Products (TEX)
(Based on Real Value Added)

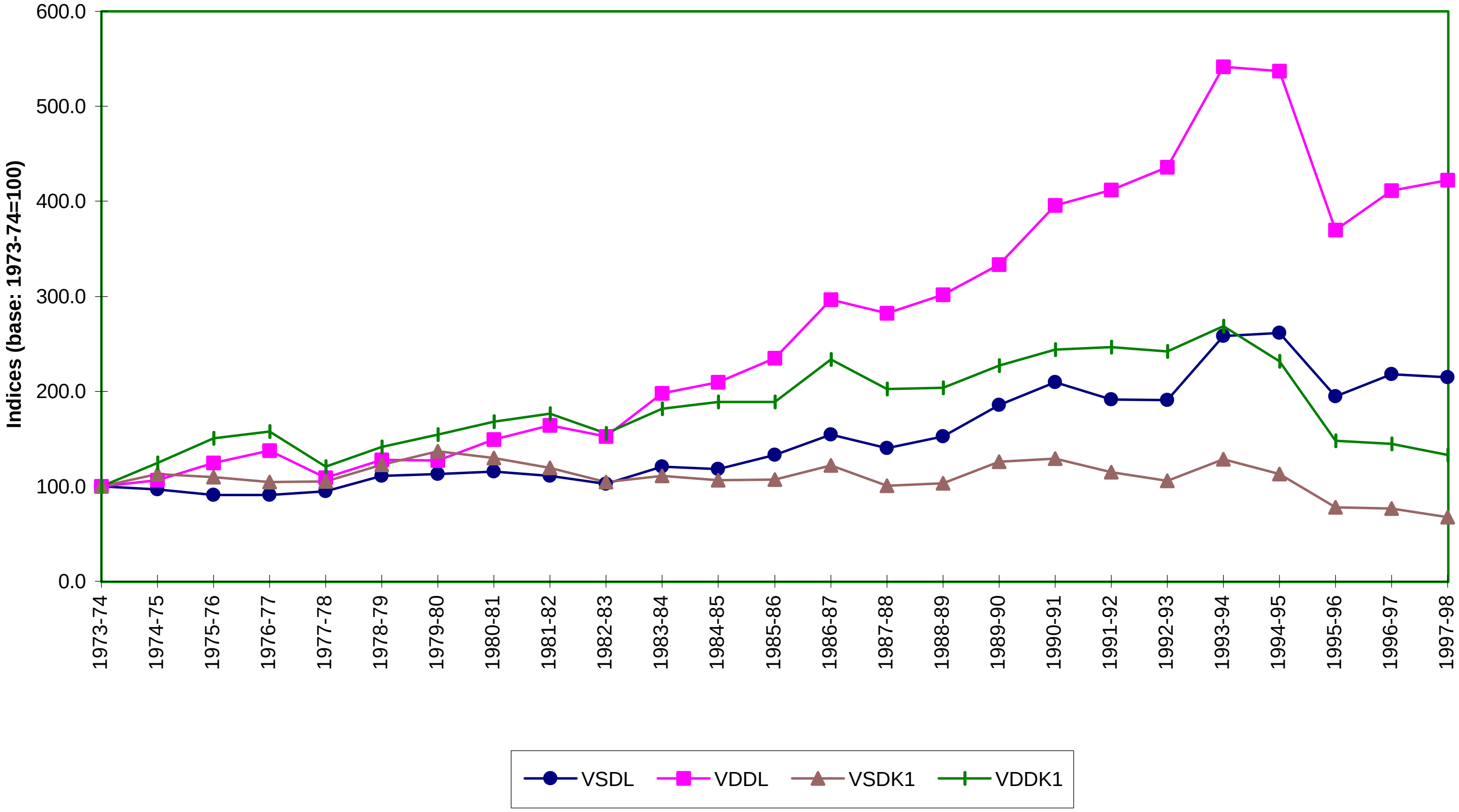


Figure 5.2: Partial Productivity Indices for Metal & Metal Products (METAL) (Based on Real Value Added)

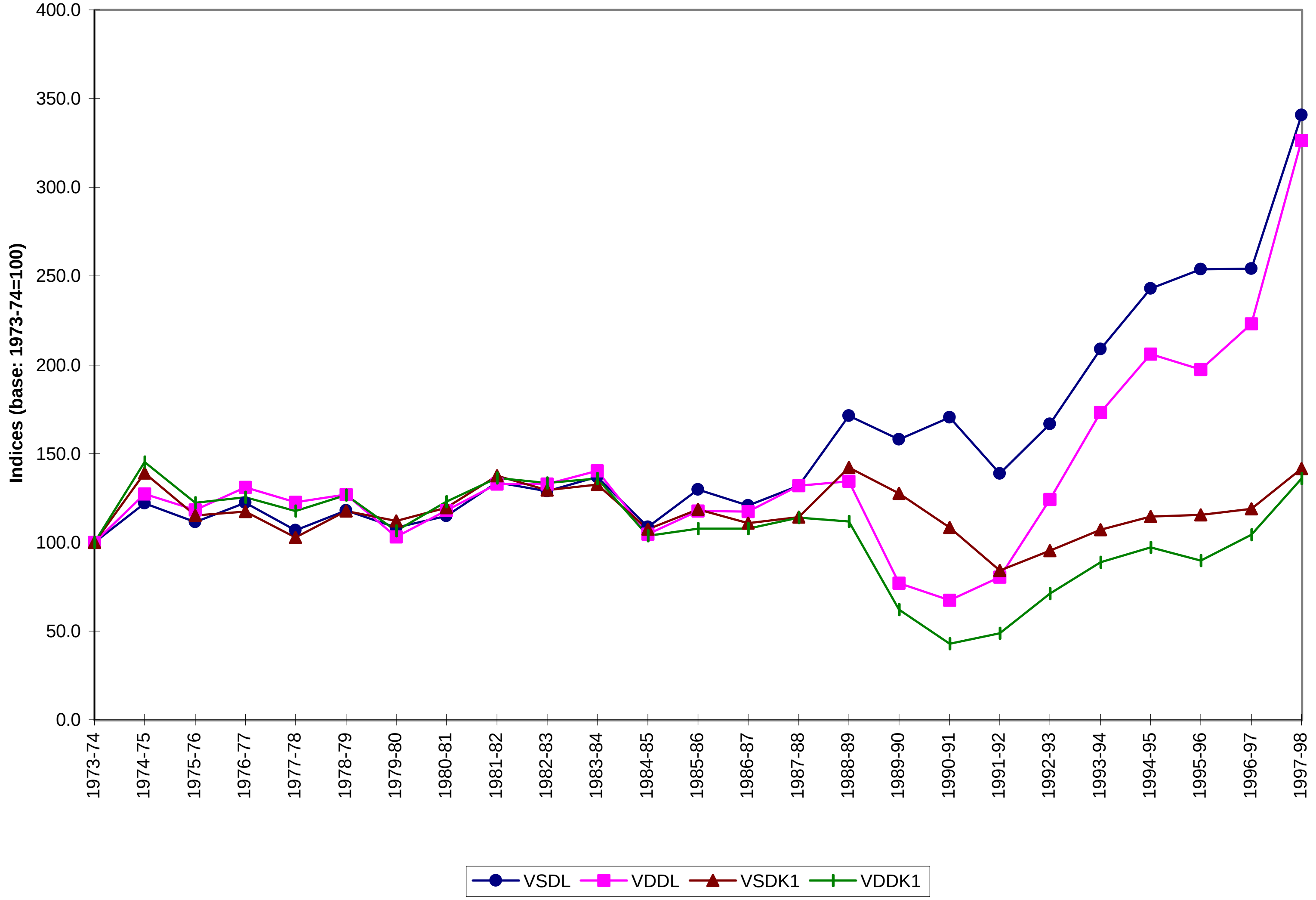


Figure 5.3: Partial Productivity Indices for Machinery & Transport Equipments
(Based on Real Value Added)

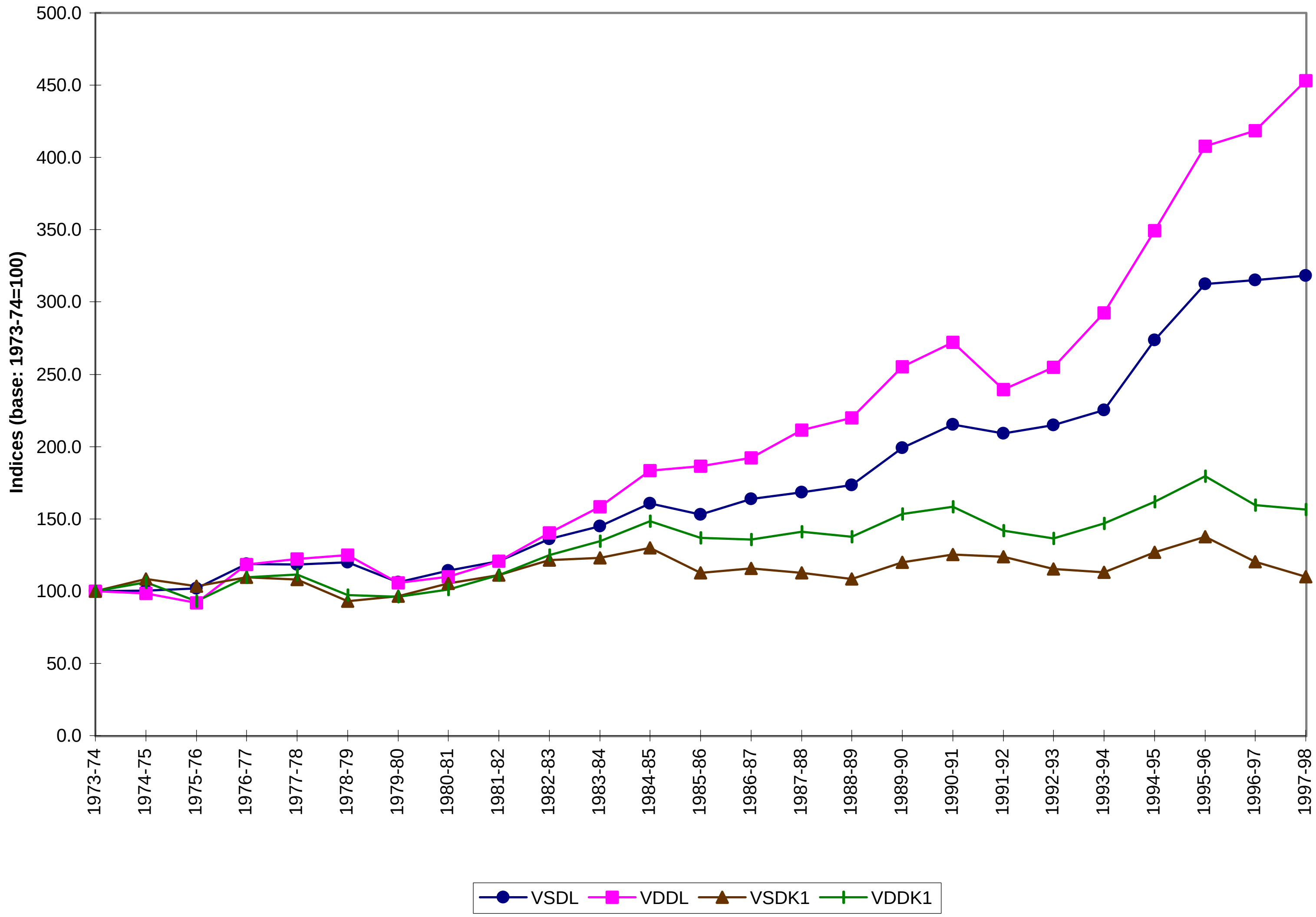


Figure 5.4:Partial Productivity Indices for Chemicals & Chemical Products (CHEM) (Based on Real Value Added)

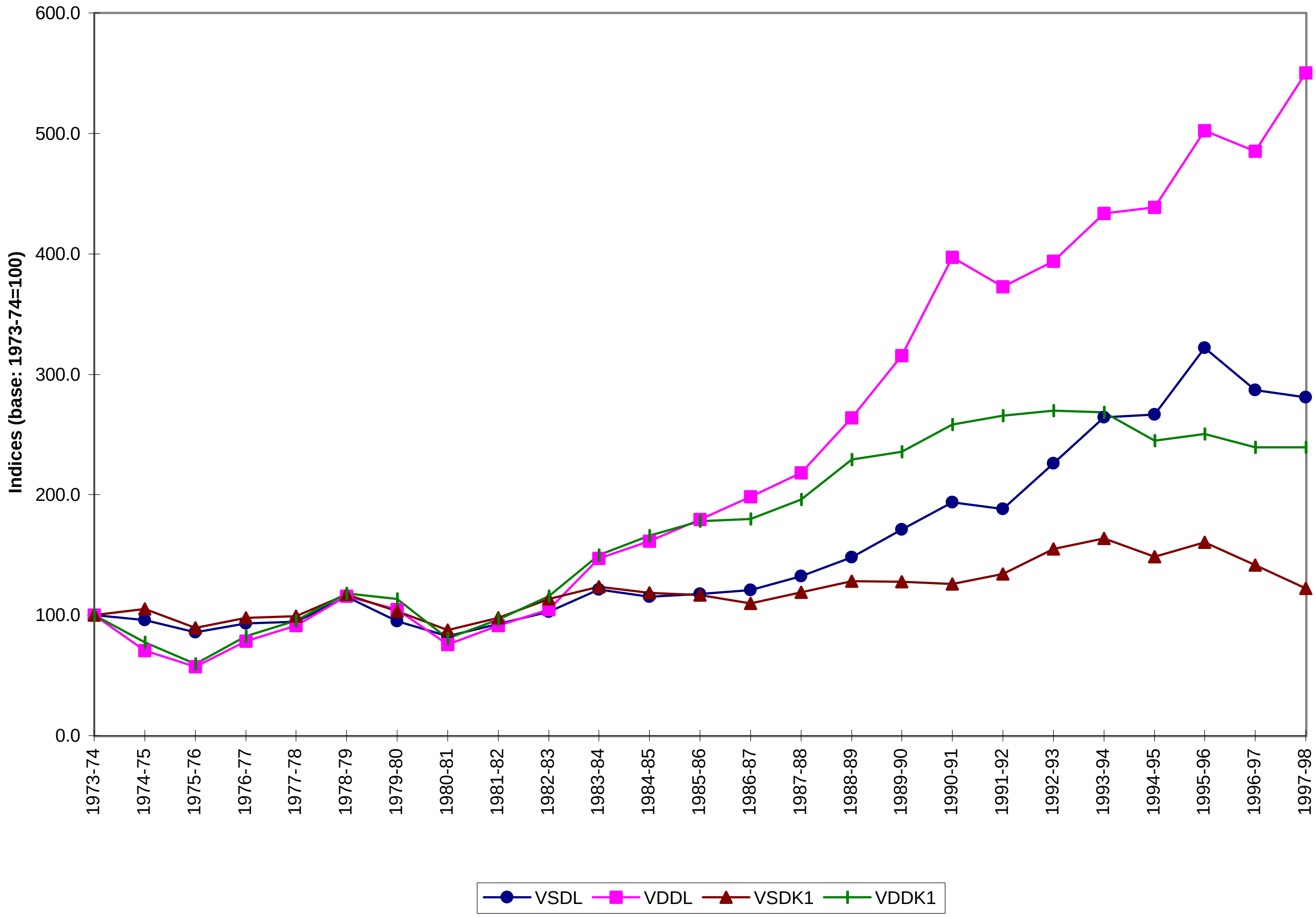


Figure 5.5: Partial Productivity Indices for Leather & Leather Products (LEATH)
(Based on Real Value Added)

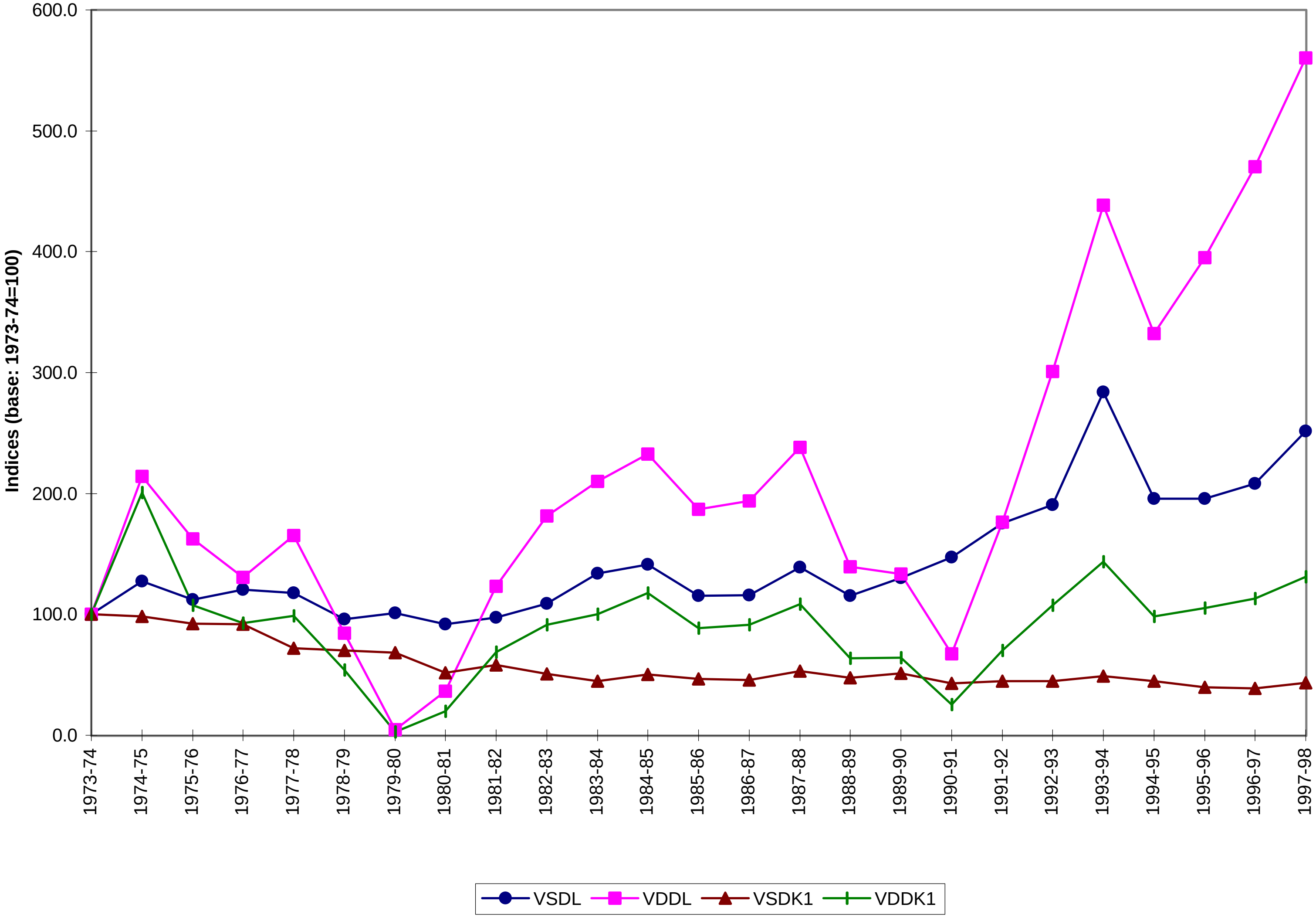


Figure 5.6: Partial Productivity Indices for Selected Manufacturing (SMFG)
(Based on Real Value Added)

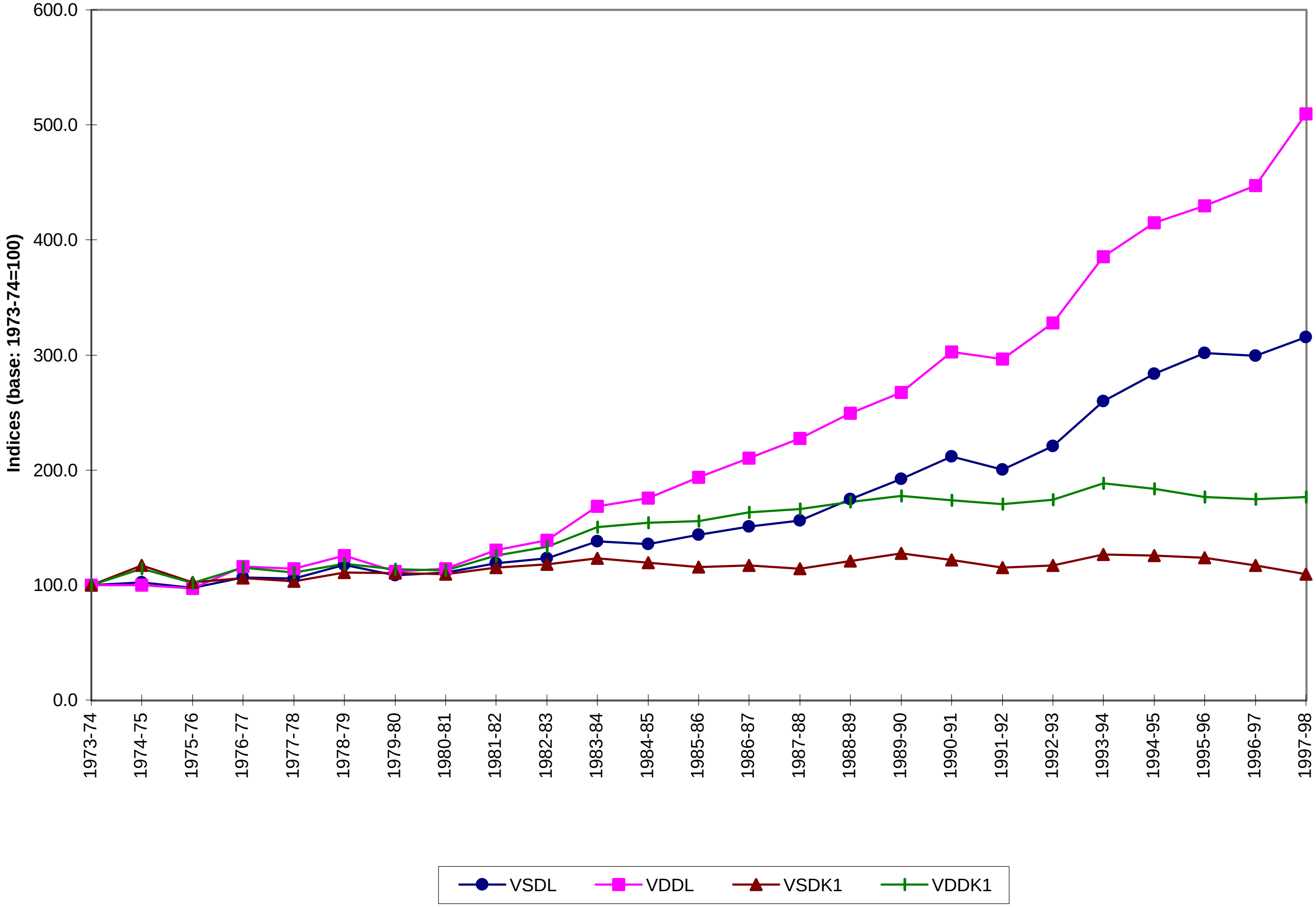


Figure 5.7: Partial Productivity Indices for Manufacturing (MFG)
(Based on Real Value Added)

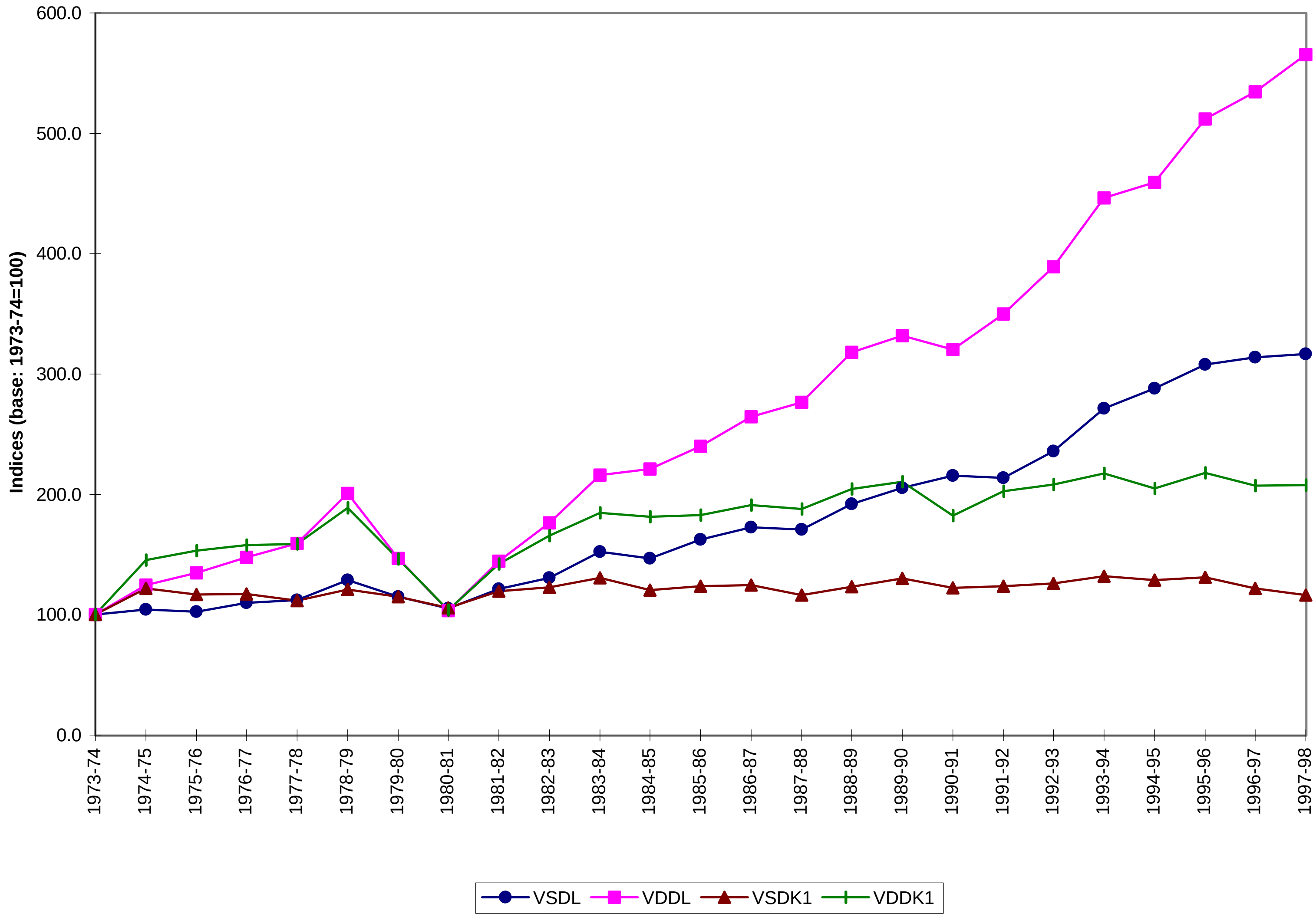


Figure 6.1 Productivity Indices for Textile Industry (Base: 1973-74=100)

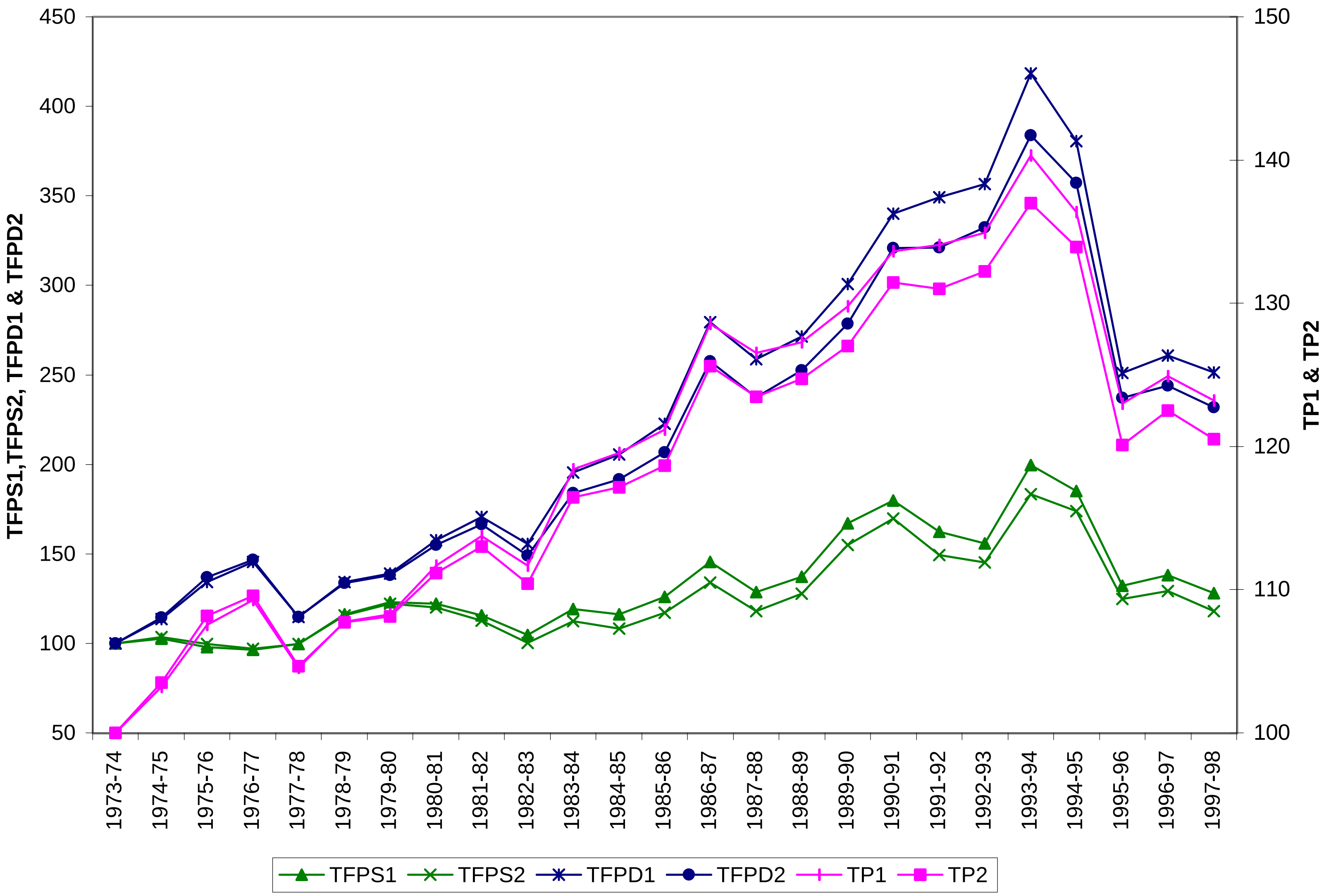


Figure 6.2 Productivity Indices for Metal Industry (Base: 1973-74=100)

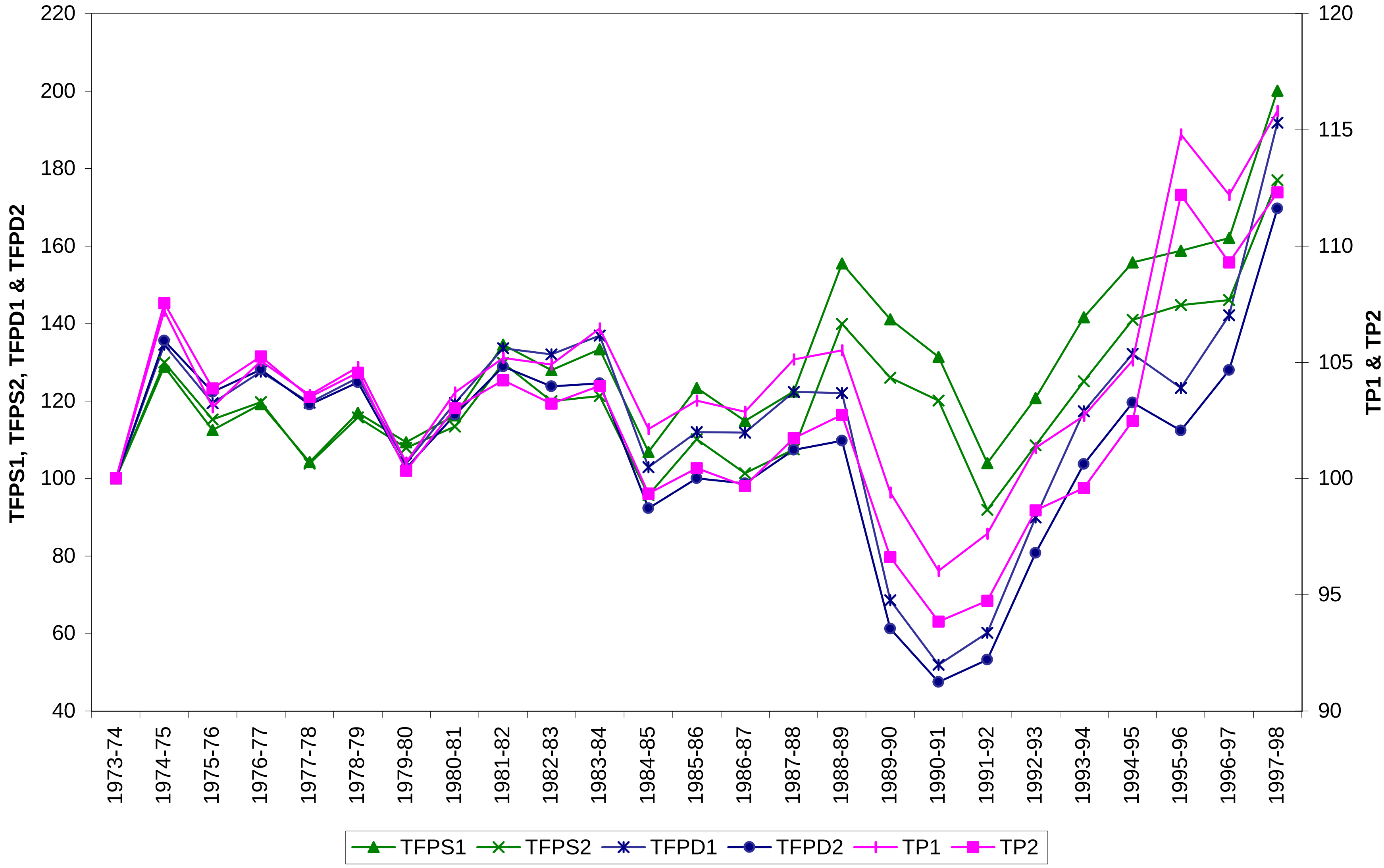


Figure 6.3 Productivity Indices for Machinery & Transport Equipment Industry (Base 1973-74=100)

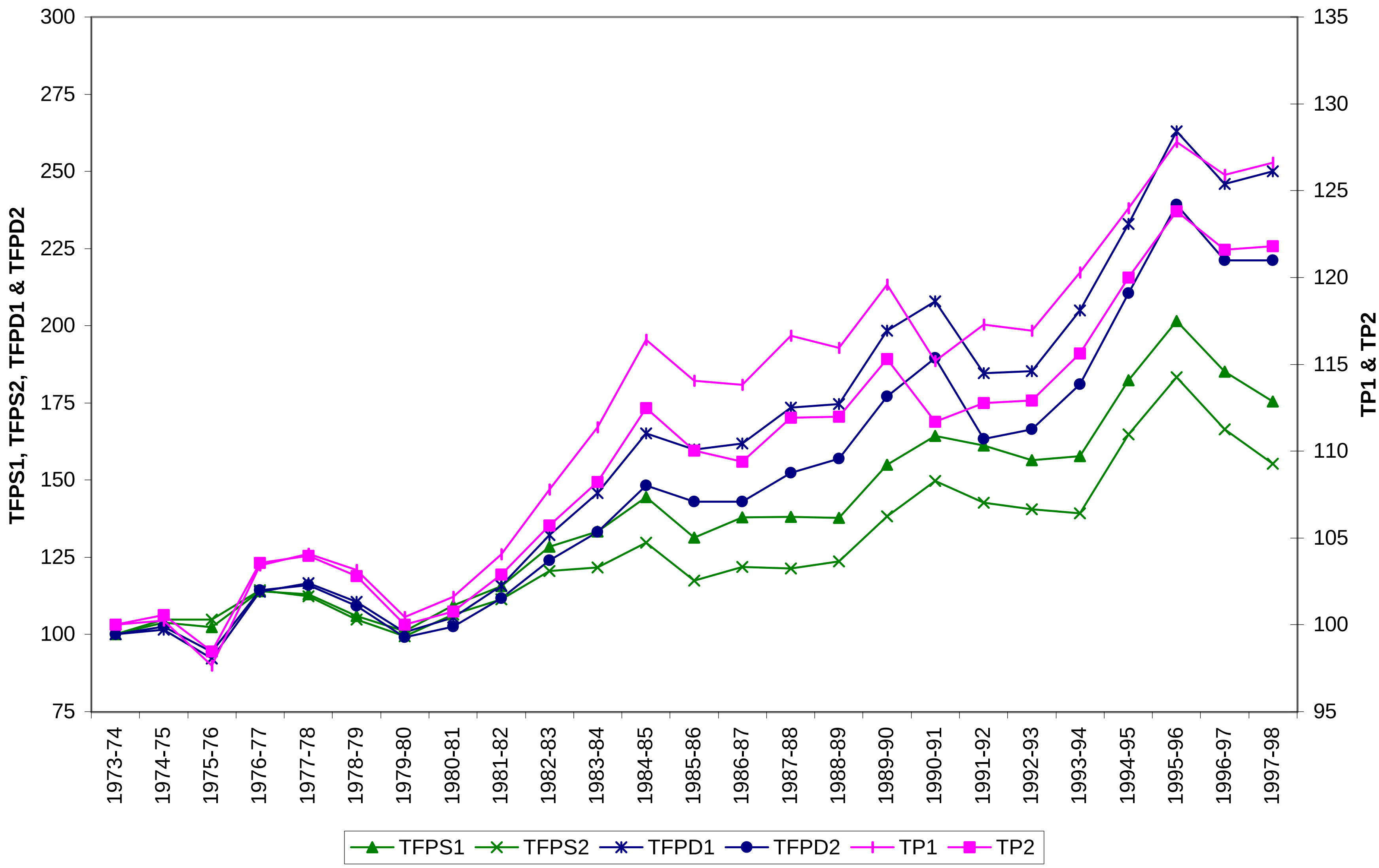


Figure 6.4 Productivity Indices for Chemical Industry (Base 1973-74=100)

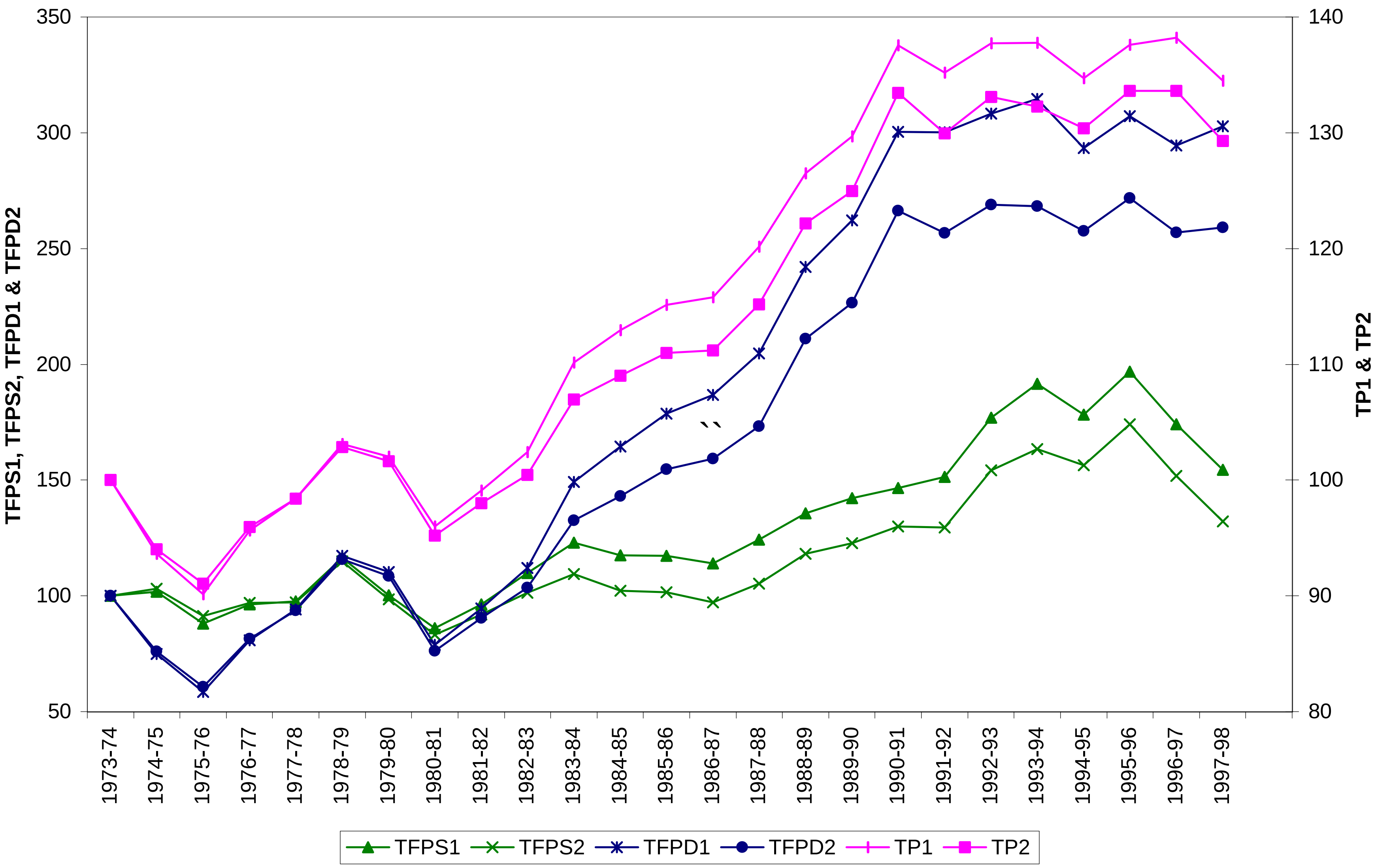


Figure 6.5 Productivity Indices for Leather Industry (Base 1973-74=100)

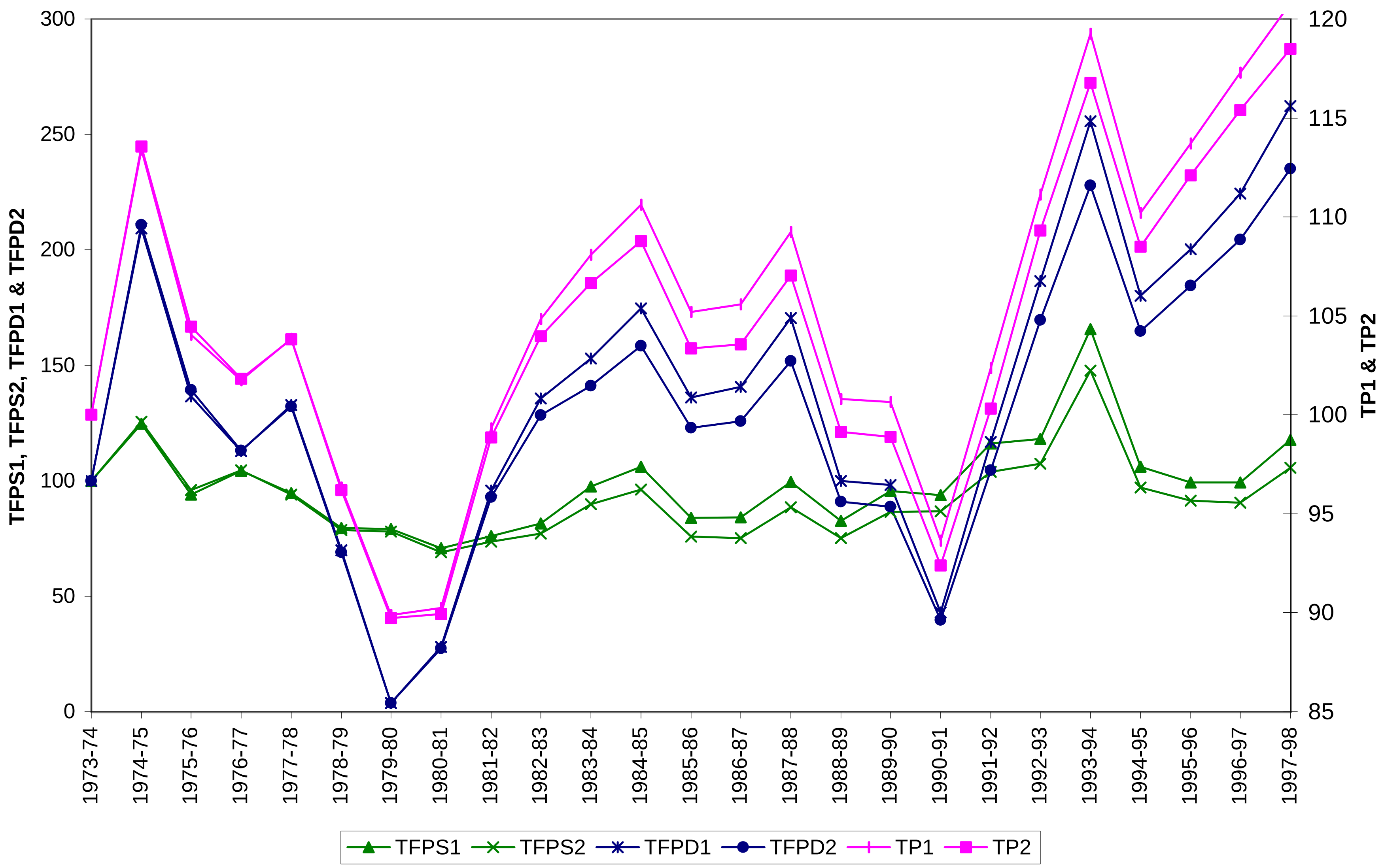


Figure 6.6 Productivity Indices for Selected Manufacturing Industries (Base 1973-74=100)

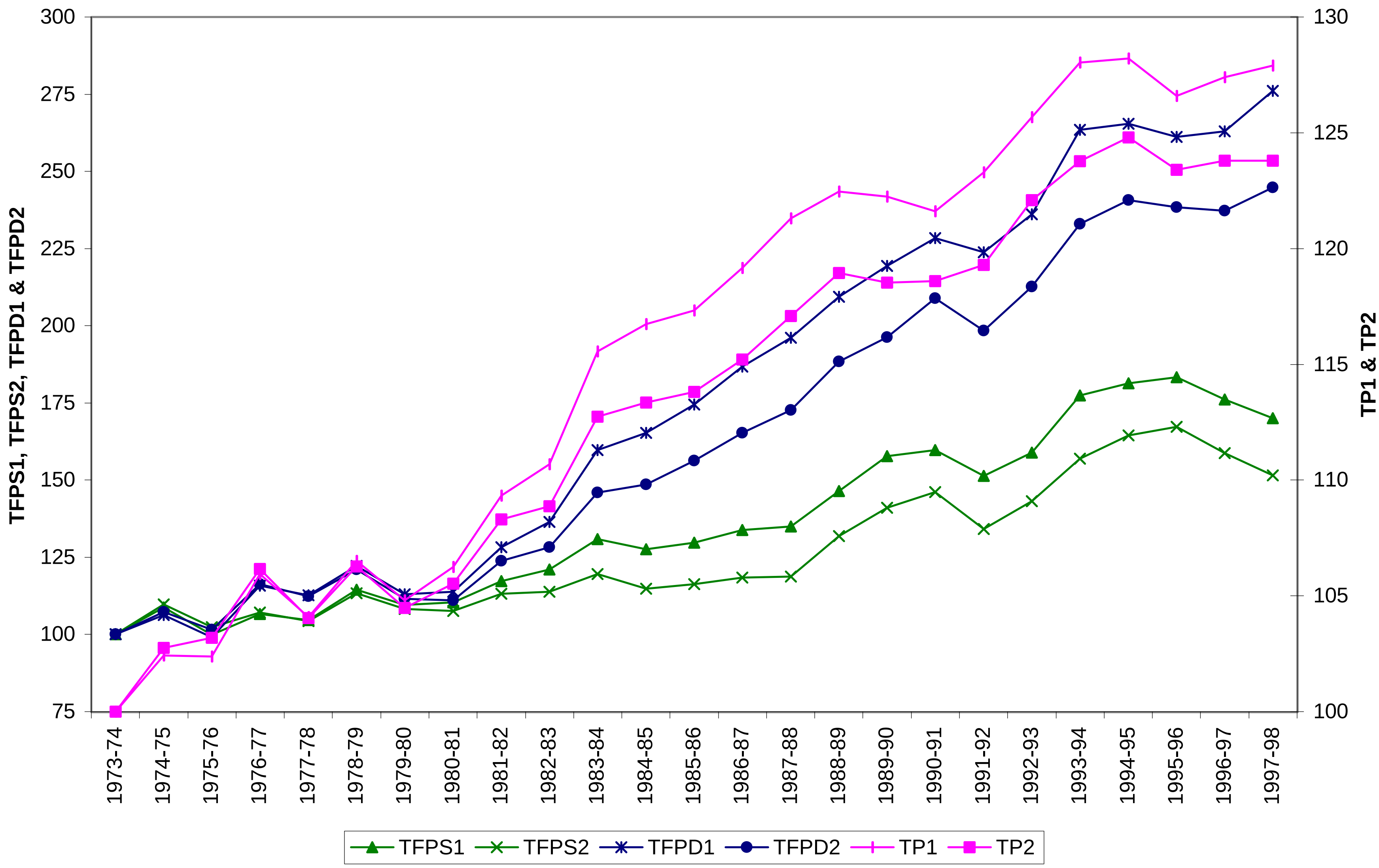
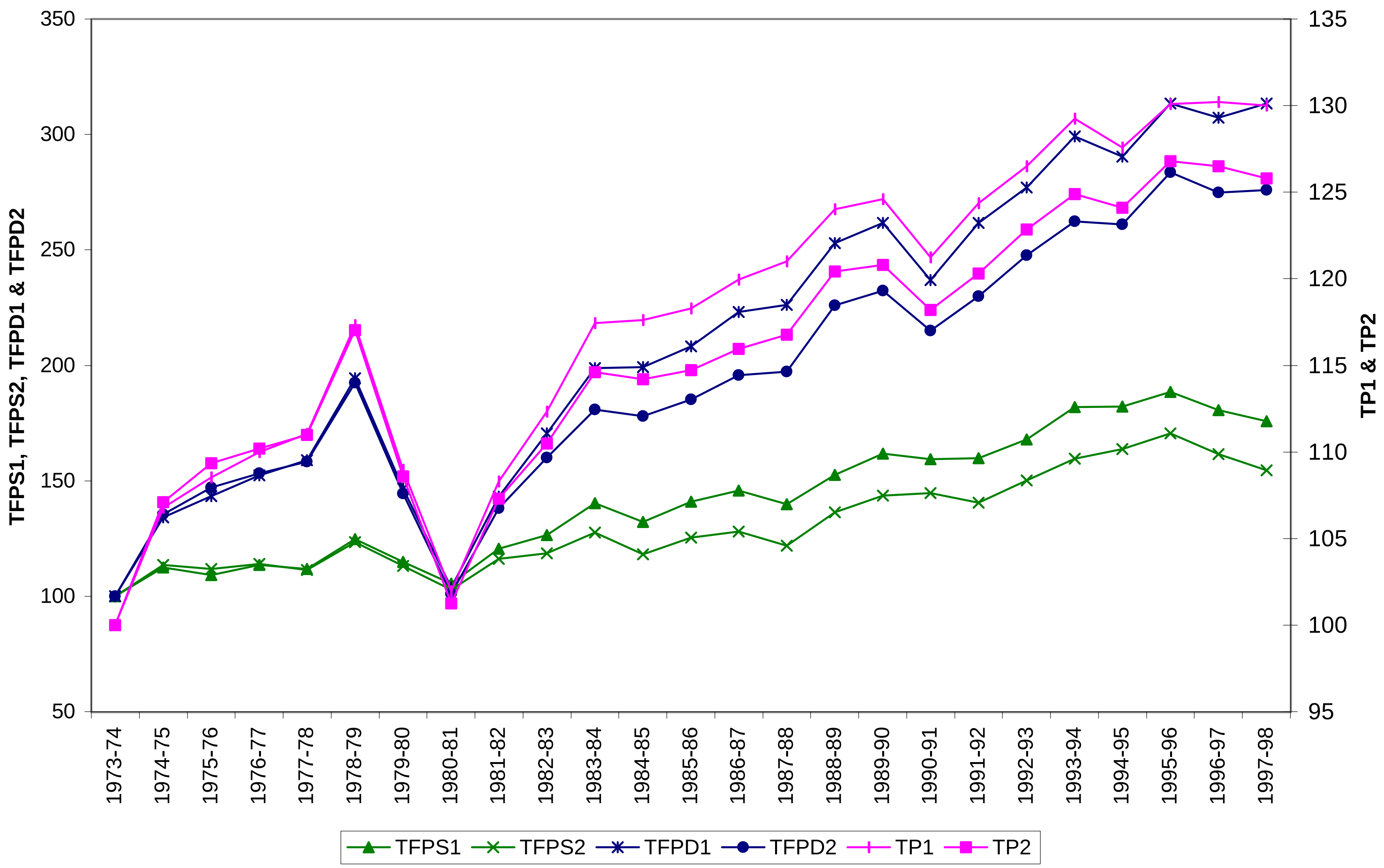


Figure 6.7 Productivity Indices for Manufacturing Sector (Base 1973-74=100)



Bibliography:

Abramovitz, Moses [1956], 'Resources and Output Trends in the United States Since 18970', *American Economic Review*, Vol. 46, pp. 5-23.

Abramovitz, Moses [1986], 'Catching Up, Forging Ahead, and Falling Behind', *Journal of Economic History*, Vol. XLVI, pp. 385-406.

Ahluwalia, I.J., [1991], *Productivity and Growth in Indian Manufacturing*, Oxford University Press, New Delhi.

Ahluwalia, I.J., [1994], ' TFPG in Manufacturing Industry', *Economic and Political Weekly*, Vol. 29, p. 2836.

Ark, B. van [1996a], **'**Productivity and Competitiveness in Manufacturing; A Comparison of Europe, Japan and the United States**'** in Wagner K. and B. van Ark (eds), 1996, *International Productivity Differences*, Elsevier Science B.V., Amsterdam.

Ark, B. van [1996b], 'Issues in Measurement and International Comparison Issues of Productivity- An Overview', in Organisation for Economic Co-operation and Development [1996], *Industry Productivity: International Comparison and Measurement Issues***,** OECD Proceedings, Paris.

Arrow, K.J., H.B. Chenery, B.S. Minhas, and R.M. Solow [1961], 'Capital-Labour Substitution and Economic Efficiency', *Review of Economics and Statistics*, Vol XLIII, pp. 225-50.

Auty, R.M. [1997], 'Competitive Industrial Policy and Macro Performance' *Journal of Development Studies*, Vol. 33, pp. 445-463.

Bahmani-Oskooee, M., H. Mohtadi and G. Shabsigh (1991), 'Exports, Growth and Causality in LDCs: A Re-examination', *Journal of Development Economics*, Vol. 36, pp. 405-15.

Bahmani-Oskooee, M. and J. Alse (1993), 'Export Growth and Economic Growth' *Journal of Developing Areas*, Vol 27, pp. 535-42.

Balakrishnan, P. and K. Pushpangadan [1994], 'Total Factor Productivity Growth in Manufacturing Industry: A Fresh Look' *Economic and Political Weekly*, Vol. 29, pp.2028-35.

Balakrishnan, P. and K. Pushpangadan [1995], 'Total Factor Productivity Growth in Manufacturing Industry' *Economic and Political Weekly*, Vol.30.

Balassa, B. [1985], 'Exports, Policy Choices, and Economic Growth in Developing Countries After the 1973 Oil Shock', *Journal of Development Economics*, Vol 18, pp. 23-35.

Barro, Robert J. and Xavier Sala-I-Martin [1991], 'Convergence across States and Regions' *Brookings Papers on Economic Activity*, pp. 107-58.

Baumol, William J. and K. McLennan (eds.) [1985], *Productivity Growth and U.S. Competitiveness*, Oxford University Press, New York.

Baumol, William J. [1986], 'Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show', *American Economic Review*, Vol. 76, pp. 1072-85.

Bernard, Andrew B. and Charles I. Jones [1996], 'Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries' *American Economic Review*, Vol. 86, pp 1216-1238.

Bhatia, D.P. [1987], 'Estimates of Value Added at Constant Prices in the Manufacturing Sector: An Erroneous Methodology' *Economic and Political Weekly*, Vol. 16, pp. 721-23.

Bhatia, D.P. [1990], 'Misleading Growth Rates in the Manufacturing Sector of India' *Journal of Income and Wealth*, Vol. 12, pp 222-25.

Brahmananda, P. R. [1982], *Productivity in the Indian Economy: Rising Inputs for Falling Outputs*, Himalaya Publishing House, Mumbai.

Bruno, M. [1984], 'Raw Materials, Profits, and the Productivity Slowdown' *Quarterly Journal of Economics*, Vol XCIX, pp. 1-29.

Caves, Richard E. [1998], 'Industrial Organization and New Findings on the Turnover and Mobility of Firms', *Journal of Economic Literature*, Vol. XXXVI, pp. 1947-82.

Chirstensen, L.R., D.W. Jorgenson and L.J. Lau [1971], 'Conjugate Duality and the Transcendental Logarithmic Production Function' *Econometrica*, Vol. 39., pp.255-6.

Chirstensen, L.R., D.W. Jorgenson and L.J. Lau [1973], ' Transcendental Logarithmic Production Frontiers' *Review of Economics and Statistics*, Vol.55, pp.28-45.

da Costa, G.C. [1992]**,** *Value and Distribution: In Neoclassical and Classical Systems*, Himalaya Publishing House, Mumbai.

Denison, Edward F. [1967], *Why Growth Rates Differ: Postwar Experience in Nine Western Countries*, The Brookings Institution, Washington D. C.

Denison, Edward F. [1979], *Accounting for Slower Economic Growth*, The Brookings Institution, Washington D. C.

Dholakia, B. H. and R. H. Dholakia [1994], 'Total Factor Productivity Growth in Indian Manufacturing', *Economic and Political Weekly*, Vol.30, pp. 3342-44.

Dollar, David and Edward N. Wolff [1988}, 'Convergence of Industry Labor Productivity Among

Advanced Economies, 1963-1982’, *Review of Economics and Statistics*, Vol. LXX, pp. 549-58.

Ghartey, E.E. (1993), 'Causal Relationship between Exports and Economic Growth: Some Empirical Evidence in Taiwan, Japan and the US', *Applied Economics*, vol. 25, pp. 1145-52.

Ghose, Devajyoti and Homi Kharas [1993], ‘International Competitiveness, the Demand for Exports and Real Effective Exchange Rates in Developing Countries’, *Journal of Development Economics*, Vol. 41, pp. 377-98.

Goldar, B.N. [1986], *Productivity in Indian Industry*, Allied Publishers Private Limited, New Delhi.

Government of India [1995], *A Technical Note to the Eighth Plan of India, 1992-97*, Perspective Planning Division, Planning Commission, New Delhi.

Griliches, Zvi [1996], ‘The Discovery of the Residual: a Historical Note’, *Journal of Economic Literature*, Vol 34, pp. 1324-1330.

Hashim, S.R. and M.M. Dadi [1973], *Capital-Output Relations in Indian Manufacturing (1946-1964)*, The Maharaja Sayajirao University Economic Series No. 2, The Maharaja Sayajirao University of Baroda, Baroda.

Haynes, Kingsley E. and Mustafa Dinc [1997], ‘Productivity Change in Manufacturing Regions: a Multifactor/Shift-Share Approach’, *Growth and Change*, Vol. 28, pp. 201-21.

Hulten, Charles R. [2000], 'Total Factor Productivity: A Short Biography', *NBER Working Paper*, # 7471.

Hulten, Charles and Sylvia Srinivasan [1999], ' Indian Manufacturing Industry: Elephant or Tiger? New Evidence on the Asian Miracle' , *NBER Working Paper*, # 7441.

Indira Gandhi Institute of Development Research, '*Policies For Industrial Competitiveness: What India can Learn From the East Asian Experience*' Project Report submitted to International Development Research Centre, Ottawa, Canada, 1996.

Industrial Credit and Investment Corporation of India Limited [1994], *Productivity in Indian Manufacturing: Private Corporate Sector 1972-73 to 1991-92*, ICICI, Mumbai.

Jayadevan, C.M.[1996], ‘Inter-state Variations in Total Factor Productivity Growth Rates: A Case Study of Organised Industry in India’, *Man & Development*, Vol.   , pp 97-108.

Jha, Raghbendra and Blabir S. Sahni [1993], *Industrial Efficiency: An Indian Perspective*, Wiley Eastern Limited, New Delhi.

Jorgenson, D.W. and Z. Griliches [1967], ‘The Explanation of Productivity Change’, *Review of*

Economic Studies, Vol. XXXIV, pp 249-83.

Jung, W.S. and J. Marshall [1985], 'Exports, Growth and Causality in Developing Countries', *Journal of Development Economics*, vol.18, pp.1-12.

Kendrick, John W.[1961], *Productivity Trends in the United States*, Princeton University Press, New Jersey.

Kendrick, John W.[1973], *Postwar Productivity Trends in the United States, 1948-69*, NBER and Columbia University Press.

Kendrick, John W.(ed.)[1984], *International Comparisons of Productivity and Causes of Slowdown*, Ballinger, Cambridge, Massachussets.

Kozicki, Sharon [1997], 'The Productivity Growth Slow-down: Diverging Trends in the Manufacturing and Service Sectors' *Economic Review*, Federal Reserve Bank of Kansas City, pp. 31- 46.

Krishna, K. L. [1987], 'Industrial Growth and Productivity in India' in P.R. Brahmananda and V.R. Panchmukhi (eds), *The Development Process of the Indian Economy*, Himalaya Publishing House, New Delhi.

Krugman, Paul [1994], ' The Myth of Asia's Miracle', *Foreign Affairs*, Vol 73, pp. 62-78.

Kunst, R. M. and Marin, D.(1989), 'Notes on Exports and Productivity: A Causal Analysis', *Review of Economics and Statistics*, vol. 71, pp. 699-703.

Leung, Charles Ka Yui and Danny T. Quah [1996] 'Convergence, Endogenous Growth and Productivity Disturbances' Journal of Monetary Economics, *Journal of Monetary Economics*, Vol. 38, pp. 535-47.

Maddison, Angus, [1987], 'Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment', *Journal of Economic Literature*, Vol. XXV, pp 649-98.

Majumdar, Sumit K.[1996], 'Fall and Rise of Productivity in Indian Industry', *Economic and Political Weekly*, Vol. 31, pp. M46-M53.

Mankiw, N, Gregory, David Romer and David N. Weil [1992], 'A Contribution to the Empirics of Economic Growth', *Quarterly Journal of Economics*, Vol. 107, pp. 407-37.

Mayes, D.J. [1996] *Sources of Productivity Growth*, Cambridge University Press, Cambridge.

Mohanty, D. [1992] , Growth and Productivity in The Indian Economy, *Reserve Bank of India Occasional Papers*, Vol 13, No.2, pp. 55-80.

Nadiri, M. Ishaq [1970], 'Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey', *Journal of Economic Literature*, Vol. VIII, pp. 1137-77.

Norsworthy, J.R., and S.L. Jang [1992], *Empirical Measurement and Analysis of Productivity and Technological Change: Applications in High-Technology and Service Industries*, Elsevier Science Publishers B.V., Amsterdam.

Organisation for Economic Co-operation and Development [1996], *Industry Productivity: International Comparison and Measurement Issues***,** OECD Proceedings, Paris.

Oulton, Nicholas [1998] 'Total Factor Productivity Growth and the Role of Externalities' *National Institute Economic Review*, pp. 99-121.

Planning Commission Government of India (1995)**,** *A Technical Note to the Eighth Plan of India (1992-97),* Perspective Planning Division, New Delhi..

Porter, M. [1990], *The Comparative Advantage of Nations*, The Free Press, New York.

Pradhan, G. and K. Barik [1998], 'Fluctuating Total Factor Productivity: Evidence from Selected Polluting Industries'**,** *Economic and Political Weekly*, Vol. 33, pp M-25-30.

Pradhan, G. and K. Barik [1999], ' Total Factor Productivity Growth in Developing Economies: A Study of Selected Industries in India'**,** *Economic and Political Weekly*, Vol. 34, pp M-92-105.

Rao, J. M., [1996a], 'Manufacturing Productivity Growth: Method and Measurement', *Economic and Political Weekly,* Vol. 31, pp. 2927-36.

Rao, J. M. [1996b], 'Indices of Industrial Productivity Growth: Disaggregation and Interpretation', *Economic and Political Weekly,* Vol. 32, 7th Dec., pp. 3177-88.

Sandesara, J.C.[1992], *Industrial Policy and Planning: 1947-91,* Sage Publications, New Delhi.

Sarel, Micheal [1995], 'Growth in East Asia: What We Can and What We Cannot Infer From It', *IMF Working Paper,* No. 98, International Monetary Fund, Washington D.C.

Sastry, D.U. [1995], 'TFPG in Manufacturing Industry' *Economic and Political Weekly*, Vol. 30, p. 123.

Solow, R.M.[1957], 'Technical Change and the Aggregate Production Function'**,** *Review of Economics and Statistics*, Vol. XXXIX, pp. 312-20.

Tinbergen, J. [1942], 'Zur Theorie der langfristigen Wirtschaftsentwicklung', *Weltwirschaftliches Archive,* May.

Wagner, Karin and Bart van Ark (eds), [1996], *International Productivity Differences:*

Measurement and Explanations, Elsevier Science B.V. Amsterdam.

Young, A. [1995] , 'The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience' *Quarterly Journal of Economics*, Vol 110, pp. 641-80.
