Globalization and its Effects on Regional Variations in Factor Substitution and Returns to Scale in the Indian Factory Sector

SK Mishra

North-Eastern Hill University, Shillong (India)

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Dept. of Economics
North-Eastern Hill University
Shillong, India – 793022

Abstract

The issue of inequality or imbalance in sectional, sectoral or regional distribution of economic and social variables is connected to welfare implications of the functioning of an economy responsible for allocation of resources, and production, distribution and consumption of the material requisites of well-being. Economic development and technological progress may or may not deliver justice in the Rawls' sense although such development and progress might be perfectly just in Mill's or Nietzsche's sense.

Inequalities and their dynamics are often studied in terms of collectives of gross variables – income, amenities and facilities, infrastructure, etc. – that directly impinge on the welfare of the people. However, deeper parameters are seldom studied in this regard. Nevertheless, these parameters - such as propensities to consume and save, rate and direction of substitution of factors of production, returns to scale, bias of technical progress, concentration of monopoly power, etc are altered in the process of development and determine the gross economic variables for a fairly long period.

In this study we make an attempt to look into the spatial/regional distribution of a few structural parameters in the factory sector of India and purport to examine if, in the wake of globalization, there have been substantial changes in their distribution. Our main apparatus of analysis is 'production functions' that permit variable elasticities of factor substitution and returns to scale. We use data at the state level for 1990-91 and 2003-04 for our analysis.

I. Introduction: As it is well known, the Indian industrial policies in the pre-liberalization era had imposed several restrictions on the manufacturing sector with regard to the scale of operation, procurement and use of raw materials and capital, nature and type of industry where private sector could enter, markets that they could supply to, etc. The policies had also favoured labour-intensive, small-size firms. They also protected inefficiency in production in some sense by restricting competition. All these restrictions did not allow an optimal allocation of resources in response to the ever-changing economic environment in the domestic as well as foreign domain. Aiming at promoting growth by eliminating supply bottlenecks that hindered competitiveness, efficiency and dynamism in the economic system, the New Economic Policy of 1991 removed many of those restrictions and regulations. With liberalization and globalization, therefore, one may expect capital to be substituted for labour, firm sizes to grow, small scale industries to be pushed behind, returns to scale to change and, in turn, production to grow in size and variety.

Table-I: Growth of Factor Employment and Distribution of Dividend in the Factory Sector, India (1981-82 – 2003-04)

Year	Index (1981-82=100) Per Factory * In 1993-94 Constant Prices				As Percentage to Net Value Added (NVA)				As % to Gross Output		As % to NVA
	Fixed Capital*	Persons Engaged	NVA*	CUT - Index of Emoloyees	Wages	Salaries	Benefits	Total Emolum	Total Inputs	Profits	Profits
1982	100.000	100.000	100.000	100.000	30.278	10.212	6.210	46.701	77.344	3.849	19.905
1983	128.529	116.625	124.970	105.367	30.877	11.169	6.210	48.256	77.804	5.110	23.736
1984	138.637	109.993	137.344	109.974	29.402	10.328	6.047	45.777	74.854	3.053	15.433
1985	140.788	105.849	128.218	110.390	32.351	11.948	6.737	51.037	76.373	2.915	15.429
1986	144.521	99.894	129.800	111.082	31.425	10.891	6.785	49.101	77.424	3.095	16.116
1987	160.791	102.535	146.130	112.841	30.723	10.804	6.607	48.133	77.301	2.135	11.603
1988	167.228	102.503	144.377	112.496	31.530	11.491	6.676	49.697	77.538	3.203	17.050
1989	170.991	100.463	158.895	111.923	29.716	7.866	7.829	45.412	77.347	3.537	19.069
1990	177.741	101.729	169.576	113.037	27.649	7.875	7.626	43.150	77.688	4.210	22.109
1991	200.663	99.984	184.950	112.456	25.608	7.044	7.310	39.962	77.241	3.220	17.574
1992	201.305	98.584	173.741	112.692	24.774	5.781	7.694	38.248	77.885	3.944	20.403
1993	216.370	98.387	191.126	112.614	23.623	7.865	7.193	38.682	76.759	6.717	32.339
1994	229.593	96.707	216.345	113.066	19.899	5.784	6.702	32.385	75.363	7.183	34.287
1995	250.030	99.806	233.678	113.239	20.291	5.973	6.304	32.568	75.445	6.569	31.598
1996	264.259	101.070	252.778	114.894	20.065	4.788	7.512	32.365	75.687	5.659	26.677
1997	286.149	95.536	283.313	116.066	16.875	9.196	3.418	29.489	75.075	6.511	32.718
1998	302.315	98.545	284.390	101.120	17.893	7.722	5.850	31.465	76.297	6.036	32.522
1999	276.538	90.922	245.909	109.301	17.067	6.256	7.356	30.679	77.834	5.271	30.544
2000	276.969	82.658	255.404	109.314	16.973	6.550	7.348	30.872	78.999	3.851	24.856
2001	267.254	80.965	229.684	109.986	19.266	8.292	7.756	35.314	80.758	3.624	24.174
2002	291.710	80.220	233.022	109.579	19.014	7.783	8.586	35.384	80.962	5.471	35.890
2003	291.963	82.521	270.525	109.987	17.227	7.128	7.650	32.005	81.038	7.173	45.505
2004	291.870	81.128	299.222	109.592	15.019	6.771	6.957	28.747	80.755	3.849	19.905

Based on data from *Annual Survey of Industries*, Ministry of Statistics and Programme Implementation, Govt. of India (http:www.mospi.nic.in).

A number of researchers have found these changes occurring (Mishra & Nayak, 2007). Some have found globalization discriminating against the unorganized sector, pushing them farther to the margin (Hensman, 2001; Saptari, 2001). The percentage of workers in manufacturing in urban areas started decreasing since 1977, and continued apace between 1987-88 and 1993-94, while two sectors that have experienced systematic

increases in employment share have been the "wholesale and retail trade" and "community and other services". Kundu (1997) explains the loss of manufacturing employment in terms of jobs being subcontracted out by large manufacturing units to smaller ones which are often household units that classify themselves as service units (Dutt and Rao, 2000).

As a matter of fact, the industrial matrix of India started changing slowly only in the early 1980's, and those changes picked up momentum after liberalization in 1991. This is betrayed by the trends in labour and capital employed in the factory sector. Clearly, there is a decline in the employment of labour and increase in that of capital (Table-I). The labour CUT index (Capacity Utilization Index or index of the ratio of man-days worked by employees to their number) increased and reached at its peak in 1997, which, on account of the slow down of the economy afterwards, could not sustain itself. The share of wages and salaries in the Net Value Added (NVA) declined and the share of profits appreciated. It is obvious that substitution of capital for labour took place vigorously (Mishra, 2006-b).

II. Our Objectives: In this study we intend to investigate as to the regional and structural changes in the manufacturing sector of India (possibly) brought about by liberalization and globalization of the economy. We assess structural changes in terms of employment of labour and capital, possibly indicated by replacement of the former by the latter. We also assess it in terms of returns to scale. It is well known that different states in India are at different levels of Industrialization. Some are industrially under-developed while some others are quite advance and enjoy the economies of agglomeration (Lall et al., 2001). We intend to assess the impacts of the new industrial policies on regional distribution of indicators of industrialization such as the labour-capital ratio, returns to scale and productivity. We intend to investigate if these changes bridged up or accentuated the gaps between the less industrialized and the more industrialized states.

III. The Data: In this study we use the data (see Table-II) on labour, capital, net value added and number of industrial establishments/factories provided by Report on Currency and Finance 1997-98, Govt. of India (reproduced in *Basic Statistics of North Eastern Region 2000, NEC, Govt. of India, Shillong*) and *Annual Survey of Industries*, Ministry of Statistics and Programme Implementation, Govt. of India (http:www.mospi.nic.in). The first source provides data for 1990-91 while the second source provides data for 2003-04. By *Labour* is meant the "total persons engaged" in the factories, by *Capital* is meant the "Fixed Capital" and *Net Value Added* (NVA) is "Gross value of output net of the value of total inputs and depreciation". The data are detailed state-wise, including the Union Territories. However, to make 2003-04 data comparable with 1990-91 data, aggregation is done for Bihar and Jharkhand, Madhya Pradesh (MP) and Chattisgarh, and Uttar Pradesh (UP) and Uttaranchal. In the category "others" we have the aggregate data for other states including the North-Eastern India (except Assam).

IV. Methods of Analysis: Our current interest is to study the regional variations and changes in the measures of inequality in matters of the structural parameters of industrial development that occurred in the post-globalization period in India. For this purpose we

have used production functions as the apparatus of analysis. Production functions are technological relationships between the output and the inputs that are used by (efficient) industrial establishments. In response to changes in technological, economic and social environment, the industrial establishments determine the scale of operation and substitute the one factor of production (input) for the others so as to continuously move closer to the input mix that is most productive or rewarding.

In the literature on production functions we get a large number of specifications of functions, beginning with Thünen-Wicksell-Cobb-Douglas (TWCD) production function (Humphrey, 1997) to the most generalized (neo-classical) production function (Sato, 1975). However, the specifications such as TWCD and CES (of Arrow, Chenery, Minhas and Solow, 1961) are of little use to us at present since they assume a constant elasticity of substitution among the factors of production. They also do not permit variability in returns to scale as the scale of production changes. Among the production functions that permit variable elasticity of substitution with an assumption of homotheticity are: Constant Marginal Share (CMS; Bruno, 1968), Lu and Fletcher (1968), Sato and Hoffman (1968), Revankar (1971) and Kadiyala (1972). Kadiyala's production function includes TWCD, CES, Lu-Fletcher, Revankar and Sato-Hoffman production functions as its special cases. Ryuzo Sato's generalized production function (Sato, 1975) is applicable to non-homothetic cases also and includes homothetic production functions as its special cases. However, non-homotheticity requires measuring biased technical progress, which may not be possible to do in this study. Zellner and Revankar (1969) generalized homothetic production functions to allow for variable returns to scale. In the present study we have used Bruno's CMS with Zellner-Revankar generalization such that it allows for variability in the elasticity of substitution as well as returns to scale. In part, the choice is guided by parsimony in the number of parameters to be estimated and the degree of fit (R^2) of the function to our data. Easy interpretability of estimated parameters also has been one of the considerations in this regard.

Estimation of most of the functions that permit variability in substitution elasticity and returns to scale together is not easy-going. One cannot use a simple Least Squares (LS) procedure since in Zellner-Revankar generalization, the LS estimates are misleading and one has to use the maximum likelihood (ML) method with iterated least squares (Mishra, 2007). Bruno's function in itself is nonlinear. Most of the classical optimization methods fail to optimize and therefore estimate the function. To surmount this problem we have used the most powerful method of global optimization, namely, the Differential Evolution (DE) method (Storn and Price, 1995). The details of DE are available elsewhere (Mishra, 2006-a).

By estimating Bruno-Zellner-Revankar production function we have obtained the elasticities of substitution and returns to scale for different states. Together with these two measures, we have also used five other indicators of structural changes, namely, L-N (labour per factory), K-N (capital per factory), O-N (or NVA-N, net value added per factory), K-L (capital-labour ratio) and P-N (population-weighted changes in the number of factories) in factor analysis to identify the major factors of structural changes brought about by liberalization in 1990-2004 period.

Finally, we have used appropriate methods to measure the extent of regional disparities and inequalities in distribution of relevant indicators of industrial development.

Table-II. Indicators of Industrial Sector of the Indian Economy

State/Union Territories	Year 1990-91*				Year 2003-04**				$\frac{\Delta(NFact)}{\Delta Popn}$
	NFACT	LABOUR	CAPITAL	NVA	NFACT	LABOUR	CAPITAL	NVA	x lakh
Andhra Pradesh	15205	832120	15779	2981	14802	864112	34216	13375	-3.195
Assam	1548	108953	1032	734	1570	113993	6696	3741	0.399
Bihar & Jharkhand	3409	360362	6938	2598	2907	201933	19310	8773	-1.638
Chandigarh	295	12185	45	70	263	8938	312	164	-9.518
Dadra & N Haveli	127	5680	116	73	960	51861	4764	2801	781.302
Daman & Diu	53	2642	27	14	1386	59877	2422	2335	1811.06
Delhi	3453	144554	879	1016	3197	115478	2105	2024	-4.445
Goa	220	17309	241	158	549	34457	3739	2288	142.278
Gujarat	10943	675447	13099	4468	12795	729310	85789	28865	15.218
Haryana	3070	252974	3658	1636	4265	318266	15134	9143	19.638
Himachal Pradesh	282	53580	1118	378	530	36753	5714	1750	21.032
Jammu & Kashmir	235	13577	66	76	342	26952	382	188	3.394
Karnataka	5911	418955	4844	2769	7067	507410	35429	13844	11.294
Kerala	3484	271961	2661	1222	5491	316611	6930	4091	56.286
MP & Chattisgarh	3962	417099	10324	3007	4277	313904	22338	10633	8.056
Maharashtra	15595	1239152	22162	12004	17474	1114070	83472	41910	1.615
Orissa	1465	153220	4745	1153	1678	124983	16115	3215	3.185
Pondicherry	233	21661	204	97	610	39438	2301	1989	174.111
Punjab	6255	400960	5667	1857	6853	336397	9256	5314	11.283
Rajasthan	3358	241329	5099	1556	5452	245274	14012	5173	12.885
Tamil Nadu	14617	962589	11385	5793	20246	1162594	46421	19101	66.14
UP & Uttaranchal	10417	789011	14699	4625	9916	611164	32108	14163	-1.083
West Bengal	5606	740980	8490	3198	5942	515267	24090	7903	2.136
Others	436	26204	380	34	502	21039	277	149	1.875
India	110179	8162504	133658	51517	129074	7870081	473331	202933	7.974

NFACT = No. of Factories; NVA = Net Value Added (Rs. Crore) ; Captal = Fixed Capital (Rs. Crore) ; Labour = No. of Employees; * Source : Report on Currency & Finance-1997-98; ** Source : MOSPI (asi_table3_2003_04.htm)

V. Observations on Growth in Number of Factories: A cursory perusal of Table-II indicates, first of all, that in the terminal year of our analysis (2003-04) the number of factories at the national level have increased (in comparison to 1990-91) by about 17 percent. In Goa, Pondicherry, Dadra & Nagar Haveli (DNH) and Daman & Diu (DD) the number of factories have more than doubled. On the other hand, the number of factories in Bihar & Jharkhand (BJ), Chandigarh, Delhi, UP & Uttaranchal (UPU) and Andhra Pradesh have reduced. If we consider the growth rate of the number of factories relative to growth rate in population during 1991-2004, we may possibly get a better view of industrial development in different states. We observe that the states in the eastern and central parts of India have experienced a setback or attracted lesser number of factories than those in other parts of India.

VI. The Average Size of Industrial Establishments: The size of a factory may be measured either in terms of the manpower it employs or the fixed capital that it applies to production. Each of these measures has its specific significance and limitations. While the size of the manpower employed by a factory may indicate its role in sharing the returns to industrialization among the people, it may be borne in mind that the issues of efficiency of labour, the quality of manpower employed, the nature of technology employed in production, the wage rate of labour, etc are the crucial considerations. On the other hand, fixed capital applied to production may indicate the nature of production technology and the share of capital in the returns to industrializations, but the issues regarding measurement of capital (Robinson, 1953; Felipe and Fisher, 2001) capacity under-utilization and X-efficiency, input and output specific rates of inflation, etc are very significant.

In Table-III we present the state-wise figures on labour and capital per establishment (factory) for 1990-91 and 2003-04. We also present the labour-capital ratios for those years. We observe that overall the manpower employed by the industrial establishments has reduced during the reference years. However, in some states such as Andhra Pradesh (AP), Assam, DNH, J&K and Karnataka, the measure has shown an increase. On the other hand, in some states such as Bihar & Jharkhand, Himachal Pradesh (HP), Madhya Pradesh & Chattisgarh (MPC), Orissa and West Bengal (WB), the manpower employed per factory has shown a sizeable decline. Different states have different reasons that have led to such changes.

Table-III. Labour, Capital per Establishment and Labour Capital Ratio in Industrial Sector, India

State/Union Territories	Labour per Establishment		Capital per Establishment*		Labour/Capital Ratio**	
	1990-1991	2003-2004	1990-1991	2003-2004	1990-1991	2003-2004
Andhra Pradesh	54.7267	58.3781	1.0378	2.3116	52.736	25.255
Assam	70.3831	72.6070	0.6667	4.2647	105.575	17.025
Bihar & Jharkhand	105.7090	69.4644	2.0352	6.6427	51.940	10.457
Chandigarh	41.3051	33.9848	0.1525	1.1859	270.778	28.658
Dadra & N Haveli	44.7244	54.0219	0.9134	4.9621	48.966	10.887
Daman & Diu	49.8491	43.2013	0.5094	1.7477	97.852	24.718
Delhi	41.8633	36.1207	0.2546	0.6584	164.453	54.857
Goa	78.6773	62.7632	1.0955	6.8103	71.822	9.216
Gujarat	61.7241	56.9996	1.1970	6.7049	51.565	8.501
Haryana	82.4020	74.6227	1.1915	3.5484	69.156	21.030
Himachal Pradesh	190.0000	69.3453	3.9645	10.7808	47.925	6.432
Jammu & Kashmir	57.7745	78.8070	0.2809	1.1166	205.712	70.575
Karnataka	70.8772	71.7999	0.8195	5.0133	86.489	14.322
Kerala	78.0600	57.6600	0.7638	1.2620	102.203	45.690
MP & Chattisgarh	105.2749	73.3935	2.6058	5.2229	40.401	14.052
Maharashtra	79.4583	63.7559	1.4211	4.7769	55.913	13.347
Orissa	104.5870	74.4833	3.2389	9.6038	32.291	7.756
Pondicherry	92.9657	64.6525	0.8755	3.7714	106.181	17.143
Punjab	64.1023	49.0876	0.9060	1.3507	70.753	36.342
Rajasthan	71.8669	44.9879	1.5185	2.5700	47.329	17.505
Tamil Nadu	65.8541	57.4234	0.7789	2.2929	84.549	25.044
UP & Uttaranchal	75.7426	61.6341	1.4111	3.2380	53.678	19.035
West Bengal	132.1762	86.7161	1.5144	4.0543	87.277	21.389
Others	60.1009	41.9104	0.8716	0.5508	68.958	76.088
India	74.0840	60.9734	1.2131	3.6671	61.070	16.627

* Rs Crore; ** Person per Crore of Rs; [Rs. One Crore = Rs. 10 million]

The figures on application of fixed capital per establishment indicate that overall, there is an increase in this measure. It becomes more evident when we look at the figures on labour-capital ratio. Overall, in 2003-04 the labour-capital ratio has remained only slightly more than a quarter (27.23 percent) of that in 1990-91. In states such as Punjab, AP, Kerala, Rajasthan, UPU, MPC, J&K, Delhi, Haryana and Tamilnadu, the rate of reduction in labour-capital ratio has been slower than that in India as a whole. On the other hand, Chandigarh, Goa, HP, Assam, Pondicherry, Gujarat, Karnataka, BJ, Maharashtra, Orissa and WB, the rate of reduction in labour-capital ratio has been faster.

The average change in NVA in response to the average change in the number of factories has been positive in India (801.35 percent). States such as WB, Gujarat, Orissa, and Karnataka have shown the said rate higher than India's. On the other hand, the rate has been negative for states such as AP, UPU, BJ, Delhi and Chandigarh. The response of the gross measure of labour productivity to capital labour ratio has appreciated during the reference period as shown in Table-IV.

Table-IV: Response of Labour Productivity to Capital-Labour Ratio

Parameters	1990-91 (Linear Model); R^2=0.104				2003-04 (Exponential Model); R^2=0.567			
	Coeff	See(coef)	t-Value	p-level	Coeff	See(coef)	t-Value	p-level
Intercept	0.468594	0.111791	4.1917	0.000378	0.015893	0.558582	0.0285	0.977558
K/L Ratio	0.110240	0.068919	1.5996	0.123961	1.776117	0.318340	5.5793	0.000013
Model	$L_P = a_0 + a_1(K/L) + u$; See=standard error				$L_P = b_0 + b_1 \ln(K/L) + v$; See=standard error			

VII. Considering Variable Elasticity of Substitution and Returns to Scale: Now we turn to substitution of capital for labour more systematically. We use the Constant Marginal Share (CMS) production function of Bruno (1968) specified as $NVA = AK^{\alpha}L^{1-\alpha} - mL$ or $NVA/L = A(K/L)^{\alpha} - m$, which implies that productivity of labour increases with capital-labour ratio at a decreasing rate. The CMS production function contains the linear production function as a special case. It defines the elasticity of substitution, $\sigma = 1 - [m\alpha/(1-\alpha)](L/NVA)$. When the output-labour ratio increases (e.g. with economic growth), the elasticity of substitution in this function tends to unity and thus the CMS tends to the Cobb-Douglas production function.

We apply Zellner-Revankar (ZR) generalization on Bruno's production function to permit variability to returns to scale and elasticity of substitution. In the ZR generalization, Bruno function takes the form as $NVA\exp(\theta NVA) = AK^{\rho\alpha}L^{\rho(1-\alpha)} - mL$. We have estimated the Bruno-Zellner-Revankar model separately for 1990-91 and 2003-04 as well as jointly for both time points. The estimated parameters of these production functions are presented in Table-V. The jointly estimated NVA and elasticity of substitution and returns-to-scale functions are presented in Table-VI. The observed and estimated NVA are presented in Fig.I-A (estimated separately) and Fig.I-B (estimated jointly) for visualization of the fit of these models. We find that the output elasticity of capital during 1990-2004 has been substantial. The efficiency factor (that captures effects of technical progress) has been significant. As it has been mentioned earlier, the technical progress has been assumed to be Hicks-neutral. We have not considered biased technical progress in the present study although it has evidently been significant. Elasticities of

substitution and returns to scale estimated separately and jointly are presented in fig.II-A and Fig.II-B respectively.

In the estimates of Bruno's function (Table-V) the value of m is positive for 1990-91 as well as 2003-04. Secondly, the capital elasticity of production (α) in 1990-91 was 0.23, which increased to 0.74 in 2003-04. In Bruno-Zellner-Revankar estimates, the value of m increased so as to alter its sign. The capital elasticities of production in Bruno and Bruno-ZR are comparable for 1990-91. But they are quite different for 2003-04, although in both estimates they are larger than those in 1990-91. The returns-to-scale parameter (ρ) has appreciated in 2003-04.

Table-V: Estimated Parameters of Bruno and Bruno-Zellner-Revankar Production Functions

Year	A	α	m	ρ	θ	$\ln(l^*)$	R^2	Model
1990-91	0.028568	0.2338961	0.0042499	-	-	-	0.86009	Bruno *
2003-04	0.229756	0.7410565	0.0024374	-	-	-	0.95089	
1990-91	0.390938	0.2471963	-0.0002339	0.7102755	-7.8827266E-05	-179.25	0.98247	Bruno & ZR **
2003-04	0.852339	0.3397814	0.0135536	0.8096587	-2.0072827E-05	-203.78	0.99116	
1990-04	2.760090	0.8822494	0.0001732	0.7588309	-1.8943993E-05	-431.59	0.97836	

* Estimated by Least Squares; ** Estimated by Max Likelihood maximizing iterated Least Squares (Zellner & Revankar, 1969)

Table-VI: Net Value Added (Observed and Expected) for Bruno and Bruno-Zellner-Revankar Production Functions and their Elasticity of Substitution and Returns-to-Scale Functions (Joint 1990-2004)

States/Uninon Territories	Obse-rved	Bruno (1990-91)		Bruno-Zellner-Revankar (1990-91)			Obse-rved	Bruno (2003-04)		Bruno-Zellner-Revankar (2003-04)		
		Est(B)	$\sigma(B)$	Est (BZR)	$\sigma(BZR)$	$\rho(BZR)$		Est(B)	$\sigma(B)$	Est (BZR)	$\sigma(BZR)$	$\rho(BZR)$
Andhra P	2981	5866.717	0.638	6229.519	0.638	0.804	13375	16033.290	0.549	12898.405	0.916	1.016
Assam	734	583.650	0.807	802.441	0.807	0.770	3741	2927.385	0.787	3032.658	0.960	0.817
Bihar & JH	2598	2555.174	0.820	3326.246	0.820	0.798	8773	7655.300	0.839	7142.830	0.970	0.910
Chandigarh	70	42.129	0.774	79.803	0.774	0.760	164	149.108	0.620	290.263	0.929	0.761
HNH	73	41.169	0.899	143.258	0.899	0.760	2801	1904.690	0.871	2216.778	0.976	0.801
DD	14	14.608	0.755	50.249	0.755	0.759	2335	1131.004	0.821	1410.266	0.967	0.794
Delhi	1016	637.613	0.815	735.300	0.815	0.774	2024	1082.765	0.602	1343.076	0.926	0.789
Goa	158	108.401	0.858	257.389	0.858	0.761	2288	1442.808	0.895	1801.140	0.980	0.793
Gujarat	4468	4802.320	0.804	5560.885	0.804	0.829	28865	32529.370	0.824	31777.784	0.967	1.674
Haryana	1636	1607.928	0.799	2057.025	0.799	0.783	9143	6876.031	0.757	6335.088	0.955	0.918
Himachal	378	391.457	0.816	798.723	0.816	0.764	1750	2036.235	0.854	2383.608	0.973	0.785
J&K	76	53.888	0.768	104.544	0.768	0.760	188	198.546	0.000	364.286	0.814	0.762
Karnataka	2769	2436.453	0.804	2635.133	0.804	0.801	13844	14980.070	0.744	12777.405	0.952	1.029
Kerala	1222	1476.780	0.711	1648.316	0.711	0.777	4091	3511.752	0.460	3387.070	0.900	0.823
MP & C	3007	3243.764	0.820	4442.408	0.820	0.805	10633	9409.450	0.794	8467.418	0.962	0.950
Maharashtra	12004	8546.112	0.866	9580.052	0.866	0.982	41910	34800.580	0.815	41346.706	0.966	3.683
Orissa	1153	1290.739	0.828	2343.661	0.828	0.776	3215	5988.397	0.729	5465.330	0.950	0.808
Pondicherry	97	115.757	0.710	233.583	0.710	0.760	1989	1007.243	0.862	1307.148	0.974	0.789
Punjab	1857	2525.893	0.720	2876.855	0.720	0.787	5314	4572.129	0.558	4240.011	0.918	0.844
Rajasthan	1556	1771.331	0.799	2567.653	0.799	0.782	5173	6157.933	0.669	5461.920	0.938	0.841
Tamil Nadu	5793	5649.545	0.784	5294.811	0.784	0.852	19101	21723.040	0.575	18088.907	0.921	1.189
UP & Utt	4625	5525.941	0.779	6099.747	0.779	0.832	14163	14330.530	0.699	12207.824	0.944	1.037
West Bengal	3198	4293.413	0.699	4051.944	0.699	0.808	7903	10977.590	0.545	8806.268	0.915	0.892
Others	34	166.742	0.000	361.143	0.000	0.759	149	144.020	0.015	287.157	0.817	0.761

B=Bruno; ZR=Zellner-Revankar; BZR=Zellner-Revanker generlization of Bruno's CMS; Est=Estimated

A perusal of Fig.II-A (individually estimated) indicates that for most of the industrially developed states, the elasticity of substitution function has shown a decline, which is quite large in Delhi, Kerala, Tamilnadu, Punjab and West Bengal. Gujarat is a notable exception to this general tendency. However, Fig.II-B (jointly estimated) gives a quite different picture. The elasticity of substitution in all states has appreciated. In the joint estimation the efficiency parameter is quite large in comparison to those in separate estimation. It appears that the elasticities and technical progress have not been independent and therefore a trade off has taken place between the efficiency and the substitution parameters.

Fig.-I-A: Observed & Expected NVA by Bruno and Bruno-Zellner-Revamkar Functions - 1990-91 & 2003-04 (Indiv)

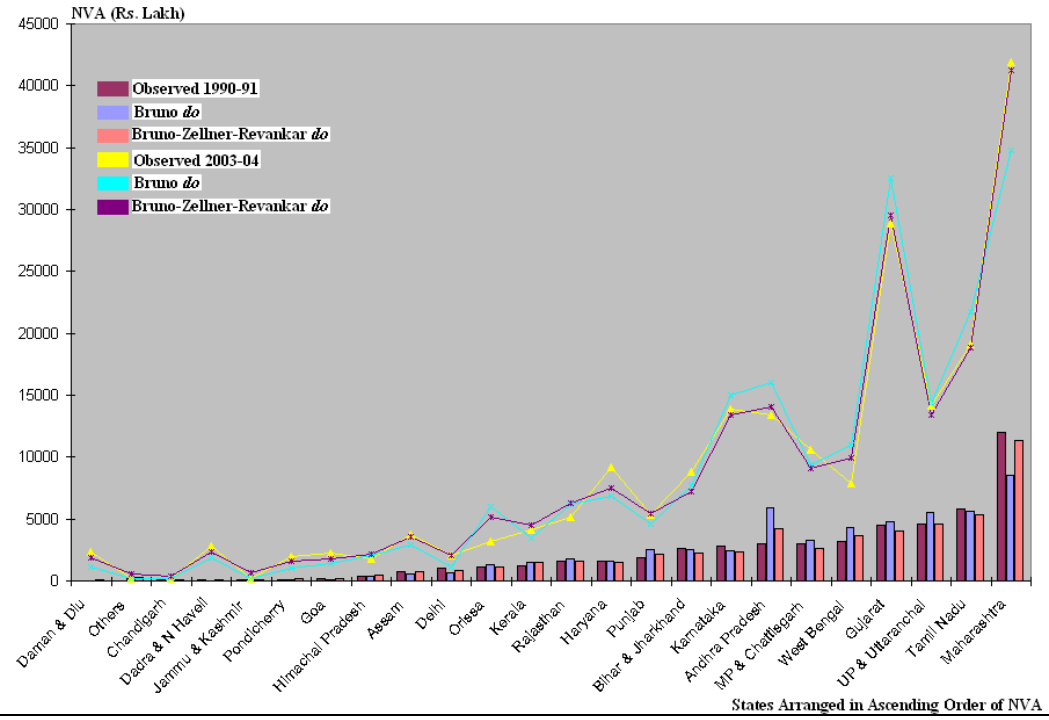


Fig.-I-B: Observed & Expected NVA by Bruno and Bruno-Zellner-Revamkar Functions - 1990-2004 (Joint)

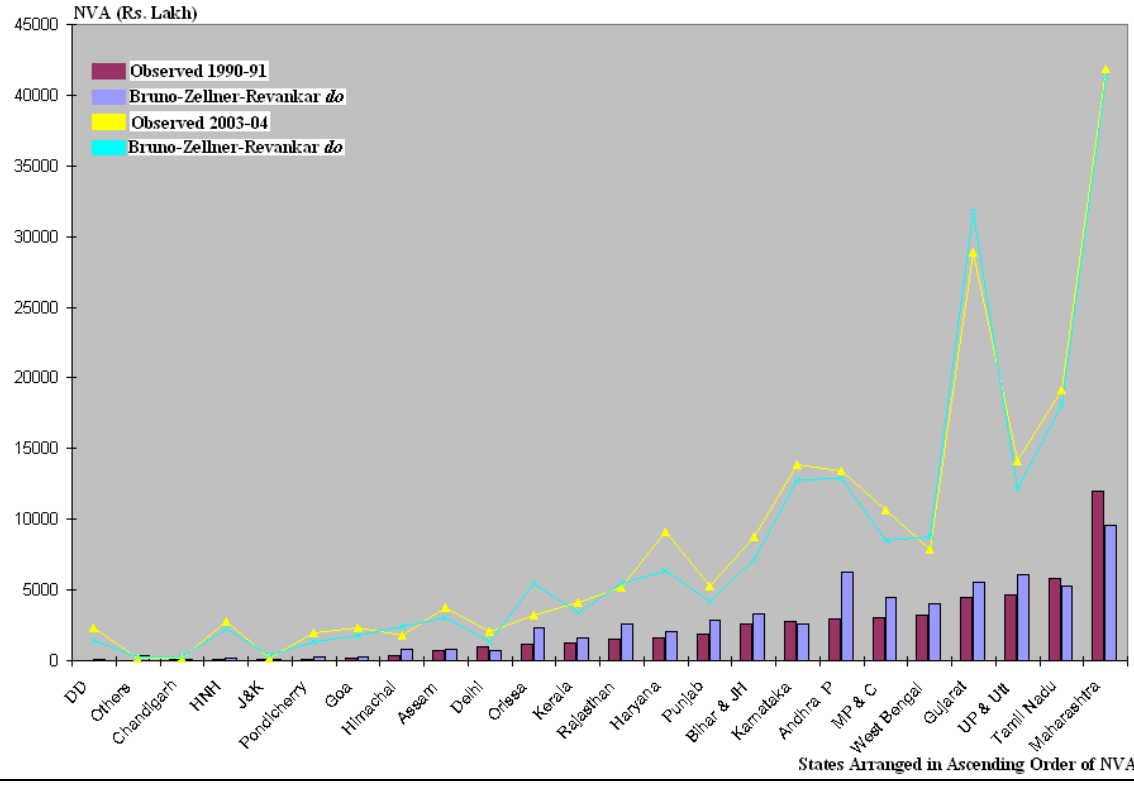


Fig.-II-A: Elasticity of Substitution and Returns-to-Scale functions Estimated by Bruno and Bruno-Zellner-Revamkar Production Functions - 1990-91 & 2003-04 (indiv)

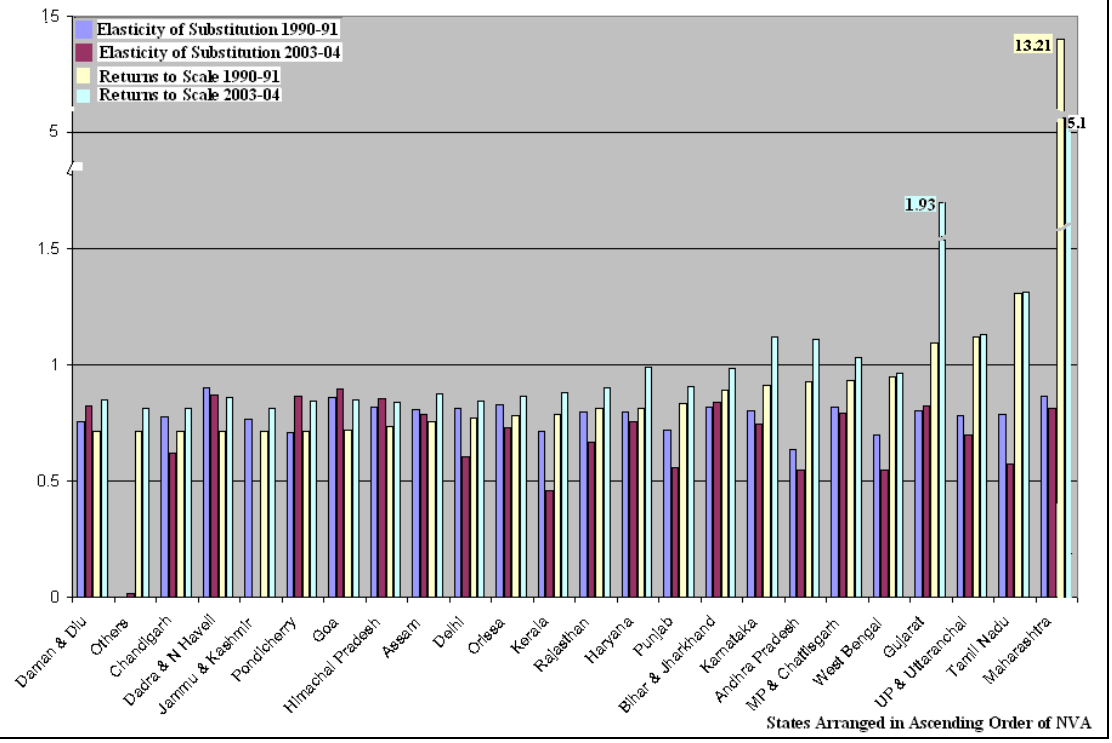
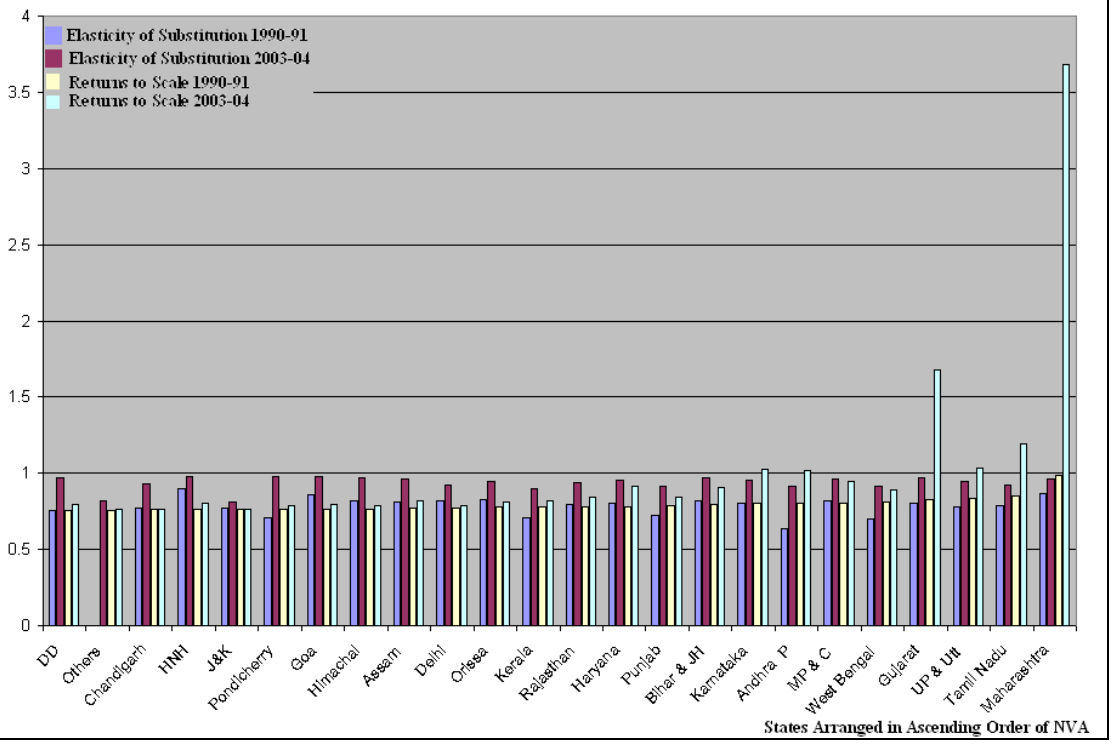


Fig.-II-B: Elasticity of Substitution and Returns-to-Scale functions Estimated by Bruno and Bruno-Zellner-Revamkar Production Functions – 1990-2004 (joint)



In separately estimated cases, returns-to-scale has appreciated in most of the states - Gujarat, Haryana, Andhra and Karnataka in particular. A large decline in Maharashtra is conspicuous. In the jointly estimated case, the returns to scale have appreciated largely in Maharashtra, Gujarat, Tamilnadu, Karnatataka, Andhra , UPU and Haryana.

VIII. Factors of Structural Changes in Industrial Sector: Now we apply factor analysis to the indicators of structural changes in the industrial sector brought about by globalization and liberalization. The objective is to obtain such factors which are linearly independent of each other and represent the indicators sufficiently well. As it has been hinted at earlier, we have used seven indicators: [1] L-N (labour per factory), [2] K-N (capital per factory), [3] O-N (output per factory which is the net value added per factory), [4] K-L (capital-labour ratio), [5] P-N (population-weighted changes in the number of factories), [6] the elasticity of substitution, and [7] returns to scale.

Table-VII. Factor Loadings (Varimax normalized) : Extraction Method: Principal components

Indicators	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5
Labour/Factory (L_N)	0.034145	0.145015	0.120902	0.011475	0.981137
Capital/Factory (K_N)	0.984266	-0.005979	0.053340	-0.010165	0.118699
Capital-Labour Ratio (K_L)	0.985717	-0.040851	-0.000744	-0.003212	-0.114530
NVA/Factory (O_N)	0.971113	-0.115304	0.016532	0.037658	0.051283
Substitution Elasticity (S) indiv	-0.094158	0.981776	-0.065994	0.041864	0.143813
Returns to Scale (R) indiv	0.013971	0.039776	0.041253	0.998151	0.010940
NFact P-weighted (P_N)	-0.036488	0.064353	-0.989466	-0.042363	-0.116870
Explained Variance	2.895035	1.005637	1.002835	1.001516	1.026927
Proportion to Total	0.413576	0.143662	0.143262	0.143074	0.146704

Table-VIII. Factor Scores of Indicators of Industrial Structure and Development (R, S indiv)

States/UT	Factor Score 1990-91					Factor Score 2003-04				
	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5
Andhra Pradesh	-0.6996	0.8780	0.5347	-0.2244	-0.7546	-0.0480	-1.1564	0.3082	-0.0386	-0.2992
Assam	-0.7572	0.6938	0.4307	-0.2963	-0.0880	0.7735	-0.1621	0.2869	-0.2061	0.1138
Bihar & Jharkhand	-0.3927	0.5232	0.2476	-0.2338	1.3016	1.8190	0.1821	0.2983	-0.1732	-0.0957
Chandigarh	-0.9485	0.8652	0.6134	-0.3183	-1.2296	-0.4110	-0.7060	0.5000	-0.2117	-1.3412
Dadra & N Haveli	-0.5211	0.6771	-1.5229	-0.2342	-0.8396	1.3730	0.2203	-1.6734	-0.1568	-0.4999
Daman & Diu	-0.7536	0.4324	-4.2787	-0.1231	-0.2524	-0.0582	-0.2986	-4.3379	-0.0218	-0.4469
Delhi	-0.8903	0.8562	0.5932	-0.2867	-1.2095	-0.7582	-0.8386	0.4758	-0.1860	-1.1978
Goa	-0.5635	0.6077	0.0016	-0.2975	0.2948	1.9065	0.4857	-0.0141	-0.2551	-0.4091
Gujarat	-0.6020	0.7818	0.4340	-0.1255	-0.4547	1.8797	0.2524	0.3151	0.3078	-0.6897
Haryana	-0.6221	0.6434	0.3177	-0.2686	0.3834	0.4424	-0.3400	0.2213	-0.1326	0.2336
Himachal Pradesh	0.0372	0.0373	-0.2547	-0.3218	4.6816	2.9985	0.5068	0.2728	-0.3310	-0.2534
Jammu & Kashmir	-0.9009	0.7694	0.4930	-0.3156	-0.5795	-0.8273	-3.7003	0.0198	-0.0963	0.9180
Karnataka	-0.7176	0.6988	0.3970	-0.2154	-0.0708	1.0910	-0.3208	0.2320	-0.0700	0.1023
Kerala	-0.7899	0.6710	0.2505	-0.2798	0.2229	-0.5718	-1.5872	0.1431	-0.1334	-0.2223
MP & Chattisgarh	-0.2584	0.5518	0.2261	-0.2222	1.2798	1.1759	-0.1083	0.2492	-0.1282	0.1346
Maharashtra	-0.5280	0.3644	0.0767	6.3714	0.2644	1.0767	-0.0430	0.2340	2.0443	-0.2994
Orissa	-0.0962	0.5867	0.2476	-0.3128	1.2437	2.6037	-0.1689	0.2322	-0.2634	0.1206
Pondicherry	-0.7615	0.5548	-0.1397	-0.3030	0.8563	0.6566	0.1681	-0.1010	-0.2173	-0.2072
Punjab	-0.7365	0.7817	0.4435	-0.2659	-0.3570	-0.4582	-1.0899	0.3395	-0.1442	-0.6596
Rajasthan	-0.5268	0.7378	0.3946	-0.2818	-0.0549	0.2469	-0.5133	0.3792	-0.1738	-0.9627
Tamil Nadu	-0.7426	0.7154	0.2704	0.0014	-0.2540	-0.0415	-1.0583	0.1329	0.0749	-0.3311
UP & Uttaranchal	-0.5793	0.7070	0.4054	-0.1168	0.0978	0.3948	-0.4978	0.3249	-0.0540	-0.2815
West Bengal	-0.6375	0.3712	0.1109	-0.2007	2.3416	0.5221	-1.3224	0.1252	-0.1135	0.8707
Others	-0.8057	1.0046	0.5164	-0.3458	-0.5590	-0.9918	-3.4143	0.2269	-0.1025	-0.5610
Production function estimated for 1990-91 and 2003-04 separately										

Table-IX. Factor Loadings (Varimax normalized) : Extraction Method: Principal components					
Indicators	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5
Labour/Factory (L_N)	0.036925	0.990533	-0.034378	0.113735	-0.054701
Capital/Factory (K_N)	0.973649	0.125085	0.070773	0.051226	0.135196
Capital-Labour Ratio (K_L)	0.969429	-0.108722	0.105504	-0.001470	0.160116
NVA/Factory (O_N)	0.924715	0.052687	0.150714	0.030086	0.289474
Substitution Elasticity (S) joint	0.351826	-0.067506	0.081985	-0.051535	0.928045
Returns to Scale (R) joint	0.164116	-0.035173	0.981862	0.048082	0.072997
NFact P-weighted (P_N)	-0.040353	-0.112838	-0.046789	-0.990823	0.041393
Explained Variance	2.896588	1.029924	1.013000	1.003166	0.999011
Proportion to Total	0.413798	0.147132	0.144714	0.143309	0.142716

Factor analysis has been done twice; first using the separately estimated elasticities of substitution and returns to scale and then using the jointly estimated ones, together with other five indicators. In both cases, we identify five factors. The first factor loads heavily on three indicators; K-N, K-L and O-N. In both exercises, this factor explains nearly 41 percent of variation. We may identify this factor as 'productivity due to capital deepening' or *pkd*. The other factors load on single indicators each – and may be identified easily with substitution, returns to scale, labour-intensiveness and population weighted increase in number of factories. Each of them explains almost same percentage of variation – about 14 to 15 percent. Findings of factor analysis are almost identical for both cases – when production functions are estimated separately and when they are estimated jointly.

Table-X. Factor Scores of Indicators of Industrial Structure and Development (R, S joint)										
States/UT	Factor Score 1990-91					Factor Score 2003-04				
	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5
Andhra Pradesh	-0.4790	-0.6806	-0.1150	0.3929	-1.3136	-0.1169	-0.4359	0.2061	0.4130	0.5262
Assam	-0.8162	0.0169	-0.2059	0.3821	0.0922	0.6983	0.1008	-0.3710	0.3452	0.6509
Bihar & Jharkhand	-0.4435	1.3697	-0.1518	0.2152	0.1056	1.8173	-0.0727	-0.3127	0.3071	0.2878
Chandigarh	-0.9629	-1.1005	-0.2360	0.5349	-0.1558	-0.4759	-1.4131	-0.3964	0.5885	0.7126
Dadra & N Haveli	-0.6395	-0.7232	-0.2248	-1.5521	0.4926	1.3760	-0.4795	-0.4208	-1.6634	0.3329
Daman & Diu	-0.6479	-0.2453	0.0118	-4.3395	-0.6482	-0.1417	-0.4893	-0.0955	-4.2774	0.6304
Delhi	-0.9615	-1.0666	-0.2245	0.5286	0.1286	-0.8620	-1.2794	-0.2742	0.5780	0.8307
Goa	-0.6763	0.3940	-0.2359	-0.0204	0.4086	1.9450	-0.3515	-0.6129	-0.0334	0.2437
Gujarat	-0.6290	-0.3343	-0.1104	0.3633	-0.0746	1.7646	-0.5775	1.4559	0.2162	-0.0206
Haryana	-0.6552	0.4719	-0.1758	0.2669	-0.0148	0.3229	0.2104	-0.0747	0.2867	0.7218
Himachal Pradesh	0.0030	4.6383	-0.1640	-0.2316	0.1366	3.2465	-0.2318	-0.8591	0.1980	-0.3956
Jammu & Kashmir	-0.9110	-0.4722	-0.2120	0.4242	-0.1747	-0.6369	0.3376	-0.2387	0.3324	0.1004
Karnataka	-0.7697	0.0354	-0.1365	0.3438	0.0338	1.0261	0.0736	0.0893	0.2762	0.4307
Kerala	-0.7075	0.2868	-0.1361	0.1674	-0.6276	-0.6010	-0.4383	-0.1710	0.2999	0.6073
MP & Chattisgarh	-0.2836	1.3482	-0.1650	0.1833	0.0196	1.1096	0.1317	-0.1092	0.2871	0.4906
Maharashtra	-0.6340	0.3990	0.2514	0.3199	0.4136	0.3705	0.0011	6.4003	0.0231	0.1284
Orissa	-0.0969	1.3116	-0.2717	0.1966	-0.0125	2.8222	0.0426	-0.7030	0.2342	-0.2915
Pondicherry	-0.6758	0.8937	-0.1382	-0.2094	-0.6186	0.5496	-0.1647	-0.4127	-0.0660	0.7494
Punjab	-0.6502	-0.2698	-0.1575	0.3464	-0.6339	-0.5279	-0.7895	-0.1608	0.4558	0.6844
Rajasthan	-0.5307	0.0466	-0.2193	0.3252	-0.1157	0.2022	-1.0147	-0.2805	0.4440	0.5521
Tamil Nadu	-0.7714	-0.1455	-0.0057	0.2086	-0.1391	-0.1603	-0.4343	0.6246	0.2145	0.5239
UP & Uttaranchal	-0.5743	0.1943	-0.0804	0.3350	-0.2360	0.2858	-0.3166	0.1925	0.3812	0.5877
West Bengal	-0.5554	2.3444	-0.0074	0.0582	-0.6371	0.5197	0.6716	-0.1213	0.2642	0.4307
Others	0.3370	-0.7091	0.0341	0.1491	-6.0171	-0.8020	-1.0842	-0.2779	0.5065	0.0729
Production function estimated for 1990-91 and 2003-04 jointly										

IX. A Study of Regional Variations and Inequality: We propose to measure the degree of inequality in distribution of factor scores of industrial structure and development obtained above by a few measures that we would like first to describe. Among the measures of dispersion we have two popular measures: the one that is based on the Euclidean norm (called standard deviation) and the other that is based on the absolute norm. The general formula for these measures is:

$$d_L = \left(\frac{1}{n^2} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \left| Z_i - Z_j \right|^L \right)^{1/L}$$

For $L = 2$, we have the measure $d_2 / \overline{z}$ (coefficient of variation) and for $L = 1$ we have $d_1 / \overline{z}$ (Gini coefficient). Here $\overline{z} = mean(Z) = (1/n) \sum_{i=1}^{n} Z_i$. Since both these measures have mean in their denominator, they are liable to misguide us when some values of Z are negative and others positive. Consider a case when some values of Z are negative and others positive such that mean is very small (or zero, say). Then these measures would not be of any use to measure absolute inequality. Yet these measures can be used for measuring relative inequality.

In the present case, each factor extracted by us has mean, say, μ_a for 1990-91 and μ_b for 2003-04. Moreover, $\mu_a = -\mu_b$ such that the overall mean of the factor is zero. Therefore, the relative measure of inequality is simply the ratio of d values for 1990-91 to that for 2003-04. If this ratio is less than unity, we infer that inequality has increased and vice versa. Another measure of inequality may be the relative range. In Table-XI we present such measures of inequality.

Table-XI. Measures of Relative Inequality of Factors of Industrial Structure and Growth

Estimation method	Year	pkd	S	P-N	R	L-N
Mean absolute Deviation Estimated Separately (ES)	1990-91	0.1251	0.1066	0.3524	0.3037	0.6132
	2003-04	0.6053	0.5211	0.3171	0.1450	0.2856
	Relative	0.2067	0.2045	1.1113	2.0940	2.1470
Mean absolute Deviation Estimated jointly (JS)	1990-91	0.1516	0.4391	0.3374	0.0584	0.6043
	2003-04	0.6109	0.1744	0.3320	0.4678	0.2822
	Relative	0.2481	2.5183	1.0162	0.1248	2.1414
Range (ES)	Relative	0.2470	0.2299	1.0112	2.8279	2.6165
Range (JS)	Relative	0.3164	5.3084	1.0017	0.0721	2.7528

We observe that the results based on separate estimation of parameters of substitution and returns to scale are quite at variance with those based on the joint estimation. Yet, if we go by the first factor (*pkd*) that explains the maximum variance, inequality has increased. There in no dominance of other factors among themselves as each one explains 14 to 15 percent of variations. Hence, they may be considered equally representative. Among them, the L-N and P-N factors suggest that inequality has decreased. Population-weighted growth of factories and reduction of employment in the factory sector have reduced inequality among the states in their respective spheres.

Regarding returns to scale we note that the separately estimated returns to scale function of Maharashtra is unduly large (Fig.-II-A). This state is in fact an outlier in the analysis that might have pulled the parameters in its favour (since the least squares

estimator is disturbed by the presence of outliers). It might have had impacts on the estimated substitution function also. On the other hand, in the joint estimation procedure, Maharashtra does not appear to have disturbed the estimated parameters very much. If our argument is valid, then we accept the jointly estimated parameters and factors based on them. Then in matters of substitution of capital for labour, inequalities have decreased. It goes well with a decrease in inequality in L-N. Consistent with this is the increase in inequality in returns to scale. Such a conclusion is also consistent with increase in inequality in the *pkd* factor.

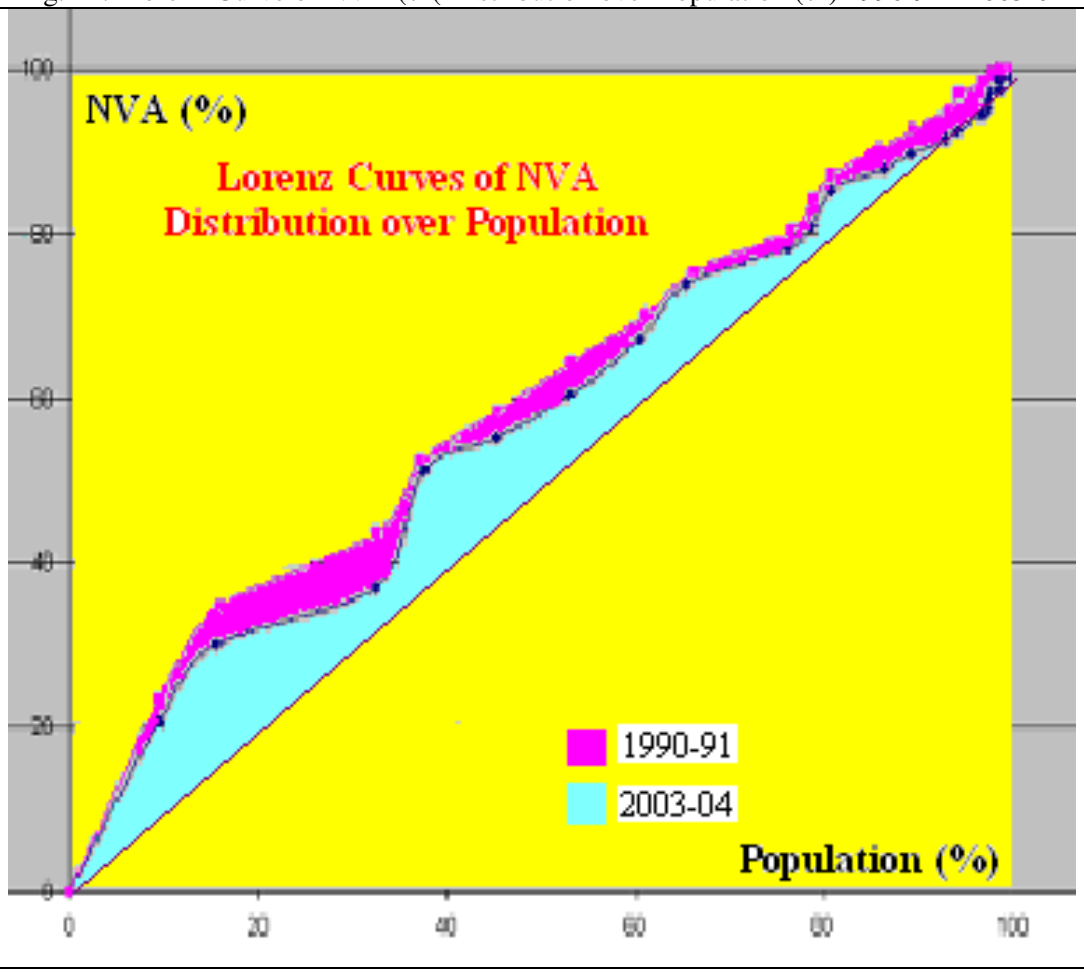
Table-XII. Cumulative variation in NVA and Population – 1990-91 – 2003-04

States/UT	Net Value Added*		Cumulative NVA*		Cum NVA Commanded #		Cum Population #	
	1990-91	2003-04	1990-91	2003-04	1990-91	2003-04	1990-91	2003-04
Maharashtra	12004	41910	12004	41910	23.301	20.652	9.327	9.440
Tamil Nadu	5793	19101	17797	61011	34.546	30.065	15.927	15.382
UP & Uttaranchal	4625	14163	22422	75174	43.523	37.044	32.364	32.493
Gujarat	4468	28865	26890	104039	52.196	51.268	37.245	37.429
West Bengal	3198	7903	30088	111942	58.404	55.162	45.288	45.166
MP & Chattisgarh	3007	10633	33095	122575	64.241	60.402	53.108	53.075
Andhra Pradesh	2981	13375	36076	135950	70.027	66.993	60.966	60.379
Karnataka	2769	13844	38845	149794	75.402	73.815	66.281	65.476
Bihar & Jharkhand	2598	8773	41443	158567	80.445	78.138	76.486	76.277
Punjab	1857	5314	43300	163881	84.050	80.756	78.883	78.639
Haryana	1636	9143	44936	173024	87.226	85.262	80.828	80.721
Rajasthan	1556	5173	46492	178197	90.246	87.811	86.028	86.283
Kerala	1222	4091	47714	182288	92.618	89.827	89.466	89.298
Orissa	1153	3215	48867	185503	94.856	91.411	93.207	92.838
Delhi	1016	2024	49883	187527	96.828	92.408	94.320	94.239
Assam	734	3741	50617	191268	98.253	94.252	96.968	96.817
Himachal Pradesh	378	1750	50995	193018	98.987	95.114	97.579	97.404
Goa	158	2288	51153	195306	99.293	96.242	97.717	97.533
Pondicherry	97	1989	51250	197295	99.482	97.222	97.813	97.628
Jammu & Kashmir	76	188	51326	197483	99.629	97.314	98.725	98.631
Dadra & N Haveli	73	2801	51399	200284	99.771	98.695	98.741	98.654
Chandigarh	70	164	51469	200448	99.907	98.775	98.817	98.744
Others	34	149	51503	200597	99.973	98.849	99.988	99.984
Daman & Diu	14	2335	51517	202932	100.000	100.000	100.000	100.000
India	51517	202933	51517	202933	100.000	100.000	100.000	100.000

* in Rs. Crores; # in percentage to total (India)

X. Concluding Remarks: Our analysis has indicated that in matters of capital deepening and output growth in the factory sector regional inequalities have increased. Many less industrialized states (in relative sense) have shed labour force employed in their factories and thus have come closer to the more industrialized states in the proportionate employment of labour to capital. This phenomenon has reduced the inequality. The elasticity of substitution moves closer to unity with industrial development. This tendency has been observed. Increase in inequality in returns to scale has only supported these tendencies.

Fig.-III. Lorenz Curve of NVA (%(Distribution over Population (%) 1990-91 - 2003-04



Our conclusions may, however, be looked in the light of those criticisms that are put forth against the use of an aggregate production function (see Felipe, Fisher, Pressman, Shaikh, etc.). They have shown almost conclusively that aggregate production functions cannot be used at all. On the other hand, use of the aggregate production function as the surrogate production function (Samuelson, 1962) has been in practice. Until the critics provide an alternative method to do what the aggregate production function purports to do, its use will continue. Our exercise may be taken in that spirit.

In measuring inequality or distributive justice we have applied the criteria that goes with Mill's concept of justice – the greatest good of the greatest number. However, there are other concepts of justice. In the sense of John Rawls, justice means improvement for the most deprived ones. Viewed accordingly, several states/Union Territories with small NVA and lower industrial development have come up very fast. However, in the category of 'others', we have a number of states (especially in the North Eastern Region) that might not have come up to any measure. We do not have detailed information regarding those states. Thus we cannot assert that globalization and

liberalization have delivered justice in the Rawls' sense. Percentage shares and growth are illusive in nature (see Table-XII, Fig.-III). A small increase is large in percentage if the base is small. Of course, some part of the fruits of industrialization has definitely gone to the less developed states, but a greater part of the benefit has gone to the industrially developed states with rich physical and social infrastructure and this is quite in the line of Nietzsche. Nietzsche (1879) in his *Human, All Too Human* (section 92) writes:

> *"Justice (fairness) originates among those who are approximately equally powerful, … where there is no clearly recognizable predominance and a fight would mean inconclusive mutual damage, there the idea originates that one might come to an understanding and negotiate one's claims: the initial character of justice is the character of a trade. Each satisfies the other inasmuch as each receives what he esteems more than the other does. One gives another what he wants, so that it becomes his, and in return one receives what one wants. Thus justice is repayment and exchange on the assumption of an approximately equal power position; revenge originally belongs in the domain of justice, being an exchange. Gratitude, too."*

Hence, globalization has been quite just to those states that can negotiate. After all, why should one get a share in the gains that one has not earned by employing one's resources, physical or intellectual, and why the ethic of the servile should dictate the fate of the efficient, intelligent and masters? Why should the herd rule the heroes? Why should a lame, laden on the back of a runner, look to his laurels?

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