IV. RESULTS AND DISCUSSION

The results of the study on "**Analysis of Manufacturing Sector in the Southern States of India Before and After Economic Reforms**" are discussed under the following heads:

A. Efficiency Analysis

a. Technical Efficiency

b. Scale Efficiency

c. Cost Efficiency

d. Allocative Efficiency

B. Decomposition of Total Factor Productivity Growth

C. Relation among Real Wages, Inflation and Productivity

D. Production Function Estimates

A. Efficiency Analysis

There are four basic forms of efficiency, viz., technical, scale, cost and allocative efficiencies. These efficiency measures were derived by using DEA model. An important point to be remembered here regarding returns to scale of the industries is that, while production function estimates the same over years, DEA estimates scale score each year. Technical and scale efficiency were investigated taking into account gross output as dependent variable and number of workers and fixed capital as independent variables. Level of efficiency is discussed taking into account the CRS and VRS production technology for the pre and post reform periods, state wise for the reference period under study. Cost and allocative efficiencies were measured taking into account input prices (wage rate and rate of return on capital) in addition to output and input data (labour input and capital input). A value of unity indicates the industry is on the frontier, while a value of less than unity indicates the presence of inefficiency.

a. Technical Efficiency

The technical efficiency scores both under Constant Returns to Scale (CCR model) and Variable Returns to Scale (BCC model) options based on the DEA model are presented in Table-2 and illustrated in Figure-1 for the southern states of India, for the reference

period under study covering pre reform period (1970-71 to 1990-91) and post reform period (1991-92 to 2013-14).

TABLE – 2

TECHNICAL EFFICIENCY (TE) ESTIMATES – PRE REFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1970-71	0.645	1.000	0.658	0.909	0.729	1.000	0.473	0.996	0.847	1.000
1971-72	0.643	0.965	0.813	1.000	0.762	1.000	0.491	0.983	0.814	1.000
1972-73	0.814	1.000	0.817	0.984	0.481	0.838	0.509	1.000	0.900	1.000
1973-74	0.823	1.000	0.778	1.000	0.478	0.825	0.578	0.996	0.729	0.989
1974-75	0.963	1.000	0.836	1.000	0.663	0.835	0.786	1.000	0.881	1.000
1975-76	1.000	1.000	0.793	0.902	0.704	0.862	0.794	0.987	0.952	1.000
1976-77	0.963	0.964	0.777	0.887	0.701	0.848	0.847	0.985	0.929	0.973
1977-78	0.844	0.846	0.824	0.916	0.747	0.877	0.876	0.979	0.902	0.954
1978-79	0.856	0.877	0.806	0.871	0.772	0.892	0.903	0.985	0.956	0.974
1979-80	0.763	0.779	0.828	0.909	0.769	0.874	0.944	1.000	0.914	0.937
1980-81	0.843	0.844	1.000	1.000	0.980	0.995	1.000	1.000	0.983	0.996
1981-82	0.861	0.871	1.000	1.000	1.000	1.000	0.970	0.987	1.000	1.000
1982-83	0.971	0.986	0.976	1.000	0.890	0.928	1.000	1.000	1.000	1.000
1983-84	0.956	0.966	0.957	0.975	0.735	0.887	0.910	0.989	0.927	0.940
1984-85	0.972	0.973	0.941	0.953	0.770	0.903	0.955	0.968	0.952	0.966
1985-86	1.000	1.000	0.896	0.904	0.796	0.966	0.909	0.976	1.000	1.000
1986-87	0.957	0.964	0.902	0.908	0.809	0.987	0.901	0.980	0.996	0.997
1987-88	0.996	1.000	0.884	0.888	0.881	0.944	0.891	0.946	0.982	0.986
1988-89	1.000	1.000	0.869	0.871	1.000	1.000	0.913	0.985	0.992	0.995
1989-90	0.980	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1990-91	1.000	1.000	1.000	1.000	0.905	0.905	1.000	1.000	0.933	0.976
$\overline{X}$	0.898	0.954	0.874	0.947	0.789	0.922	0.840	0.988	0.933	0.985
σ	0.112	0.067	0.094	0.051	0.147	0.064	0.175	0.013	0.071	0.020
C.V	12.53	7.040	10.738	5.415	18.69	6.971	20.774	1.366	7.576	2.081
Average inefficiency	0.114	0.048	0.144	0.056	0.267	0.084	0.190	0.012	0.072	0.015
DMUs	4	10	4	8	3	5	4	7	4	9

Source: Calculations are based on ASI data

Foot note: Average inefficiency = $1-\overline{X}/\overline{X}$

CRS – Constant Returns to Scale

VRS – Variable Returns to Scale

C.V – Co-efficient of Variation

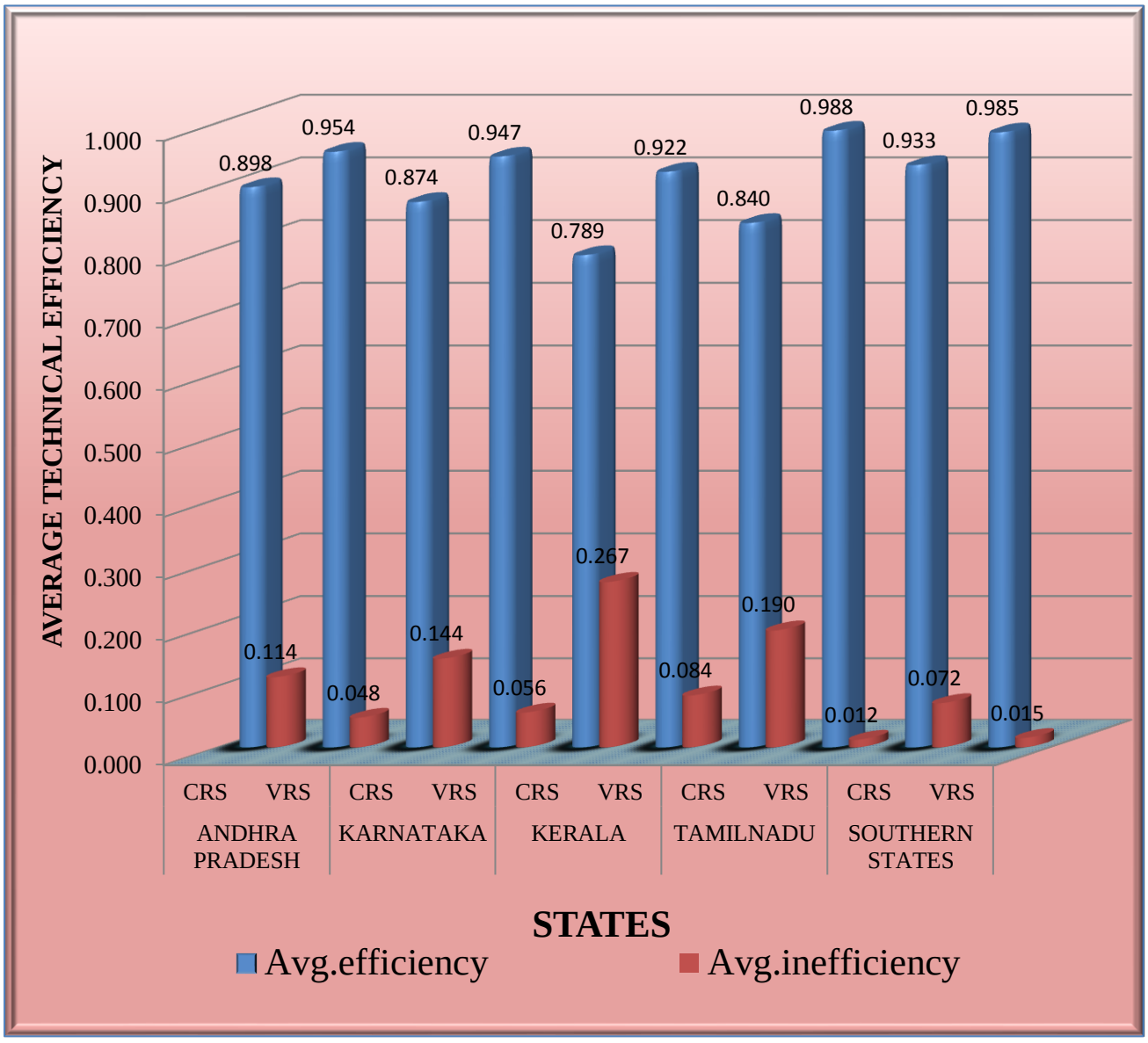
Under Constant Returns to Scale (CRS) production technology, the average efficiency during pre-reform period were 0.898, 0.874, 0.789, 0.840 and 0.933 respectively in the aggregate manufacturing sector of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Southern states as a whole. This implied that the industries producing its output on the efficiency frontier would have needed only 89.8 percent, 87.4 percent, 78.9 percent 84.0 percent and 93.3 percent of the inputs currently being used. In other words, it would have needed 10.2 percent, 12.6 percent, 21.1 percent, 16.0 percent and 6.7 percent more inputs to produce the same output, which meant waste of resources to the extent mentioned above. The average technical inefficiency figures showed that it was the maximum for Kerala (26.7 percent) when it was the minimum for Andhra Pradesh (11.4 percent).The stability in the growth of technical efficiency was little high for Karnataka (10.734 percent), since co-efficient of variation was low for this state and low for Tamil Nadu (20.774 percent) across the states. And it was only (7.576 percent) for the southern states as a whole.

In case of VRS production technology, the average efficiency during pre-reform period were 0.954, 0.947, 0.922, 0.988 and 0.985 respectively in the manufacturing sector of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and southern states as a whole. This implied that the industries producing its output on the efficiency frontier would have needed only 95.4 percent, 94.7 percent, 92.2 percent, 98.8 percent and 98.5 percent respectively of the inputs currently being used. Only negligible percent of waste of resources to the extent of 4.6 percent, 5.3 percent, 7.8 percent, 1.2 percent and 1.5 percent more inputs to produce the same output, which meant waste of resources to the extent mentioned above. The estimates regarding inefficiency showed that it was the maximum again for Kerala (8.4 percent) and minimum for Tamil Nadu (1.2 percent). The stability in the growth of Technical efficiency was high for Tamil Nadu since the magnitude of variability was 1.366 percent; it was low for Andhra Pradesh (7.040 percent).

FIGURE –1

AVERAGE TECHNICAL EFFICIENCY ESTIMATES

(PRE REFORM PERIOD)



It is very clear that under VRS production technology, the number of efficient Decision Making Units (DMUs) exceeded the number of efficient DMUs under CRS production technology. Always under VRS production technology, higher average efficiency was recorded with below 10 percent of variation (C.V). It may be due to the reason that DMUs (years) that were efficient under Constant Returns to Scale (CRS) production technology were accompanied by new efficient DMUs that might operate under increasing or decreasing returns to scale. High degree of average technical inefficiency particularly under Constant Returns to Scale production technology, can be attributable to the fact that the industries may not be using the most efficient technology available to transform the inputs into outputs – due to differences in products produced, the industries were likely to have different best practice frontiers; due to relatively small regional spheres of operation of the industries might have resulted in inefficiencies; and due to structural problems regarding staff efficiency and operating efficiency might have prevented the firm from improving its efficiency level.

The technical efficiency scores both under Constant Returns to Scale (CCR model) and Variable Returns to Scale (BCC model) options based on the DEA model for the post reform period (1991-92 to 2013-14) under study are presented in Table-3 and illustrated in Figure-2 for the southern states of India at the disaggregated and aggregated level.

TABLE – 3

TECHNICAL EFFICIENCY (TE) ESTIMATES– POST REFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1991-92	0.646	0.684	0.997	1.000	0.796	1.000	1.000	1.000	1.000	1.000
1992-93	0.691	0.791	0.909	1.000	0.684	0.870	0.980	0.993	0.977	0.992
1993-94	0.706	0.788	0.846	0.929	0.615	0.915	0.922	0.928	0.917	0.937
1994-95	0.713	0.779	0.853	0.932	0.452	0.771	0.975	1.000	0.881	0.885
1995-96	0.739	0.769	0.869	0.934	0.680	0.866	0.935	1.000	0.946	0.970
1996-97	0.752	0.788	0.779	0.828	0.627	0.867	0.871	0.902	0.902	0.915
1997-98	0.722	0.751	0.732	0.772	0.623	0.796	0.873	0.879	0.846	0.871
1998-99	0.789	0.846	0.740	0.806	0.731	1.000	0.794	0.933	0.875	0.891
1999-00	0.804	0.866	0.713	0.844	0.701	0.942	0.935	0.969	0.905	0.940
2000-01	0.808	0.934	0.722	0.866	0.660	0.913	0.938	1.000	0.888	1.000
2001-02	0.778	0.903	0.819	0.898	0.594	0.884	0.882	1.000	0.868	0.956
2002-03	0.829	0.901	0.881	0.944	0.658	1.000	0.878	0.953	0.921	0.977
2003-04	0.851	0.972	0.941	0.978	0.604	0.959	0.963	0.993	0.958	0.991
2004-05	0.938	1.000	1.000	1.000	0.609	0.978	1.000	1.000	1.000	1.000
2005-06	0.969	1.000	0.976	0.976	0.603	1.000	0.981	0.990	0.983	1.000
2006-07	1.000	1.000	1.000	1.000	0.610	0.995	0.992	0.999	1.000	1.000
2007-08	0.922	0.944	0.939	0.942	0.567	1.000	0.959	1.000	0.957	1.000
2008-09	0.922	0.927	0.862	0.884	0.577	0.926	0.860	0.928	0.893	0.894
2009-10	0.763	0.819	0.821	0.832	1.000	1.000	0.817	0.836	0.981	1.000
2010-11	0.876	1.000	0.841	0.841	0.521	0.926	0.866	0.918	0.870	0.874
2011-12	0.767	1.000	0.932	1.00	0.591	1.00	1.00	1.00	0.919	1.000

				0		0	0	0		
2012-13	0.913	1.000	0.869	0.901	0.636	0.988	0.897	0.933	0.876	0.876
2013-14	1.000	1.000	0.827	0.854	0.624	0.984	0.745	0.749	0.832	0.835
$\overline{X}$	0.822	0.890	0.864	0.911	0.642	0.938	0.916	0.952	0.922	0.948
σ	0.103	0.101	0.089	0.070	0.104	0.068	0.070	0.064	0.052	0.055
C.V	12.595	11.358	10.322	7.789	16.245	7.333	7.734	6.765	5.654	5.846
Average inefficiency	0.217	0.124	0.157	0.098	0.558	0.066	0.092	0.050	0.085	0.055
DMUs	2	7	2	5	1	7	3	8	3	8

Source: Calculations are based on ASI data

Foot note: Average inefficiency = $1-\overline{X}/\overline{X}$

CRS – Constant Returns to Scale

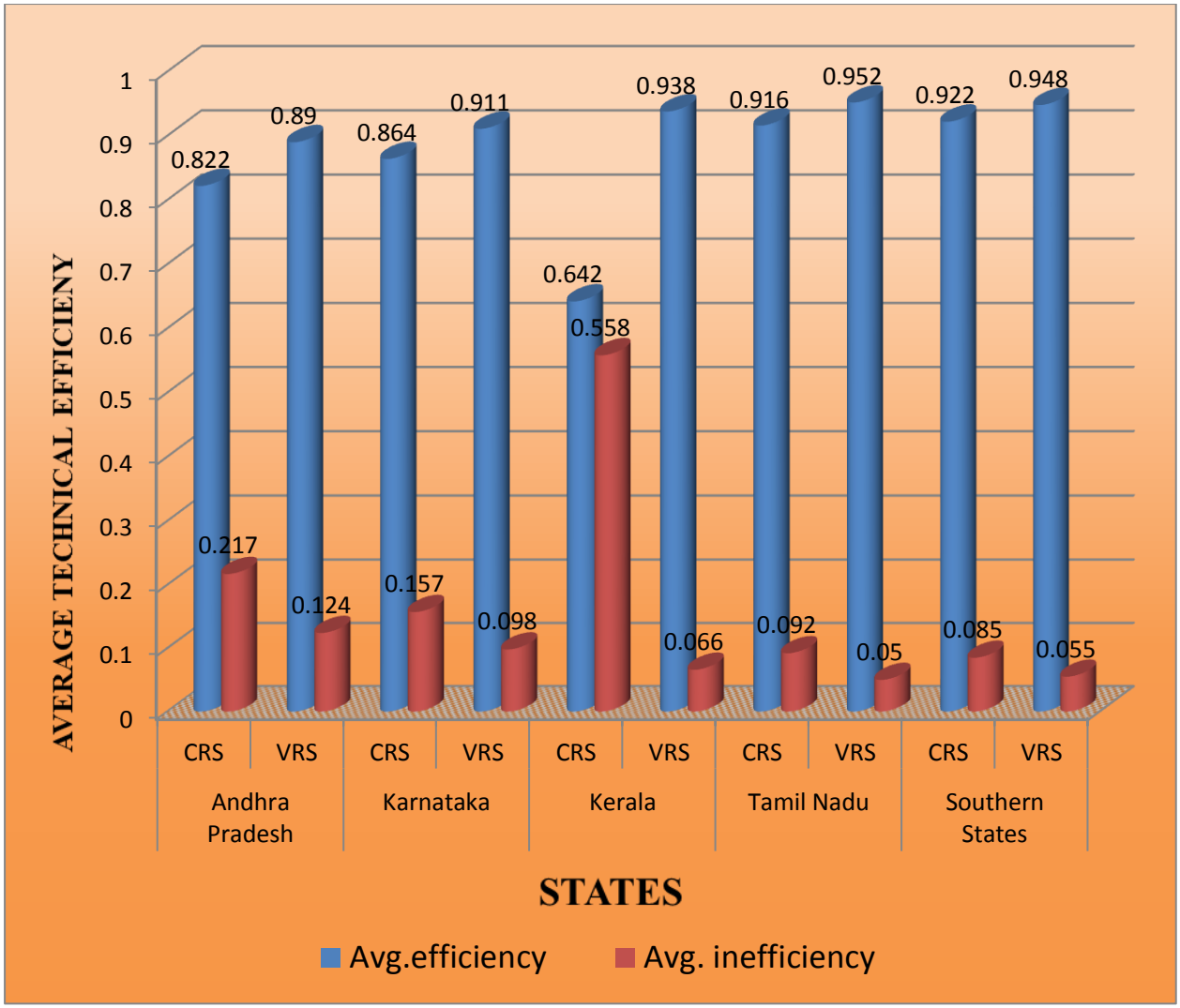
VRS – Variable Returns to Scale

C.V – Co-efficient of Variation

FIGURE – 2

AVERAGE TECHNICAL EFFICIENCY ESTIMATES

(POST REFORM PERIOD)


AVERAGE TECHNICAL EFFICIENY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.822
0.217
0.89
0.124
0.864
0.157
0.911
0.098
0.642
0.558
0.938
0.066
0.916
0.092
0.952
0.05
0.922
0.085
0.948
0.055
CRS
VRS
Andhra Pradesh
Karnataka
Kerala
Tamil Nadu
Southern States
STATES
Avg.efficiency
Avg. inefficiency

During post reform period spreading between 1991-92 and 2013-14, the same trend of greater technical efficiency under CRS production technology was observed for all the states including the whole southern states average efficiency were low in Kerala (64.2 percent) followed by Andhra Pradesh (82.2 percent), Karnataka (86.4 percent), Tamil Nadu (91.6 percent) and southern states (92.2 percent). Inefficiency estimates under CRS production technology was maximum (55.8 percent) for the manufacturing sector of Kerala and minimum (9.2 percent) for Tamil Nadu in disaggregated level. In the case of VRS production technology, the percentage of technical inefficiency recorded more (12.4 percent) for the manufacturing sector of Andhra Pradesh and minimum technical inefficiency (5 percent) was observed for the state of Tamil Nadu. At aggregate level is observed inefficiency estimates CRS production technology and VRS production technology as (0.085) and (0.055). The Instability Index (C.V) explained the fact that stability in the growth of technical efficiency was high for Tamil Nadu (7.734 percent) and low for Kerala (16.245 percent) under CRS production technology and (5.654 percent) for southern states as a whole.

Hence, it could be concluded that though the efficiency of the firms varied considerably on account of various reasons mentioned, all the firms were estimated to be on the frontier at least once. In other words, both under CRS and VRS technology, the number of inefficiency scores exceeded the number of efficiency scores or levels during the entire period (pre and post reform), which was indicative of the fact that the efficiency of firms were not strongly influenced by the size of production.

b. Scale Efficiency

Table-4 presents details regarding pre reform period scale efficiency scores of manufacturing sector of the southern states of India along with the average efficiency score, average inefficiency score and returns to scale which forms the basis to understand to scale efficiency of the firms. Figure-3 illustrates the same.

TABLE – 4

SCALE EFFICIENCY (SE) ESTIMATES –PRE REFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	Score	RTS	Score	RTS	Score	RTS	Score	RTS	Score	RTS
1970-71	0.645	IRS	0.724	IRS	0.729	IRS	0.475	IRS	0.847	IRS
1971-72	0.666	IRS	0.813	IRS	0.762	IRS	0.499	IRS	0.814	DRS
1972-73	0.814	IRS	0.831	IRS	0.574	DRS	0.509	IRS	0.900	IRS
1973-74	0.823	IRS	0.778	DRS	0.580	IRS	0.580	IRS	0.737	DRS
1974-75	0.963	IRS	0.836	IRS	0.794	IRS	0.786	IRS	0.881	IRS
1975-76	1.000	CRS	0.879	IRS	0.816	IRS	0.805	IRS	0.952	IRS
1976-77	0.999	DRS	0.876	DRS	0.827	IRS	0.860	IRS	0.955	IRS
1977-78	0.997	DRS	0.900	IRS	0.852	IRS	0.895	IRS	0.945	DRS
1978-79	0.976	DRS	0.926	IRS	0.866	IRS	0.916	IRS	0.981	DRS
1979-80	0.979	IRS	0.910	DRS	0.880	IRS	0.944	IRS	0.975	IRS
1980-81	0.998	IRS	1.000	CRS	0.985	IRS	1.000	CRS	0.987	IRS
1981-82	0.989	DRS	1.000	CRS	1.000	CRS	0.983	IRS	1.000	CRS
1982-83	0.985	DRS	0.976	DRS	0.959	IRS	1.000	CRS	1.000	CRS
1983-84	0.990	IRS	0.982	IRS	0.829	DRS	0.920	IRS	0.986	DRS
1984-85	0.999	IRS	0.988	IRS	0.853	IRS	0.986	IRS	0.985	DRS
1985-86	1.000	CRS	0.992	IRS	0.824	DRS	0.931	DRS	1.000	CRS
1986-87	0.992	DRS	0.993	IRS	0.819	DRS	0.919	IRS	0.999	DRS
1987-88	0.996	IRS	0.996	IRS	0.934	IRS	0.943	IRS	0.996	DRS
1988-89	1.000	CRS	0.998	IRS	1.000	CRS	0.927	DRS	0.997	IRS
1989-90	0.980	DRS	1.000	CRS	1.000	CRS	1.000	CRS	1.000	CRS
1990-91	1.000	CRS	1.000	CRS	0.999	IRS	1.000	CRS	0.956	DRS
$\overline{X}$	0.943	--	0.924	--	0.852	--	0.851	--	0.947	--
σ	0.109	--	0.086	--	0.124	--	0.178	--	0.072	--
C.V	11.561	--	9.327	--	14.534	--	20.871	--	7.610	--
Average inefficiency	0.061	--	0.083	--	0.174	--	0.175	--	0.056	--
DUMs	4	--	4	--	3	--	4	--	4	--

Source: Calculations based on ASI data

Foot Note: Average scale inefficiency = $1-\overline{X}/\overline{X}$

IRS – Increasing Returns to Scale

CRS – Constant Returns to Scale

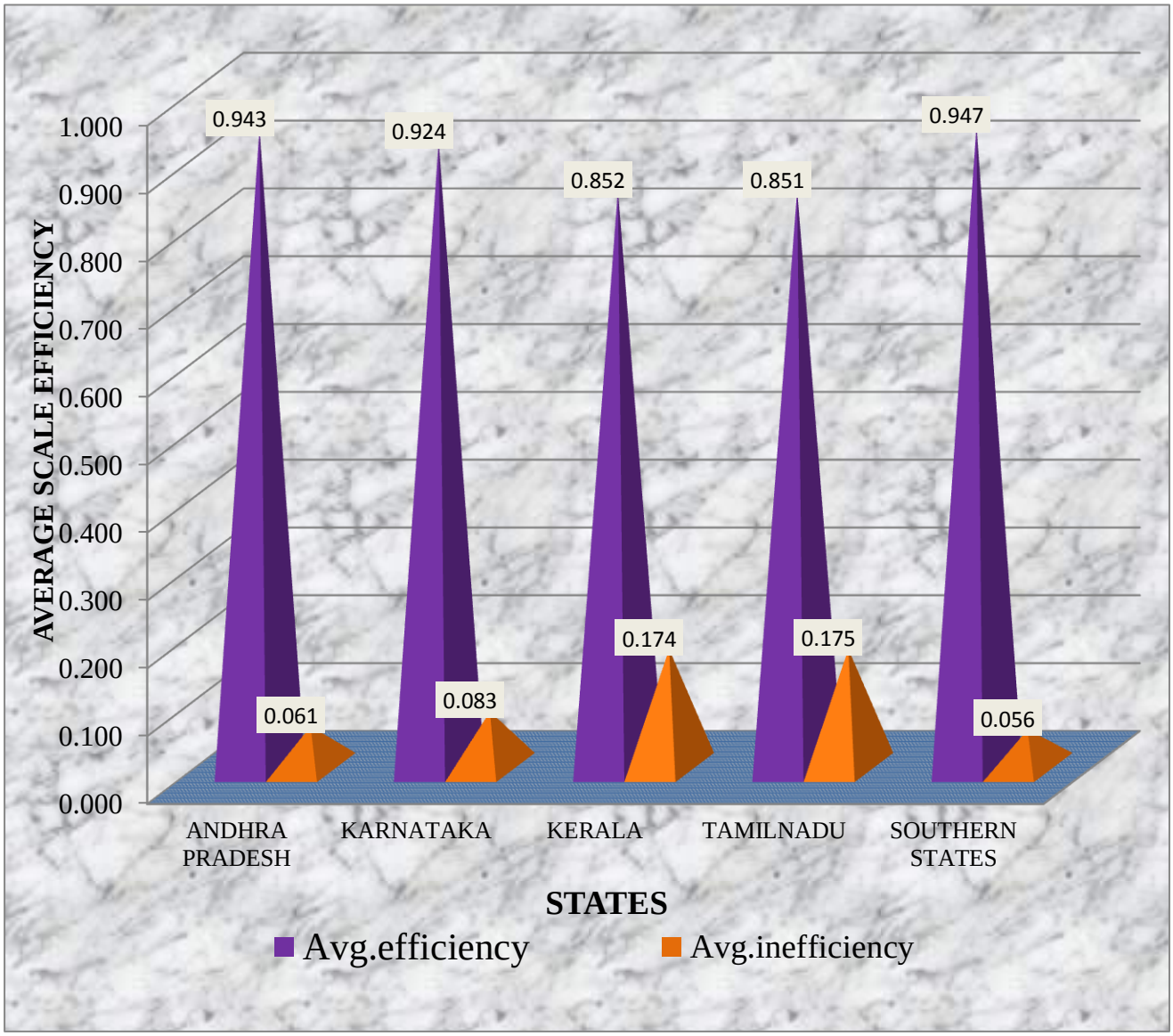
DRS – Decreasing Returns to Scale

C.V – Co-efficient of Variation

FIGURE – 3

AVERAGE SCALE EFFICIENCY ESTIMATES

(PRE REFORM PERIOD)



DEA results applied to know the scale efficiency of industries for the pre reform period revealed that the industries were not operating at an optimum scale since the average efficiency scores were less than one for all the states. The average scale efficiency was the maximum (94.3 percent) for the manufacturing sector, Andhra Pradesh followed by Karnataka (92.4percent), Kerala (85.2 percent), Tamil Nadu (85.1 percent) and it was (94.7 percent) for the southern states as whole. This trend explained the fact that additional production to the extent of 5.7 percent, 7.6 percent, 14.8 percent, 14.9 percent and 5.3 percent respectively in the above stated states and southern states as a whole by taking advantage of their scale characteristics.

Table-5 presents data on post reform period scale efficiency scores of manufacturing sector of the southern states of India both at the disaggregated and aggregated level. Figure-4 illustrates the same.

TABLE – 5

SCALE EFFICIENCY (SE) ESTIMATES – POST REFOM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	Score	**RTS**	**Score**	**RTS**	**Score**	**RTS**	**Score**	**RTS**	**Score**	**RTS**
1991-92	0.945	IRS	0.997	IRS	0.796	IRS	1.000	CRS	1.000	CRS
1992-93	0.873	DRS	0.909	DRS	0.787	DRS	0.987	IRS	0.984	DRS
1993-94	0.896	IRS	0.911	IRS	0.672	DRS	0.994	IRS	0.978	DRS
1994-95	0.915	IRS	0.915	IRS	0.587	DRS	0.975	DRS	0.996	IRS
1995-96	0.961	IRS	0.931	IRS	0.785	IRS	0.935	DRS	0.975	DRS
1996-97	0.953	DRS	0.941	IRS	0.723	DRS	0.966	IRS	0.986	IRS
1997-98	0.963	IRS	0.948	IRS	0.783	IRS	0.993	IRS	0.971	DRS
1998-99	0.932	DRS	0.918	DRS	0.731	DRS	0.851	DRS	0.982	IRS
1999-00	0.928	DRS	0.845	DRS	0.745	IRS	0.965	IRS	0.963	DRS
2000-01	0.865	DRS	0.834	IRS	0.722	DRS	0.938	DRS	0.888	DRS
2001-02	0.862	DRS	0.912	IRS	0.672	IRS	0.882	DRS	0.908	IRS
2002-03	0.920	IRS	0.934	IRS	0.658	DRS	0.921	IRS	0.943	IRS
2003-04	0.876	DRS	0.962	IRS	0.630	DRS	0.970	IRS	0.966	IRS
2004-05	0.938	IRS	1.000	CRS	0.623	DRS	1.000	CRS	1.000	CRS
2005-06	0.969	IRS	1.000	CRS	0.603	DRS	0.991	DRS	0.983	DRS
2006-07	1.000	CRS	1.000	CRS	0.613	IRS	0.993	IRS	1.000	CRS
2007-08	0.977	DRS	0.998	DRS	0.567	DRS	0.959	DRS	0.957	DRS
2008-09	0.995	IRS	0.975	DRS	0.622	IRS	0.927	IRS	0.998	IRS
2009-10	0.932	DRS	0.986	IRS	1.000	CRS	0.978	IRS	0.981	DRS
2010-11	0.876	DRS	1.000	CRS	0.562	IRS	0.943	DRS	0.995	IRS
2011-12	0.767	DRS	0.932	IRS	0.591	IRS	1.000	CRS	0.919	DRS
2012-13	0.913	IRS	0.964	IRS	0.644	IRS	0.961	DRS	1.000	CRS
2013-14	1.000	CRS	0.969	IRS	0.634	DRS	0.996	IRS	0.996	DRS
$\overline{X}$	0.924	--	0.947	--	0.685	--	0.962	--	0.973	--
σ	0.056	--	0.047	--	0.101	--	0.039	--	0.031	--
C.V	6.052	--	4.981	--	14.693	--	4.071	--	3.214	--
Average inefficiency	0.082	--	0.056	--	0.460	--	0.040	--	0.028	--
DMUs	2	--	4	--	1	--	3	--	4	--

Source: Calculations based on ASI data

Foot Note: Average scale inefficiency = $1-\overline{X}/\overline{X}$

IRS – Increasing Returns to Scale

CRS – Constant Returns to Scale

DRS – Decreasing Returns to Scale

C.V – Co-efficient of Variation

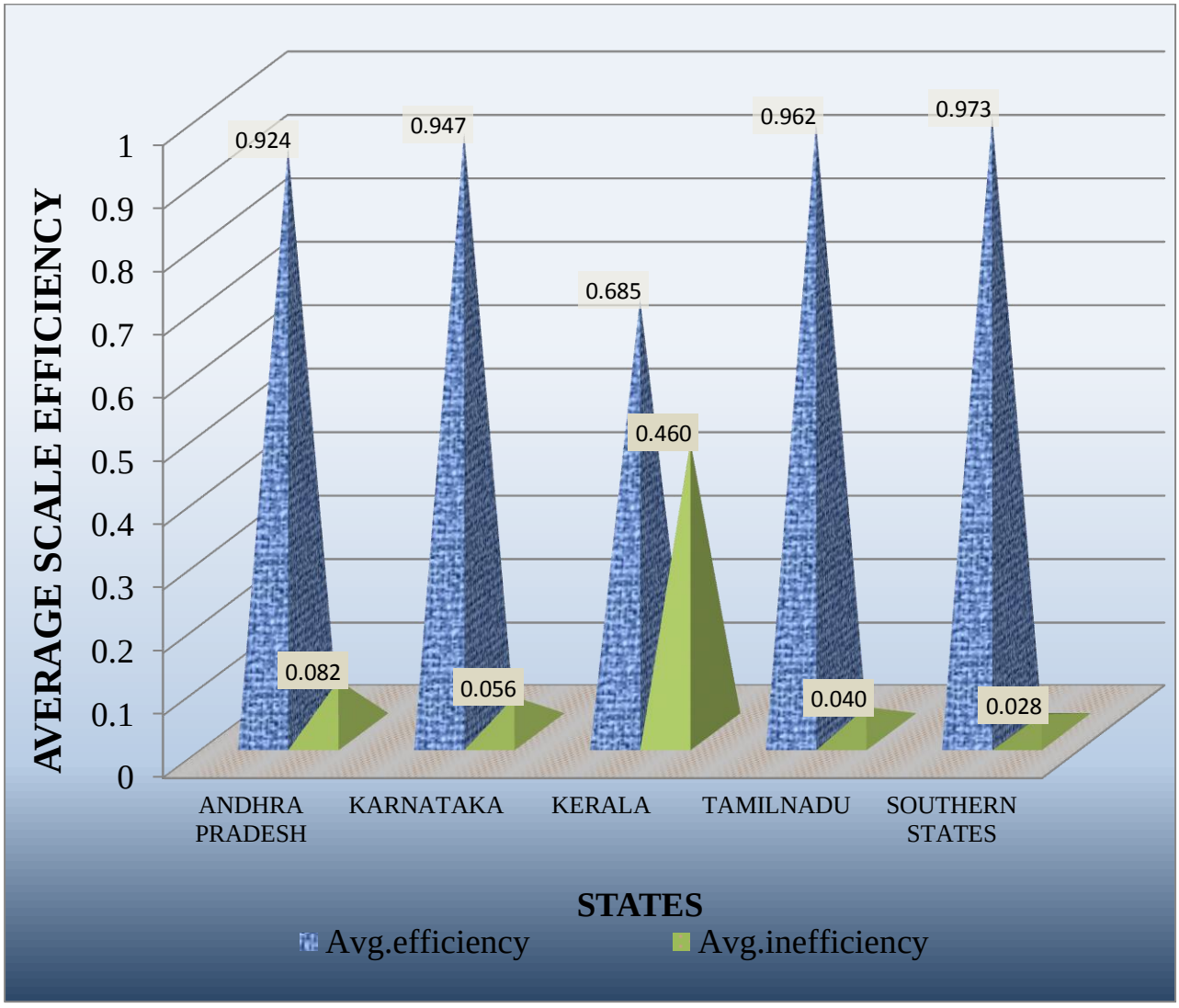
The analysis of scale efficiency during the post reform period (1991-92 to 2013-14) showed that the manufacturing sector of Tamil Nadu took the maximum scale efficiency

score (0.962) followed by Karnataka (0.947), Andhra Pradesh (0.924) and Kerala (0.685), which made the aggregate manufacturing sector of southern states as a whole to be scale efficient to the extent of 97.3 percent. The inefficiency score showed that it was more for Kerala (46 percent) and minimum for Tamil Nadu (4 percent). During the post reform period efficiency of more than 90 percent was observed in the manufacturing of all the states except Kerala. The maximum average inefficiency for Kerala would be primarily due to the reason that throughout the reference period there were wider fluctuations in the growth of efficiency scores. The variability index (C.V) showed that it was low for the manufacturing sector of Kerala and high for the manufacturing sector of Tamil Nadu across the states. The co-efficient of variation showed the instability level of scale efficiency to the extent of (3.21 percent) in southern states of India.

FIGURE – 4

AVERAGE SCALE EFFICIENCY ESTIMATES

(POST REFORM PERIOD)



Additionally, DEA allows in assessing whether a firm lies in the range of increasing, constant and decreasing returns to scale. In other words, it revealed the scale characteristics of DMUs. If market contains firms operating with increasing and decreasing returns to scale, market efficiency can be increased if more DMUs attain constant returns to scale, because fewer resources are wasted under constant returns to scale. The measurement of economies of scale, therefore, helps to assess at the same time whether higher market concentration should be encouraged to improve efficiency. A DMU may be scale inefficient, if it experiences decreasing returns to scale or if it has not taken full advantage of increasing returns to scale.

State wise Scale inefficiency estimates showed that the manufacturing sector of Andhra Pradesh and Kerala were inefficient under decreasing returns to scale during pre and post reform period respectively. Also, inefficiency was more under post reform period compared with the pre reform period under decreasing returns to scale. The pre reform period inefficiency in the aggregate manufacturing sector no doubt was due to the inefficiency of Kerala. This phenomenon might be partially due to the fact that the markets of this particular state might not have taken advantage of the available cost savings due to the absence of price transparency which in turn have allowed the scale inefficient firms to survive. In general, it is very clear that inefficiency could be due to the existence of either increasing or decreasing returns to scale.

3. Cost Efficiency

Cost efficiency estimates taking into account input prices (wage rate and rate of return on capital) in addition to output and input data (labour and capital) for the aggregate manufacturing sector of southern states of India under Constant Returns to Scale (CRS) production technology and Variable Returns Scale (VRS) production technology for the pre reform period is presented in Table-6. It is illustrated in Figure-5.

TABLE – 6

COST EFFICIENCY (CE) ESTIMATES – PRE REFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1970-71	0.487	1.000	0.650	0.902	0.464	1.000	0.358	0.866	0.781	1.000
1971-72	0.476	0.965	0.806	1.000	0.465	0.946	0.355	0.886	0.798	0.994
1972-73	0.543	1.000	0.793	0.954	0.406	0.685	0.370	0.899	0.809	0.913
1973-74	0.497	0.984	0.695	0.904	0.362	0.719	0.370	0.949	0.727	0.951
1974-75	0.517	0.984	0.701	0.857	0.497	0.835	0.421	1.000	0.880	1.000
1975-76	0.644	1.000	0.697	0.805	0.535	0.862	0.518	0.974	0.948	1.000
1976-77	0.521	0.850	0.647	0.747	0.539	0.843	0.518	0.963	0.928	0.968
1977-78	0.502	0.795	0.692	0.774	0.558	0.836	0.586	0.952	0.901	0.935
1978-79	0.529	0.771	0.674	0.728	0.626	0.876	0.625	0.951	0.953	0.974
1979-80	0.504	0.717	0.632	0.686	0.627	0.851	0.587	0.916	0.914	0.933
1980-81	0.804	0.839	0.974	0.978	0.980	0.990	0.989	1.000	0.979	0.987
1981-82	0.802	0.840	1.000	1.000	1.000	1.000	0.969	0.973	0.968	0.975
1982-83	0.927	0.940	0.968	1.000	0.879	0.887	1.000	1.000	0.998	1.000
1983-84	0.930	0.938	0.914	0.970	0.727	0.759	0.866	0.870	0.926	0.938
1984-85	0.966	0.971	0.879	0.937	0.763	0.795	0.896	0.941	0.951	0.965
1985-86	1.000	1.000	0.763	0.781	0.750	0.771	0.810	0.847	0.991	0.997
1986-87	0.952	0.952	0.749	0.793	0.795	0.821	0.806	0.828	0.989	0.995
1987-88	0.994	1.000	0.707	0.816	0.870	0.886	0.805	0.841	0.981	0.986
1988-89	0.945	1.000	0.667	0.833	0.911	0.913	0.748	0.852	0.987	0.988
1989-90	0.906	1.000	0.735	1.000	0.981	1.000	0.832	1.000	1.000	1.000
1990-91	0.538	1.000	0.660	1.000	0.871	0.883	0.794	1.000	0.894	0.894
$\overline{X}$	0.714	0.931	0.762	0.879	0.696	0.865	0.677	0.929	0.919	0.971
σ	0.212	0.090	0.117	0.105	0.204	0.090	0.223	0.060	0.079	0.032
C.V	29.699	9.667	15.354	11.945	29.310	10.404	32.939	6.458	8.596	3.296
Average inefficiency	0.401	0.074	0.312	0.137	0.438	0.157	0.476	0.076	0.088	0.030
DMUs	1	8	1	5	1	3	1	5	1	5

Source: Calculations are based on ASI data

Foot note: Average inefficiency = $1-\overline{X}/\overline{X}$

CRS – Constant Returns to Scale

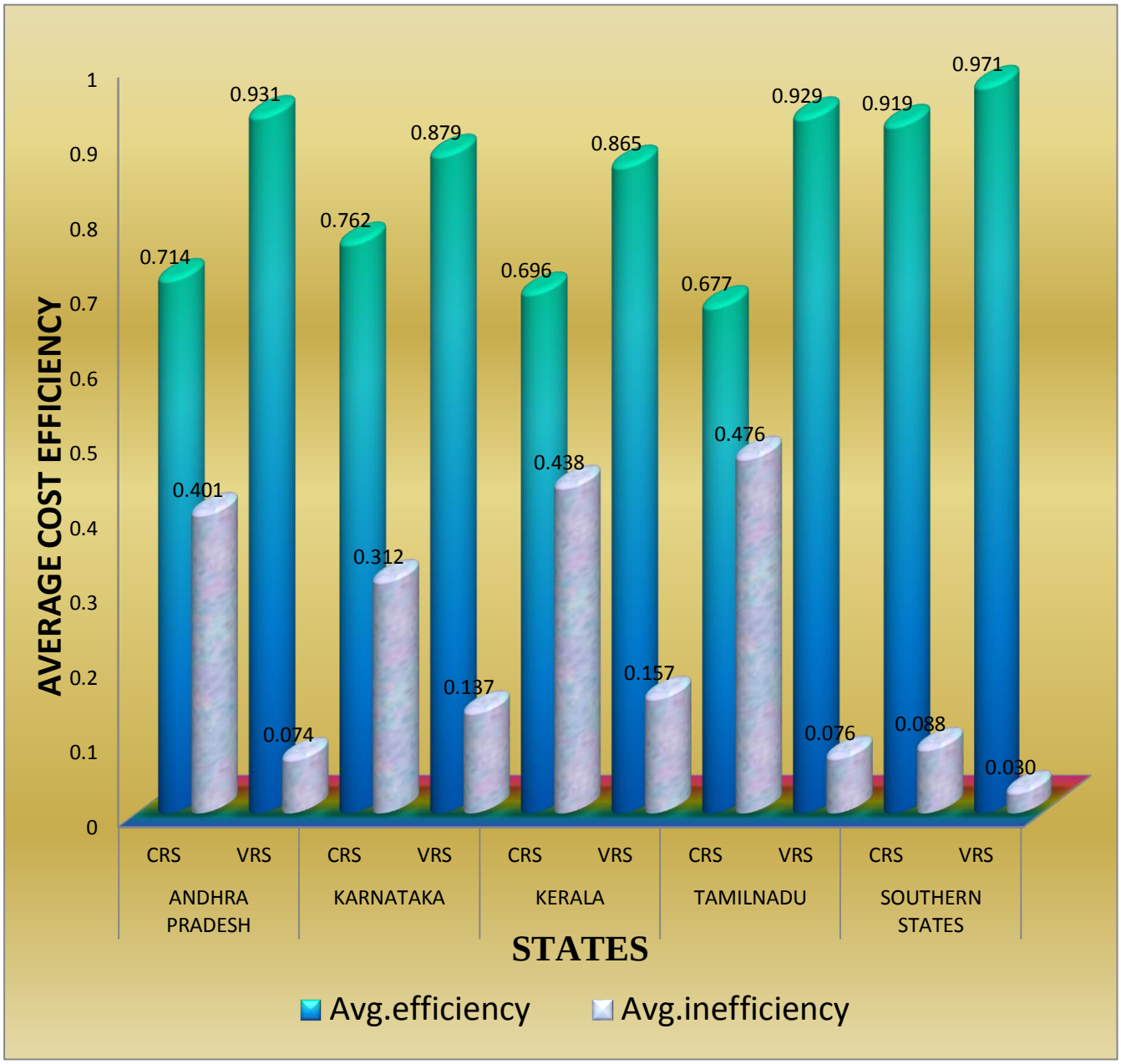
VRS – Variable Returns to Scale

C.V – Co-efficient of Variation

FIGURE – 5

AVERAGE COST EFFICIENCY ESTIMATES

(PRE REFORM PERIOD)



The cost efficiency of manufacturing sector of southern states of India for the entire pre reform period revealed that under Constant Returns to Scale (CRS) technology, the manufacturing sector of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and aggregate Southern states were efficient to the extent of 71.4 percent, 76.2 percent, 69.6 percent, 67.7 percent and 91.9 percent respectively. Under Variable Returns to Scale (VRS) production technology the same sectors of Southern states were more efficient to the extent of 93.1 percent, 87.9 percent, 86.5 percent, 92.9 percent and 97.1 percent respectively. Considering the cost efficient DMUs, it was found to be more under VRS production technology. The average cost inefficiency was more under CRS production technology than under VRS production technology. The magnitude of variability for the whole reference period during pre-reform period was very high for the manufacturing sector of Tamil Nadu to the extent of 32.94 percent and minimum for the manufacturing sector of Karnataka (15.354 percent) across states. The southern states as a whole it was recorded to the level of 8.596 percent and 3.296 respectively in CRS and VRS production technology.

Cost efficiency estimates for the aggregate manufacturing sector of southern states of India under Constant Returns to Scale (CRS) production technology and Variable Returns Scale (VRS) production technology for the post reform period is presented in Table-7 and it is illustrated in Figure-6.

TABLE – 7

COST EFFICIENCY (CE) ESTIMATES – POSTREFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1991-92	0.597	0.635	0.996	1.000	0.503	0.803	0.995	1.000	0.879	1.000
1992-93	0.642	0.663	0.896	0.900	0.490	0.757	0.978	0.980	0.855	0.935
1993-94	0.653	0.682	0.842	0.868	0.429	0.770	0.920	0.921	0.809	0.936
1994-95	0.697	0.704	0.840	0.844	0.365	0.724	0.911	0.921	0.795	0.871
1995-96	0.732	0.741	0.852	0.855	0.460	0.729	0.932	0.954	0.860	0.884
1996-97	0.746	0.749	0.755	0.758	0.526	0.841	0.869	0.869	0.825	0.870
1997-98	0.716	0.724	0.624	0.627	0.444	0.693	0.867	0.871	0.756	0.783
1998-99	0.788	0.789	0.475	0.479	0.586	0.948	0.788	0.927	0.706	0.831
1999-00	0.790	0.799	0.576	0.604	0.604	0.920	0.930	0.956	0.827	0.927
2000-01	0.781	0.794	0.634	0.671	0.580	0.903	0.918	0.966	0.848	0.959
2001-02	0.762	0.769	0.643	0.648	0.509	0.871	0.861	1.000	0.800	0.937
2002-03	0.759	0.787	0.726	0.730	0.580	1.000	0.867	0.947	0.867	0.954
2003-04	0.826	0.839	0.823	0.826	0.568	0.897	0.945	0.947	0.917	0.976
2004-05	0.852	0.885	0.984	0.984	0.578	0.901	0.963	1.000	0.995	1.000
2005-06	0.857	0.898	0.974	0.975	0.586	0.879	0.922	0.967	0.982	0.983
2006-07	0.950	1.000	0.994	1.000	0.597	0.870	0.871	0.984	0.998	1.000
2007-08	0.878	0.918	0.923	0.926	0.560	0.832	0.834	0.883	0.937	0.939
2008-09	0.860	0.906	0.859	0.864	0.568	0.800	0.730	0.769	0.893	0.893
2009-10	0.761	0.761	0.815	0.815	1.000	1.000	0.716	0.769	0.979	1.000
2010-11	0.875	1.000	0.841	0.841	0.513	0.775	0.715	0.787	0.870	0.872
2011-12	0.739	1.000	0.929	1.000	0.590	0.814	0.808	1.000	0.918	1.000
2012-13	0.823	1.000	0.868	0.896	0.629	0.852	0.737	0.840	0.875	0.876
2013-14	0.915	1.000	0.825	0.852	0.604	0.887	0.673	0.726	0.828	0.831
$\overline{X}$	0.783	0.828	0.813	0.825	0.560	0.846	0.859	0.912	0.870	0.924
σ	0.081	0.113	0.139	0.140	0.119	0.085	0.090	0.083	0.078	0.063
C.V	11.33	14.32	17.417	17.19	20.847	9.829	10.848	9.171	8.721	6.857
Average inefficiency	0.277	0.208	0.230	0.212	0.786	0.182	0.164	0.096	0.149	0.082
DMUs	0	5	0	3	1	2	0	4	0	4

Source: Calculations are based on ASI data

Foot note: Average inefficiency = $1-\overline{X}/\overline{X}$

CRS – Constant Returns to Scale

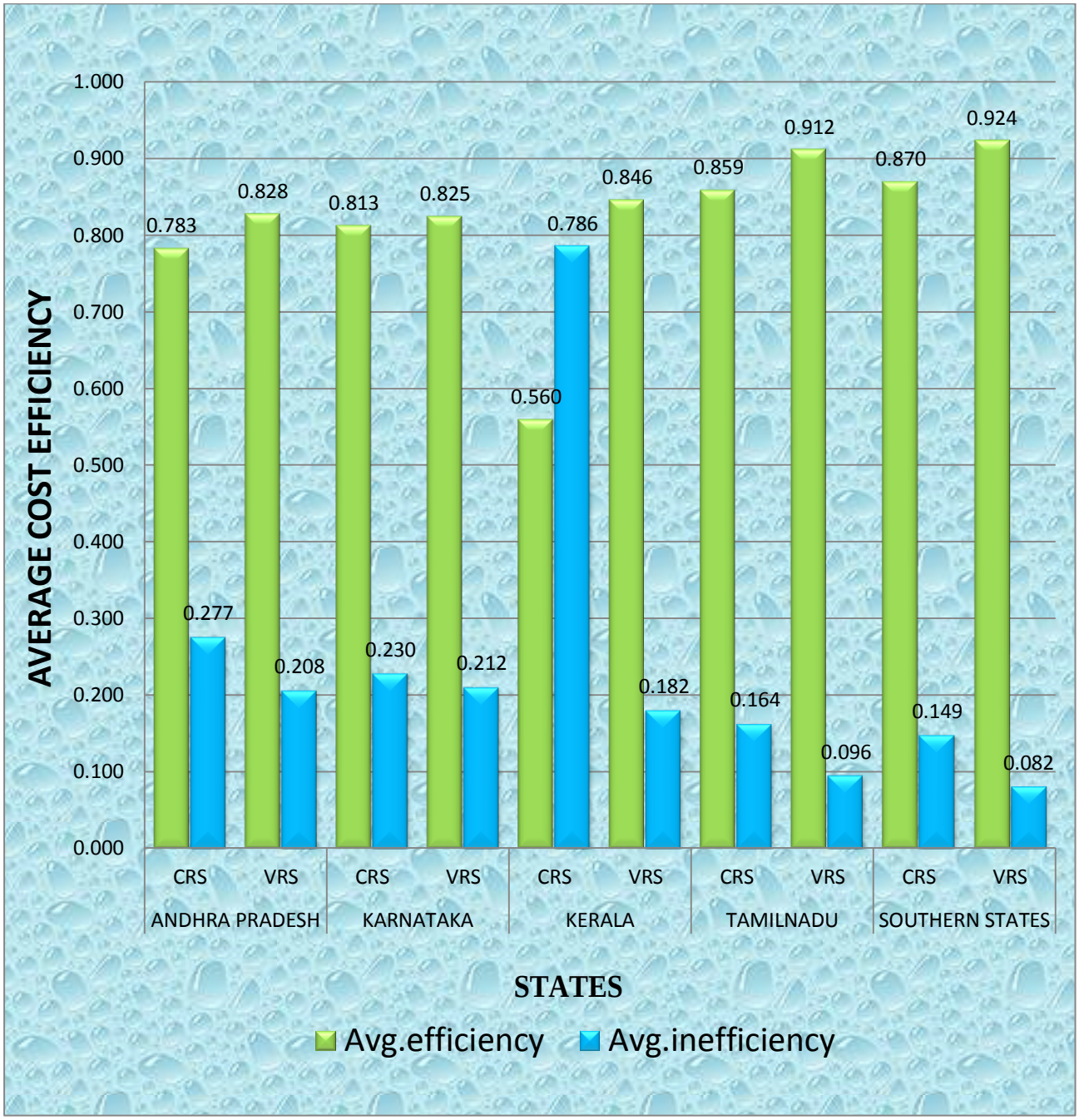
VRS – Variable Returns to Scale

C.V – Co-efficient of Variation

FIGURE – 6

AVERAGE COST EFFICIENCY ESTIMATES

(POST REFORM PERIOD)



Cost efficiency estimates during the post reform period (1991-92 to 2013-14) under CRS production technology revealed that the average scores ranged between 56.0 percent and 85.9 percent for overall in aggregate level southern scores 87 percent. The maximum efficiency was attained by the state of Tamil Nadu and minimum estimated value was observed in the state of Kerala. With regard to the efficiency estimates under VRS production technology, maximum efficiency (91.2 percent) was observed in the manufacturing sector of Tamil Nadu, followed by Kerala (84.6 percent), Andhra Pradesh (82.8 percent) and Karnataka (82.5 percent). This level of efficiency score brought out the fact that the magnitude of variation were mixed across the type of technology. This indicated the fact that the major reason for more than 90 percent of the southern state's total efficiency performance was mainly due to the efficiency level of aggregate manufacturing sector of Tamil Nadu.

With regard to inefficiency score under CRS production technology, it ranged between 16.4 percent (Tamil Nadu) and 78.6 percent (Kerala). This maximum inefficiency in the manufacturing sector of Kerala may be due to the inefficiency of the firms in the selection of cost minimizing input quantities. Under VRS production technology minimum of 9.6 percent (Tamil Nadu) and maximum of 21.2 percent (Karnataka) inefficiency was observed.

4. Allocative Efficiency

Allocative efficiency estimates taking into account input prices (wage rate and rate of return on capital) in addition to gross output and input data (labour and capital) for the aggregate manufacturing sector of southern states of India along with the aggregate sector under Constant Returns to Scale (CRS) production technology and Variable Returns Scale (VRS) production technology for pre reform period is presented in Table-8 and illustrated in Figure-7.

TABLE – 8

ALLOCATIVE EFFICIENCY (AE) ESTIMATES – PRE REFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1970-71	0.755	1.000	0.988	0.992	0.636	1.000	0.756	0.870	0.922	1.000
1971-72	0.741	1.000	0.992	1.000	0.610	0.946	0.723	0.902	0.980	0.994
1972-73	0.668	1.000	0.971	0.970	0.845	0.818	0.727	0.899	0.899	0.913
1973-74	0.604	0.984	0.894	0.904	0.757	0.871	0.641	0.952	0.997	0.962
1974-75	0.537	0.984	0.839	0.857	0.749	1.000	0.536	1.000	1.000	1.000
1975-76	0.644	1.000	0.878	0.893	0.760	0.999	0.652	0.986	0.996	1.000
1976-77	0.541	0.882	0.832	0.842	0.769	0.994	0.612	0.977	0.998	0.995
1977-78	0.594	0.940	0.840	0.845	0.747	0.953	0.669	0.973	0.999	0.980
1978-79	0.618	0.879	0.836	0.836	0.810	0.983	0.693	0.965	0.997	1.000
1979-80	0.661	0.920	0.764	0.754	0.816	0.974	0.622	0.916	1.000	0.996
1980-81	0.955	0.994	0.974	0.978	1.000	0.994	0.989	1.000	0.995	0.991
1981-82	0.932	0.964	1.000	1.000	1.000	1.000	0.999	0.986	0.968	0.975
1982-83	0.955	0.954	0.992	1.000	0.987	0.956	1.000	1.000	0.998	1.000
1983-84	0.973	0.970	0.955	0.995	0.989	0.855	0.952	0.881	1.000	0.999
1984-85	0.994	0.997	0.934	0.984	0.990	0.880	0.938	0.971	1.000	0.999
1985-86	1.000	1.000	0.852	0.864	0.943	0.798	0.891	0.867	0.991	0.997
1986-87	0.995	0.987	0.830	0.873	0.983	0.832	0.895	0.845	0.993	0.998
1987-88	0.998	1.000	0.800	0.919	0.987	0.939	0.903	0.889	0.998	1.000
1988-89	0.945	1.000	0.768	0.956	0.911	0.913	0.819	0.865	0.995	0.994
1989-90	0.924	1.000	0.735	1.000	0.981	1.000	0.832	1.000	1.000	1.000
1990-91	0.538	1.000	0.660	1.000	0.963	0.975	0.794	1.000	0.959	0.916
$\overline{X}$	0.789	0.974	0.873	0.927	0.868	0.937	0.793	0.940	0.985	0.986
σ	0.183	0.038	0.097	0.074	0.127	0.068	0.143	0.055	0.027	0.026
C.V	23.191	3.940	11.124	7.990	14.680	7.209	18.084	5.879	2.770	2.614
Average inefficiency	0.267	0.027	0.145	0.079	0.152	0.067	0.262	0.064	0.015	0.014
DMUs	1	9	1	5	2	4	1	5	5	7

Source: Calculations are based on ASI data

Foot note: Average inefficiency = $1-\overline{X}/\overline{X}$

CRS – Constant Returns to Scale

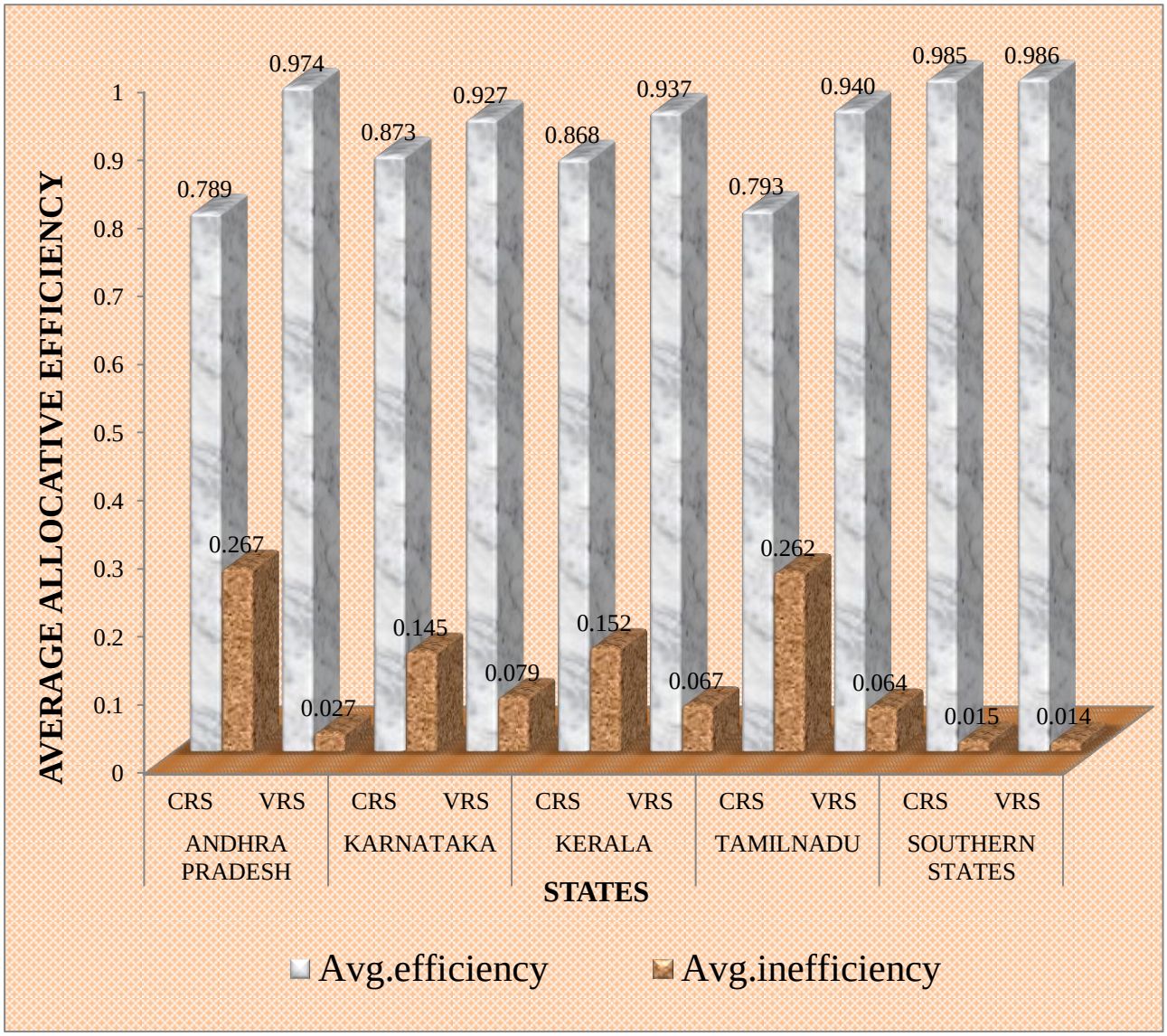
VRS – Variable Returns to Scale

C.V – Co-efficient of Variation

FIGURE – 7

AVERAGE ALLOCATIVE EFFICIENCY ESTIMATES

(PRE REFORM PERIOD)



The allocative efficiency estimates during pre-reform period revealed that the southern states under CRS production technology had on an average allocative efficiency level of 78.9 percent, 87.3 percent, 86.8 percent and 79.3 percent respectively in the manufacturing sectors of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu which made the aggregate southern states manufacturing sector to reach the level of 98.5 percent, implying 21.1 percent, 12.7 percent, 13.2 percent, 13.4 percent wastage in terms of selection of combination of inputs. The overall inefficiency in the southern states as a whole recorded 20.7 percent based on the above figures.

In the case of VRS production technology, an average allocative efficiency of 97.4 percent, 92.7 percent, 93.7 percent, 94.0 percent could be observed in the manufacturing sector of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu implying that the sectors were on an average wasted (inefficiency) 2.7 percent, 7.9 percent, 6.7 percent and 6.4 percent of the resources based on ineffective selection of combination of inputs respectively in the above mentioned industries of the southern states. As expected, more efficient DMUs were observed in VRS production technology compared to CRS production technology. Average inefficiency scores explained the fact that it was very low for the Southern states as a whole in case of CRS and VRS production technology.

Details regarding the estimates of allocative efficiency in the Southern states of India during post reform period are shown in Table-9. Figure-8 illustrates the same.

TABLE – 9

ALLOCATIVE EFFICIENCY (AE) ESTIMATES – POST REFORM PERIOD

States / DMU	Andhra Pradesh		Karnataka		Kerala		Tamil Nadu		Southern States	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1991-92	0.923	0.928	0.999	1.000	0.632	0.803	0.995	1.000	0.879	1.000
1992-93	0.928	0.838	0.985	0.900	0.716	0.871	0.998	0.986	0.876	0.942
1993-94	0.925	0.866	0.995	0.934	0.698	0.842	0.998	0.993	0.882	0.999
1994-95	0.978	0.903	0.985	0.906	0.807	0.939	0.934	0.921	0.903	0.985
1995-96	0.991	0.963	0.980	0.916	0.677	0.842	0.996	0.954	0.910	0.911
1996-97	0.992	0.950	0.969	0.916	0.838	0.970	0.997	0.964	0.914	0.951
1997-98	0.991	0.964	0.853	0.812	0.714	0.871	0.994	0.991	0.893	0.899
1998-99	0.999	0.932	0.641	0.594	0.801	0.948	0.993	0.994	0.807	0.933
1999-00	0.983	0.922	0.809	0.716	0.862	0.977	0.995	0.987	0.914	0.986
2000-01	0.967	0.850	0.877	0.775	0.879	0.989	0.978	0.966	0.954	0.959
2001-02	0.979	0.852	0.785	0.722	0.857	0.986	0.976	1.000	0.922	0.980
2002-03	0.916	0.873	0.824	0.774	0.880	1.000	0.987	0.994	0.941	0.976
2003-04	0.971	0.863	0.875	0.844	0.940	0.936	0.981	0.954	0.958	0.985
2004-05	0.908	0.885	0.984	0.984	0.950	0.921	0.963	1.000	0.995	1.000
2005-06	0.884	0.898	0.999	0.999	0.973	0.879	0.940	0.976	1.000	0.983
2006-07	0.950	1.000	0.994	1.000	0.978	0.875	0.878	0.986	0.998	1.000
2007-08	0.951	0.973	0.983	0.984	0.989	0.832	0.869	0.883	0.980	0.939
2008-09	0.932	0.977	0.997	0.978	0.985	0.864	0.849	0.829	1.000	0.998
2009-10	0.997	0.930	0.993	0.979	1.000	1.000	0.876	0.920	0.999	1.000
2010-11	0.999	1.000	1.000	1.000	0.985	0.837	0.826	0.857	1.000	0.998
2011-12	0.964	1.000	0.997	1.000	0.999	0.814	0.808	1.000	0.999	1.000
2012-13	0.901	1.000	0.999	0.995	0.990	0.863	0.822	0.900	0.999	1.000
2013-14	0.915	1.000	0.997	0.998	0.968	0.901	0.902	0.969	0.995	0.995
$\overline{X}$	0.954	0.929	0.936	0.901	0.875	0.902	0.937	0.957	0.944	0.975
σ	0.036	0.057	0.097	0.117	0.109	0.061	0.067	0.050	0.055	0.031
C.V	3.790	6.117	10.37	12.99	12.50	6.788	7.195	5.185	5.799	3.195
Average inefficiency	0.048	0.076	0.068	0.110	0.143	0.109	0.067	0.045	0.059	0.026
DMUs	0	5	1	4	1	2	0	4	3	6

Source: Calculations are based on ASI data

Foot note: Average inefficiency = $1-\overline{X}/\overline{X}$

CRS – Constant Returns to Scale

VRS – Variable Returns to Scale

C.V – Co-efficient of Variation

Inter-temporal comparison showed that during the post reform period from1991-92 to 2013-14, the maximum allocative efficiency of 95.4 percent was recorded by the manufacturing sector of Andhra Pradesh and the minimum efficiency of 87.5 percent was recorded in the manufacturing sector of Kerala under CRS production technology. Also, the

maximum inefficiency score of 0.143 (14.3percent) was observed in the manufacturing sector of Kerala and minimum score of 0.048 (4.8 percent) was recorded in the manufacturing sector of Andhra Pradesh. Under VRS production technology all southern states had allocative efficiency of more than 90 percent. With regard to inefficiency estimates, the maximum was recorded in the manufacturing sector of Kerala (11.0 percent) and minimum for the manufacturing sector of Tamil Nadu (4.5 percent). It is indicative of the fact that an optimal distribution of goods and services, taking into account consumer's preferences was prevalent in the manufacturing sector of Tamil Nadu.

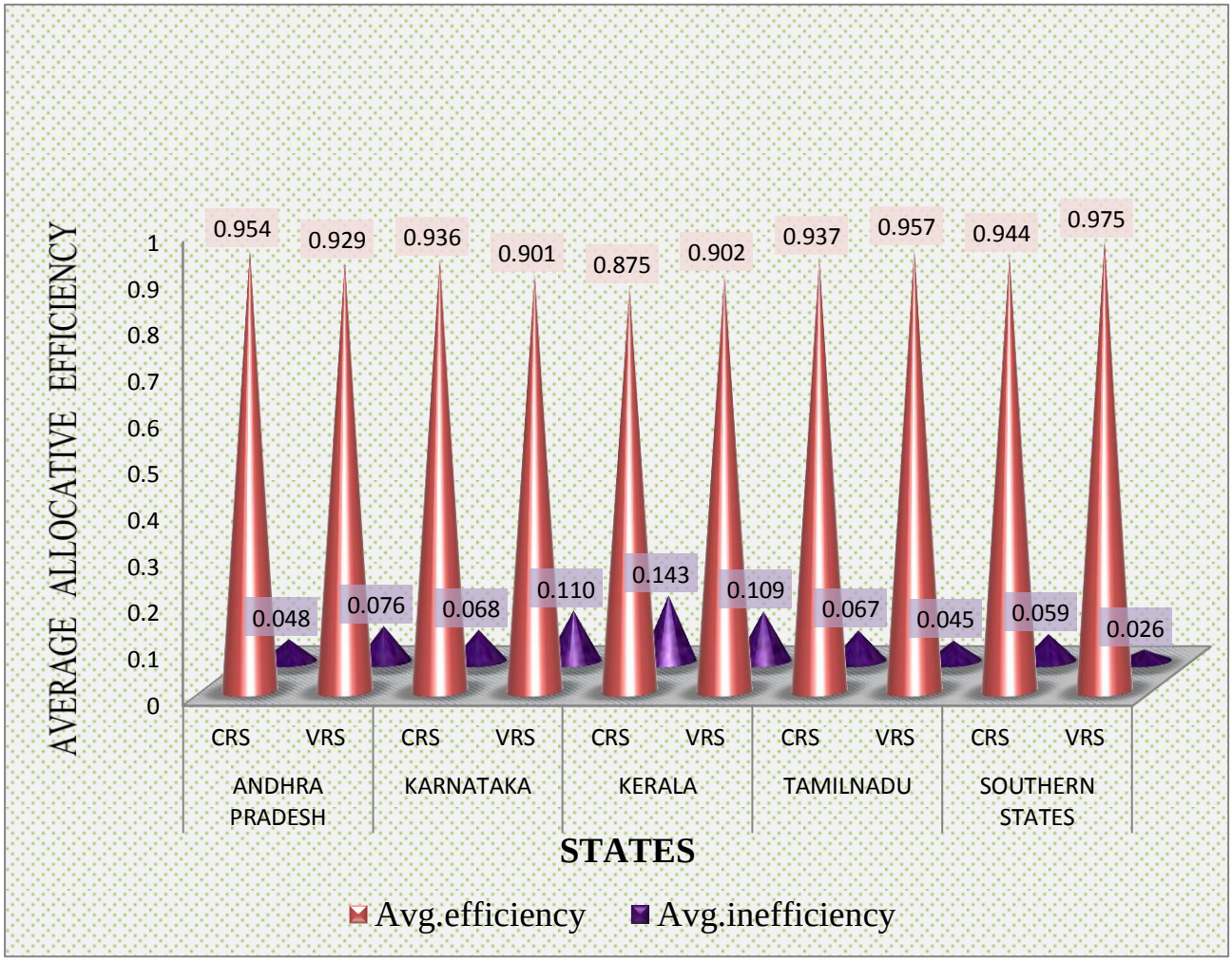
The figures showed that allocative efficiency had improved from pre reform period to post reform period in Andhra Pradesh, Karnataka and Tamil Nadu and in Kerala. The co-efficient of variation for both the periods explained the fact that the inconsistency in the growth of allocative efficiency level was more under CRS technology which was approximately ranging between 11 percent (11.124) and 23 percent (23.18) across states and 2.77 percent at the aggregate level during pre-reform period. Whereas under post reform period the figure ranged between 4 percent (3.790) and 13 percent (12.503) across the states which had made the aggregate level inconsistency to the extent of 6 percent (5.799).

Based on the findings the hypothesis framed as "there is no significant difference in the technical, scale, cost and allocative efficiency level in the manufacturing sector of southern states of India before and after reform period" was rejected and the alternative hypothesis was accepted.

FIGURE – 8

AVERAGE ALLOCATIVE EFFICIENCY ESTIMATES

(POST REFORM PERIOD)



A. Decomposition of Total Factor Productivity Growth

In this section, an attempt has been made to decompose of productivity changes into two mutually exclusive components namely technical efficiency change and technological change. Technical efficiency change was further decomposed into pure efficiency change and scale efficiency change. By applying input oriented non-parametric Malmquist Productivity Index (MPI) approach before and after regime shift the results were obtained. It presents the mean estimates (geometric means) of Malmquist Indices of Total Factor Productivity Growth (TFPG).

The input oriented non-parametric Malmquist indices of productivity change for the entire pre and post reform period for Andhra Pradesh is presented in Table-10 and Table-11 respectively.

TABLE – 10

MALMQUIST INDICES AND THEIR COMPONENTS – ANDHRA PRADESH

(PRE REFORM PERIOD)

Year	Sources of Productivity growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1971-72	0.910	1.070	0.980	0.930	0.970
1972-73	1.090	1.130	1.030	1.060	1.230
1973-74	1.010	0.890	1.000	1.010	0.900
1974-75	0.930	1.260	0.990	0.950	1.170
1975-76	1.030	1.010	1.020	1.010	1.040
1976-77	0.900	1.060	1.000	0.900	0.950
1977-78	0.850	1.040	0.740	1.150	0.880
1978-79	0.980	1.030	0.980	1.000	1.010
1979-80	0.920	1.010	1.150	0.800	0.920
1980-81	0.910	1.110	0.780	1.160	1.010
1981-82	1.030	0.970	1.150	0.900	1.000
1982-83	1.090	1.030	0.950	1.140	1.120
1983-84	1.150	0.850	1.400	0.820	0.980
1984-85	1.030	1.000	1.000	1.030	1.030
1985-86	1.090	0.960	1.000	1.090	1.040
1986-87	0.950	1.000	1.000	0.950	0.950
1987-88	1.050	0.980	1.000	1.050	1.030
1988-89	0.970	0.960	1.000	0.970	0.930
1989-90	0.810	1.180	0.940	0.860	0.960
1990-91	0.850	0.960	0.640	1.340	0.820
Mean	0.974	1.019	0.975	0.999	0.992

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)

PECH (pure efficiency change), SECH (scale efficiency change)

TFPCH (total factor productivity)

TABLE – 11

MALMQUIST INDICES AND THEIR COMPONENTS – ANDHRA PRADESH

(POST REFORM PERIOD)

Year	Sources of Productivity growth		PECH	SECH	TFPCH(MPI)
	EFFCH	TECHCH			
1992-93	1.000	1.072	1.000	1.000	1.072
1993-94	1.000	1.020	1.000	1.000	1.020
1994-95	1.000	1.046	1.000	1.000	1.046
1995-96	1.000	1.101	1.000	1.000	1.101
1996-97	1.000	0.979	1.000	1.000	0.979
1997-98	1.000	0.995	1.000	1.000	0.995
1998-99	1.000	1.072	1.000	1.000	1.072
1999-00	1.000	1.053	1.000	1.000	1.053
2000-01	1.000	1.029	1.000	1.000	1.029
2001-02	1.000	0.946	1.000	1.000	0.946
2002-03	1.000	1.093	1.000	1.000	1.093
2003-04	1.000	1.014	1.000	1.000	1.014
2004-05	1.000	1.112	1.000	1.000	1.112
2005-06	1.000	1.020	1.000	1.000	1.020
2006-07	1.000	1.070	1.000	1.000	1.070
2007-08	1.000	0.921	1.000	1.000	0.921
2008-09	1.000	0.992	1.000	1.000	0.992
2009-10	0.817	1.136	1.000	0.817	0.928
2010-11	1.224	0.923	1.000	1.224	1.130
2011-12	1.000	0.899	1.000	1.000	0.899
2012-13	1.000	1.202	1.000	1.000	1.202
2013-14	1.000	1.103	1.000	1.000	1.103
Mean	1.001	1.034	1.000	1.000	1.034

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)
PECH (pure efficiency change), SECH (scale efficiency change)
TFPCH (total factor productivity)

Productivity improvement has not been recorded in Andhra Pradesh during pre-reform period. MPI had shown a decline of 0.8 percent per annum. In the most cases, the improvement in productivity seems to be caused by an improvement in technological change. Improvement in both the components together was observed in the in the post reform period. This implied that implementation of economic reforms have shown an advancement in productivity growth in the case of aggregate manufacturing sector in the state of Andhra Pradesh during post reform period. In other words, technology (shift in production frontier) contributed much to the TFP growth during post reform period compared to technical efficiency change.

The investigation regarding whether TFPG has been achieved by improvement in technical efficiency (Catch-up) and improvement in technology (shift in production frontier) has been carried out for the manufacturing sector of Karnataka. The decomposition of TFPG into efficiency change and technical change for pre and post reform period is presented in Table-12 and Table-13 respectively.

TABLE – 12

MALMQUIST INDICES AND THEIR COMPONENTS – KARNATAKA

(PRE REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1971-72	1.000	1.140	1.000	1.000	1.140
1972-73	1.000	1.100	1.000	1.000	1.100
1973-74	0.990	0.870	1.000	0.990	0.860
1974-75	0.880	1.260	0.970	0.910	1.110
1975-76	1.000	1.040	0.890	1.110	1.030
1976-77	1.050	0.960	1.080	0.980	1.010
1977-78	0.870	1.050	0.900	0.970	0.920
1978-79	1.170	1.050	1.190	0.980	1.220
1979-80	1.000	0.930	0.930	1.070	0.930
1980-81	0.850	1.120	0.950	0.890	0.950
1981-82	1.110	0.980	1.120	0.990	1.090
1982-83	0.910	1.070	0.910	1.000	0.970
1983-84	1.100	0.880	1.020	1.080	0.970
1984-85	0.970	1.000	1.050	0.920	0.970
1985-86	1.120	0.940	1.050	1.070	1.050
1986-87	1.020	1.000	1.000	1.020	1.020
1987-88	1.030	0.990	1.000	1.030	1.010
1988-89	1.020	0.980	1.000	1.020	1.000
1989-90	1.000	1.150	1.000	1.000	1.150
1990-91	1.000	1.030	1.000	1.000	1.030
Mean	1.000	1.023	1.000	1.000	1.023

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)

PECH (pure efficiency change), SECH (scale efficiency change)

TFPCH (total factor productivity)

TABLE – 13

MALMQUIST INDICES AND THEIR COMPONENTS– KARNATAKA

(POST REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH(MPI)
	EFFCH	TECHCH			
1992-93	0.969	1.062	1.000	0.969	1.030
1993-94	0.856	1.026	0.934	0.917	0.879
1994-95	1.155	0.926	1.070	1.079	1.070
1995-96	1.042	0.983	1.000	1.042	1.024
1996-97	0.867	1.034	0.870	0.997	0.896
1997-98	1.024	0.917	1.058	0.968	0.939
1998-99	0.906	1.117	1.087	0.833	1.011
1999-00	0.983	0.980	0.906	1.084	0.963
2000-01	1.034	0.980	1.018	1.015	1.013
2001-02	1.156	0.981	1.084	1.066	1.134
2002-03	1.060	1.016	1.000	1.060	1.076
2003-04	1.000	1.069	1.000	1.000	1.069
2004-05	1.000	1.063	1.000	1.000	1.063
2005-06	0.918	0.970	1.000	0.918	0.891
2006-07	0.867	1.110	1.000	0.867	0.963
2007-08	0.998	0.924	1.000	0.998	0.922
2008-09	1.037	0.979	1.000	1.037	1.015
2009-10	0.862	1.136	0.774	1.114	0.979
2010-11	1.040	0.923	0.957	1.087	0.960
2011-12	1.123	0.960	1.350	0.832	1.078
2012-13	0.757	1.237	1.000	0.757	0.937
2013-14	0.868	1.103	1.000	0.868	0.957
Mean	0.973	1.019	1.000	0.973	0.992

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)
PECH (pure efficiency change), SECH (scale efficiency change)
TFPCH (total factor productivity)

It is observed that the technical progress was the main contributor to TFPG in Karnataka during the pre-reform and post reform period with average efficiency score of

1.023 and 0.992. It showed 2.3 percent increases and 0.8 percent reduction in the productivity growth respectively during pre and post reform period.

Turning to the mean overall technical efficiency, they indicated positive trend overtime for the sample period, (pre and post) indicating improvement in efficiency (value greater than unity). However, not all the years registered a similar performance during the period. Some years have experienced a big increase in overall technical efficiency, while some years experienced a negative growth in technical efficiency.

The technical efficiency change decomposition showed that scale efficiency change (indicates whether the firm can increase its productivity by becoming large) and pure efficiency change have contributed to the growth of overall efficiency during pre-reform period while pure efficiency change was held responsible during post reform period.

The positive value of the scale efficiency change suggested that the aggregate manufacturing sector of Karnataka had succeeded in taking advantage of the growth in size of the sector, while the improvement in pure technical efficiency change over the reference period suggested that there was learning process, as predicted by theories of intra-firm diffusion, while analysing the trend of technical efficiency and its component, pure technical efficiency and scale efficiency during the study period, the study found that period-to-period fluctuation in pure technical efficiency had apparently contributed to the fluctuations in overall technical efficiency.

Table-14 and Table-15, reports the component measures of Malmquist TFP index for the entire pre and post reform period for the state of Kerala respectively.

TABLE – 14

MALMQUIST INDICES AND THEIR COMPONENTS– KERALA

(PRE REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1971-72	0.910	1.090	0.930	0.980	0.990
1972-73	0.880	1.150	0.950	0.930	1.010
1973-74	1.090	0.750	1.000	1.080	0.810
1974-75	1.050	1.280	1.130	0.930	1.350
1975-76	0.980	1.070	0.910	1.080	1.040
1976-77	1.070	0.960	1.100	0.970	1.030
1977-78	0.960	1.050	1.000	0.960	1.000
1978-79	1.090	1.070	1.000	1.090	1.160
1979-80	1.000	0.970	1.000	1.000	0.970
1980-81	1.000	1.160	1.000	1.000	1.160
1981-82	1.000	1.030	1.000	1.000	1.030
1982-83	1.000	1.000	1.000	1.000	1.000
1983-84	1.000	0.850	1.000	1.000	0.850
1984-85	1.000	1.000	1.000	1.000	1.000
1985-86	1.000	1.160	1.000	1.000	1.160
1986-87	1.000	1.020	1.000	1.000	1.020
1987-88	1.000	1.010	1.000	1.000	1.010
1988-89	1.000	1.100	1.000	1.000	1.100
1989-90	1.000	0.970	1.000	1.000	0.970
1990-91	1.000	0.860	1.000	1.000	0.860
Mean	1.000	1.019	1.000	1.000	1.019

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)

PECH (pure efficiency change), SECH (scale efficiency change)

TFPCH (total factor productivity)

TABLE – 15

MALMQUIST INDICES AND THEIR COMPONENTS – KERALA

(POST REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1992-93	0.946	1.072	1.000	0.946	1.014
1993-94	0.852	1.014	1.000	0.852	0.863
1994-95	0.801	1.115	1.000	0.801	0.893
1995-96	1.357	1.030	1.000	1.357	1.397
1996-97	0.979	1.002	1.000	0.979	0.981
1997-98	0.970	0.969	0.999	0.971	0.940
1998-99	1.052	1.117	0.982	1.071	1.175
1999-00	0.978	1.030	0.975	1.003	1.007
2000-01	0.960	0.985	0.972	0.987	0.945
2001-02	0.918	0.981	1.003	0.915	0.900
2002-03	1.122	0.989	1.071	1.047	1.109
2003-04	1.009	1.014	1.000	1.009	1.022
2004-05	0.884	1.202	0.986	0.896	1.063
2005-06	1.114	1.034	1.014	1.099	1.152
2006-07	1.020	1.032	1.000	1.020	1.052
2007-08	1.120	0.918	1.000	1.120	1.027
2008-09	0.976	1.005	1.000	0.976	0.981
2009-10	1.069	1.776	1.000	1.069	1.898
2010-11	1.000	0.475	1.000	1.000	0.475
2011-12	1.000	1.260	1.000	1.000	1.260
2012-13	1.000	1.000	1.000	1.000	1.000
2013-14	1.000	0.863	1.000	1.000	0.863
Mean	1.000	1.018	1.000	1.000	1.018

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)
PECH (pure efficiency change), SECH (scale efficiency change)
TFPCH (total factor productivity)

An examination of the components of the Malmquist TFP index for the manufacturing sector of Kerala showed that the productivity increase was mainly attributed to the increase in technical change during pre reform period as whole, while efficiency change and technology change contributed together for the growth of productivity during post reform period. As indicated, there was a mean increase in total factor productivity of 1.9 percent and 1.8 percent

respectively in pre and post reform period of the state of Kerala. The technical change component increased more than the efficiency change component throughout the analysis period (pre and post)in this state. The productive efficiency and scale efficiency indices were >1 only during post reform period which was indicative of a. Improvement in productive efficiency had taken place and b. Comparison to the period t, period t+1 had become close to a constant scale of return, which is gradually to the optimal size of a long- term approach.

The inter-temporal comparison of Total Factor Productivity (TFP) measured by Malmquist Productivity Index (MPI), along with the indices of technology change, efficiency change, productive efficiency change and scale efficiency change is presented in Table-16 and Table-17 for the manufacturing sector of Tamil Nadu for the pre and post reform period under study.

TABLE – 16

MALMQUIST INDICES AND THEIR COMPONENTS– TAMIL NADU

(PRE REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1971-72	0.900	1.090	1.000	0.900	0.980
1972-73	0.920	1.130	1.000	0.920	1.040
1973-74	1.220	0.840	1.000	1.220	1.020

1974-75	1.000	1.300	1.000	1.000	1.300
1975-76	1.000	1.040	1.000	1.000	1.040
1976-77	1.000	1.010	1.000	1.000	1.010
1977-78	1.000	1.040	1.000	1.000	1.040
1978-79	1.000	1.040	1.000	1.000	1.040
1979-80	1.000	0.980	1.000	1.000	0.980
1980-81	1.000	1.080	1.000	1.000	1.080
1981-82	1.000	0.970	1.000	1.000	0.970
1982-83	1.000	1.060	1.000	1.000	1.060
1983-84	1.000	0.870	1.000	1.000	0.870
1984-85	1.000	1.000	1.000	1.000	1.000
1985-86	1.000	0.960	1.000	1.000	0.960
1986-87	1.000	1.000	1.000	1.000	1.000
1987-88	1.000	0.980	1.000	1.000	0.980
1988-89	0.990	0.980	1.000	0.990	0.970
1989-90	0.940	1.120	0.960	0.980	1.060
1990-91	0.940	1.030	0.990	0.950	0.970
Mean	0.993	1.021	0.997	0.996	1.014

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)
PECH (pure efficiency change), SECH (scale efficiency change)
TFPCH (total factor productivity)

TABLE – 17

MALMQUIST INDICES AND THEIR COMPONENTS – TAMIL NADU

(POST REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1992-93	0.919	1.072	1.000	0.919	0.985
1993-94	0.928	1.014	0.909	1.022	0.941
1994-95	1.133	0.937	1.098	1.031	1.061
1995-96	0.981	0.973	0.986	0.995	0.955
1996-97	0.886	1.048	0.965	0.919	0.929
1997-98	1.013	0.917	1.053	0.962	0.929
1998-99	0.809	1.117	0.855	0.946	0.904
1999-00	1.216	0.980	1.117	1.089	1.192
2000-01	0.958	0.980	0.952	1.006	0.939
2001-02	0.952	0.981	1.015	0.938	0.934
2002-03	1.038	0.994	0.967	1.073	1.031
2003-04	0.989	1.088	0.942	1.051	1.076
2004-05	0.957	1.036	0.982	0.975	0.992
2005-06	0.952	0.996	0.982	0.969	0.948
2006-07	0.834	1.110	0.848	0.983	0.926
2007-08	1.035	0.924	1.077	0.961	0.956
2008-09	0.891	0.979	0.930	0.958	0.872
2009-10	0.868	1.136	1.043	0.832	0.986
2010-11	1.411	0.742	0.992	1.423	1.047
2011-12	1.170	0.992	1.249	0.936	1.160
2012-13	0.839	1.073	0.871	0.963	0.900
2013-14	0.849	0.977	0.932	0.911	0.830
Mean	0.974	0.999	0.985	0.989	0.973

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)

PECH (pure efficiency change), SECH (scale efficiency change)

TFPCH (total factor productivity)

The analysis of the sources of the TFP growth in the manufacturing sector of Tamil Nadu revealed that the contribution of technical progress was greater than technical efficiency change during pre-reform period and technical progress was a driving force of

productivity improvement. In other words, in the state of Tamil Nadu technology updates were at higher rate than efficiency improvement in the manufacturing sector. The combined influence of both these components explained the fact that it was high in the pre reform period when it was compared with post reform period. Also, productive efficiency figures showed that in most of the years it was equal to scale efficiency indices indicating that the major source of efficiency change was the improvement in pure technical efficiency and scale efficiency in the pre reform period. During post reform period productivity growth was fluctuating and finally productivity decline over the whole period was observed. The productive efficiency and scale efficiency indices were <1 during pre and post reform period which was indicative of a. Improvement in productive efficiency had not taken place and b. Compared to the period t, period t+1 had become close to a variable scale of return, which was gradually opposite to the optimal size of a long-term approach.

Following Table-18 and Table-19, explains the growth of total factor productivity along with the components of its growth during pre and post reform respectively under study for aggregate manufacturing sector of southern states.

TABLE – 18

MALMQUIST INDICES AND THEIR COMPONENTS–SOUTHERN STATES

(PRE REFORM PERIOD)

Year	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1971-72	0.929	1.095	0.976	0.952	1.018
1972-73	0.969	1.126	0.993	0.976	1.091
1973-74	1.070	0.835	1.001	1.069	0.894
1974-75	0.964	1.275	1.019	0.946	1.228
1975-76	1.000	1.037	0.952	1.050	1.037
1976-77	1.005	0.995	1.045	0.962	1.000
1977-78	0.917	1.045	0.902	1.017	0.958
1978-79	1.056	1.045	1.040	1.015	1.104
1979-80	0.977	0.971	1.016	0.962	0.948
1980-81	0.938	1.119	0.930	1.009	1.049
1981-82	1.035	0.986	1.065	0.972	1.020
1982-83	0.996	1.039	0.963	1.035	1.035
1983-84	1.061	0.863	1.094	0.971	0.916
1984-85	1.000	0.998	1.012	0.988	0.998
1985-86	1.050	0.997	1.012	1.038	1.047
1986-87	0.994	1.003	1.000	0.994	0.997
1987-88	1.019	0.989	1.000	1.019	1.007
1988-89	0.995	1.004	1.000	0.995	0.999
1989-90	0.936	1.103	0.976	0.959	1.032
1990-91	0.945	0.967	0.892	1.060	0.914
Mean	0.992	1.020	0.993	0.999	1.012

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)

PECH (pure efficiency change), SECH (scale efficiency change)

TFPCH (total factor productivity)

TABLE – 19

MALMQUIST INDICES AND THEIR COMPONENTS– SOUTHERN STATES

(POST REFORM PERIOD)

Years	Sources of Productivity Growth		PECH	SECH	TFPCH (MPI)
	EFFCH	TECHCH			
1992-93	0.958	1.069	1.000	0.958	1.025
1993-94	0.907	1.018	0.960	0.945	0.924
1994-95	1.012	1.003	1.041	0.972	1.015
1995-96	1.085	1.020	0.997	1.089	1.107
1996-97	0.931	1.015	0.957	0.973	0.946
1997-98	1.002	0.949	1.027	0.975	0.950
1998-99	0.937	1.106	0.978	0.959	1.036
1999-00	1.040	1.010	0.997	1.043	1.051
2000-01	0.987	0.994	0.985	1.002	0.981
2001-02	1.002	0.972	1.025	0.978	0.974
2002-03	1.054	1.022	1.009	1.045	1.077
2003-04	0.999	1.046	0.985	1.015	1.045
2004-05	0.959	1.102	0.992	0.967	1.057
2005-06	0.993	1.004	0.999	0.994	0.998
2006-07	0.927	1.080	0.960	0.965	1.001
2007-08	1.037	0.921	1.019	1.018	0.956
2008-09	0.974	0.989	0.982	0.992	0.963
2009-10	0.899	1.270	0.948	0.949	1.142
2010-11	1.158	0.740	0.987	1.173	0.857
2011-12	1.071	1.019	1.140	0.939	1.091
2012-13	0.893	1.124	0.966	0.924	1.004
2013-14	0.927	1.006	0.983	0.943	0.932
Mean	0.987	1.017	0.996	0.990	1.004

Source: Calculations are based on ASI data

Foot Note: EFFCH (efficiency change), TECHCH (technology change)
PECH (pure efficiency change), SECH (scale efficiency change)
TFPCH (total factor productivity)

The estimates of different components of the Malmquist productivity index of total factor productivity for the southern states during pre and post reform period showed that at the aggregate level productivity growth were mostly driven by technological progress before and after the reform. It implied productivity regress during the rest of the years. The average

productivity growth in both periods showed that though there was productivity increase; post reform period impact had no influence on it. In fact, the productivity growth was reduced from 1.2 percent to 0.4 percent.

Therefore, from the above analysis the hypothesis framed as "the growth of total factor productivity is not influenced by the sources of technical efficiency change and technological change in the manufacturing sector of the southern states of India before and after reform period" was rejected and the alternative hypothesis was accepted.

Following Figure-9 and Figure-10 illustrates average growth of Malmquist productivity indices in the southern states of India during pre and post reform period along with the aggregate manufacturing sector of southern states of India.

FIGURE – 9

MALQUIST PRODUCTIVITY INDEX

(PRE REFORM PERIOD)

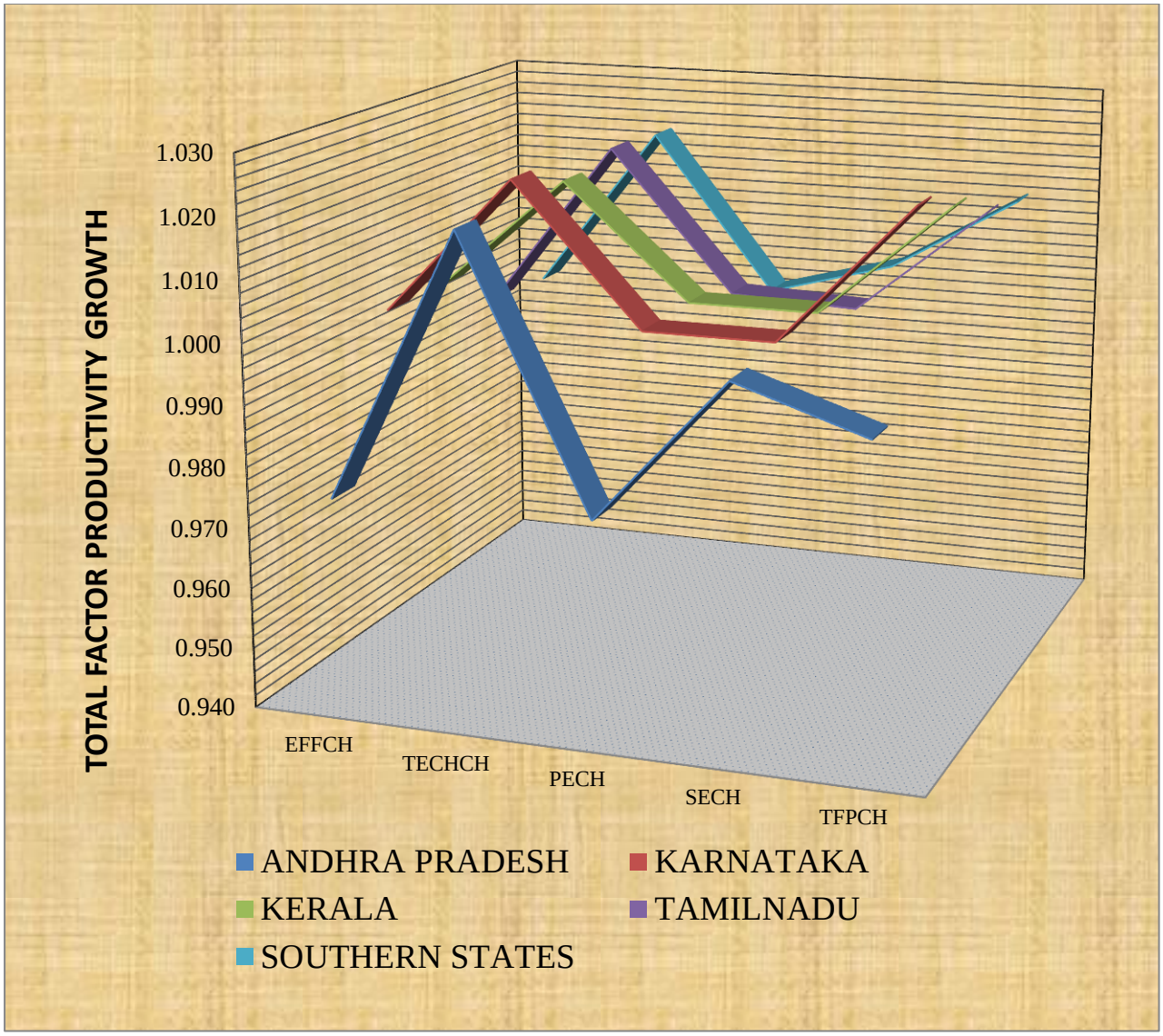
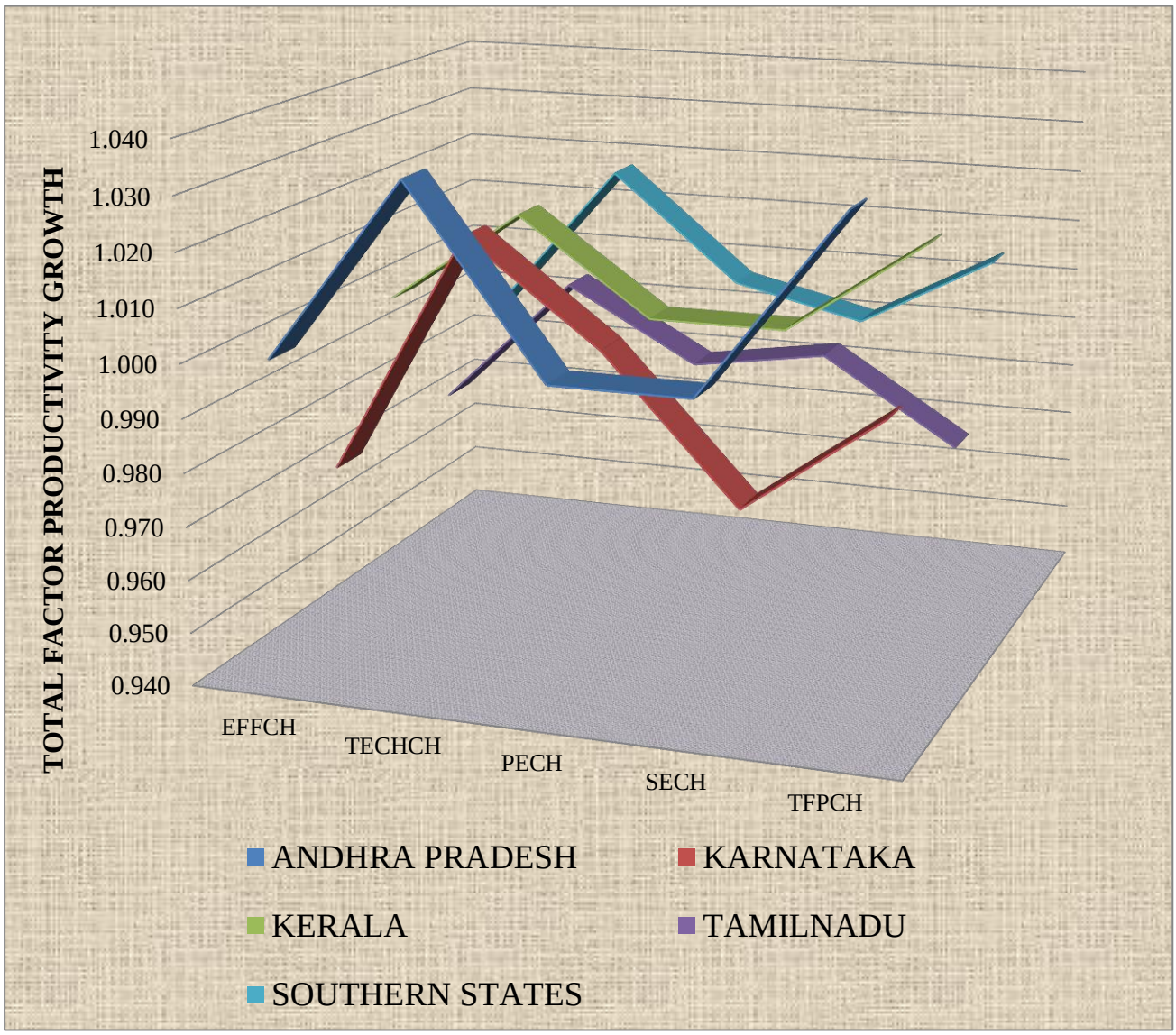

TOTAL FACTOR PRODUCTIVITY GROWTH
1.030
1.020
1.010
1.000
0.990
0.980
0.970
0.960
0.950
0.940
EFFCH
TECHCH
PECH
SECH
TFPCH
ANDHRA PRADESH
KARNATAKA
KERALA
TAMILNADU
SOUTHERN STATES

FIGURE – 10

MALMQUIST PRODUCTIVITY INDEX

(POST REFORM PERIOD)



C. Relation among Real Wages, Inflation and Productivity

Taking in to account real wage, inflation rate and labour productivity Granger causality test was applied for the data relating to pre and post reform period for the aggregated and disaggregated level for Southern states of India. To perform the pre-test, investigator employed Augmented Dickey Fuller Test (ADF), having the null hypothesis that there is unit root for all the variables selected for the Southern states of India. The Long run relationships between the variables were tested using Johansen's co-integration approach as the second procedure. The third step was to find out the causal relationship existing among variables and the fourth step was application of Vector Error Correction Model (VECM). A significant co-efficient it implies that past equilibrium errors play a role in determining the current outcomes.

a) Results of Augmented Dickey Fuller Test (ADF)

The results of Augmented Dickey Fuller Test (ADF) for the variables wage, inflation rate and labour productivity are shown in Table-20.

TABLE – 20

RESULTS OF AUGMENTED DICKEY FULLER TEST

State	Variables					
	Labour Productivity		Real Wage		Inflation	
	Pre reform	Post reform	Pre reform	Post reform	Pre reform	Post reform
Andhra Pradesh	-5.2848*	-4.7024*	-4.7764*	-5.18637*	-5.6779**	-5.5414**
Karnataka	-4.6091*	-8.3816*	-5.6313*	-5.97981*	-6.0419**	-5.4532**
Kerala	-6.5522*	-5.1113*	-4.9240*	-6.89031*	-4.8825**	-8.9454**
Tamil Nadu	-2.8398*	-5.2317*	-6.0806*	-3.95146*	-9.3026**	-4.8049**
Southern States	-4.3334*	-5.5857*	-5.2723*	-5.23818*	-4.9983**	-5.4247**

Source: Calculations are based on ASI data

Foot Note: * Stationary at first difference

** Stationary at second difference

The results showed that the test statistics for the log level of the variables labour productivity and real wages were less than the critical values in absolute terms. This implied that the null hypothesis cannot be rejected; the test statics for their first difference exceeded the respective critical values, implying rejection of null hypothesis. For inflation the test statistic showed its significance at the second difference. Hence, the variables were stationary at first and second level difference.

1. Relationships between Labour Productivity and Real Wage:

The causal relationship between labour productivity and real wage for manufacturing sector of southern states of India is discussed step wise as follows:

a) Long run relationships between labour productivity and real wage

The maximum Eigen value and trace test were used to determine the rank of the co-integrating vectors and for testing existence long run relationship existing between the variables labour productivity and real wage during pre-reform and post reform period for the southern states of India and the results are presented in Table-21 and Table-22.

TABLE – 21

UNRESTRICTED COINTEGRATION RANK TEST –LABOUR PRODUCTIVITY AND REAL WAGE (PRE REFORM PERIOD)

States	Hypothesized No. of CE (s)	Eigen value	Trace Statistic	5 percent Critical Value	Prob.**
Andhra Pradesh	None *	0.4124	19.8568	15.4947	0.0103
	At most 1 *	0.4014	9.7531	3.8414	0.0018
Karnataka	None *	0.5277	21.3768	15.4947	0.0058
	At most 1 *	0.3126	7.1231	3.8414	0.0076
Kerala	None	0.4223	15.2523	15.4947	0.0544
	At most 1 *	0.2242	4.8252	3.8414	0.0280
Tamil Nadu	None	0.3872	12.7448	15.4947	0.1245
	At most 1	0.1656	3.4398	3.8414	0.0636
Southern States	None *	0.5521	20.4939	15.4947	0.0081
	At most 1 *	0.2406	5.2299	3.8414	0.0222
States	**Hypothesized No. of CE (s)**	**Eigen value**	**Max-Eigen Statistic**	**Critical Value**	**Prob.****
Andhra Pradesh	None *	0.4124	10.1037	14.2646	0.2052
	At most 1 *	0.4014	9.7531	3.8414	0.0018
Karnataka	None *	0.5277	14.2536	14.2646	0.0502
	At most 1 *	0.3126	7.1231	3.8414	0.0076
Kerala	None	0.4223	10.4270	14.2646	0.1854
	At most 1 *	0.2242	4.8252	3.8414	0.0280
Tamil Nadu	None	0.3872	9.3050	14.2646	0.2617
	At most 1	0.1656	3.4398	3.8414	0.0636
Southern States	None *	0.5521	15.2639	14.2646	0.0346
	At most 1 *	0.2406	5.2299	3.8414	0.0222

Source: Calculations are based on ASI data

Foot note: *denotes rejection of the hypothesis at the 0.05 level

**Mackinnon-Haug-Mchelis (1999) ρ-values

TABLE – 22

UNRESTRICTED COINTEGRATION RANK TEST –LABOUR PRODUCTIVITY AND REAL WAGE (POST REFORM PERIOD)

States	Hypothesized No. of CE (s)	Eigen value	Trace Statistic	5 percent Critical Value	Prob.**
Andhra Pradesh	None *	0.2121	5.1841	15.4947	0.7890
	At most 1 *	0.0083	0.1760	3.8414	0.6748
Karnataka	None *	0.2497	6.8642	15.4947	0.5935
	At most 1 *	0.0387	0.8293	3.8414	0.3625
Kerala	None	0.2745	10.6536	15.4947	0.2337
	At most 1 *	0.1699	3.9124	3.8414	0.0479
Tamil Nadu	None	0.2361	7.4632	15.4947	0.5244
	At most 1	0.0824	1.8067	3.8414	0.1789
Southern States	None *	0.1956	6.5140	15.4947	0.6347
	At most 1 *	0.0882	1.9412	3.841466	0.1635
States	**Hypothesized No. of CE (s)**	**Eigen value**	**Max-Eigen Statistic**	**5 percent Critical Value**	**Prob.****
Andhra Pradesh	None *	0.2121	5.0080	14.2646	0.7408
	At most 1 *	0.0083	0.1760	3.8414	0.6748
Karnataka	None *	0.2497	6.0348	14.2646	0.6087
	At most 1 *	0.0387	0.8293	3.8414	0.3625
Kerala	None	0.2745	6.7411	14.2646	0.5202
	At most 1 *	0.1699	3.9124	3.8414	0.0479
Tamil Nadu	None	0.2361	5.6565	14.2646	0.6576
	At most 1	0.0824	1.8067	3.8414	0.1789
Southern States	None *	0.1956	4.5727	14.2646	0.7945
	At most 1 *	0.0882	1.9412	3.8414	0.1635

Source: Calculations are based on ASI data

Foot note: *denotes rejection of the hypothesis at the 0.05 level

**Mackinnon-Haug-Mchelis (1999) ρ-values

Based on the Trace statistic and Eigen value during pre-reform and there was sufficient evidence to reject the null hypothesis in favour of alternative hypothesis excepting

Tamil Nadu stating that there existed long run relationship among the variables Labour Productivity and Real Wage. Also, 2 co-integrating equations for Karnataka and southern states and one co-integrating equation for Andhra Pradesh and Kerala were observed. Under post reform period based on the trace statistic and Eigen value supporting evidence to reject the null hypothesis was confirmed for Kerala at 5 percent level and one co-integrating equation for Kerala was observed.

b) Short run causal relationship between labour productivity and real wage

The standard Granger causality test was applied to determine the short run causal relationship (direction) between the variables Labour Productivity (LP) and Real Wage (RW) for the manufacturing sector of southern states of India during pre and post reform period. The results of the same are reported in Table-23.

TABLE – 23

CAUSALITY BETWEEN LABOUR PRODUCTIVITY AND REAL WAGE

States	Null Hypothesis	Pre Reform Period		Post Reform Period	
		F-Statistic	prob(0.05)	F -Statistic	prob(0.05)
Andhra Pradesh	Δlog LP does not Granger cause Δlog RW	2.7213	0.1004	0.1777	0.8388
	Δlog RW does not Granger cause Δlog LP	3.3621	0.0642	0.1074	0.8988
Karnataka	Δlog LP does not Granger cause Δlog RW	3.0610	0.0789	1.1779	0.3332
	Δlog RW does not Granger cause Δlog LP	5.1109	0.0216	0.3010	0.7442
Kerala	Δlog LP does not Granger cause Δlog RW	1.6280	0.2314	0.2216	0.8036
	Δlog RW does not Granger cause Δlog LP	3.8725	0.0459	1.7180	0.2109
Tamil Nadu	Δlog LP does not Granger cause Δlog RW	0.4828	0.6270	0.2712	0.7658
	Δlog RW does not Granger cause Δlog LP	2.3543	0.1314	3.1607	0.0697
Southern States	Δlog LP does not Granger cause Δlog RW	0.7404	0.4947	0.0566	0.9451
	Δlog RW does not Granger cause Δlog LP	3.1772	0.0728	1.2217	0.3208

Source: Calculations are based on ASI data

Based on the Granger causality test it was found that the null hypotheses of labour productivity does not Granger cause wage and wage does not Granger cause labour productivity for the state of Andhra Pradesh, Tamil Nadu and southern states could not be rejected since the reported probabilities were greater than 0.05 implying that the short run relationship between labour productivity and real wage was independent of each other in these states during pre-reform period. Hence marginal productivity theory and bargaining theory was not proven since the causality runs from labour productivity to real wages was not established. Besides, the results of the Granger causality for the remaining states namely Karnataka and Kerala wage does not Granger cause labour productivity could be rejected proving the theory of efficiency wage hypothesis that higher real wages imply a higher cost of job loss for workers. When firms pay higher wages, workers exert greater effort to avoid being dismissed. Therefore, a rise in real wages will improve labour productivity by causing an increase in the cost of job loss in these two states. But the null hypothesis labour productivity does not Granger because wage cannot be rejected. Therefore, one way Granger causation runs from labour productivity to wage in the short run.

Further the Granger Causality test applied for post reform period indicated that the null hypothesis Labour Productivity does not Granger cause wage and wage does not Granger cause Labour Productivity cannot be rejected since the relationship between them were independent for all the states and for the southern states as a whole.

c) Error Correction Mechanism (ECM) – labour productivity and real wage

The coefficient of Error Correction Term (ECT) contains information about whether the past values affect the current values of the variables under study. The information obtained from the ECM is related to the speed of adjustment of the system towards long-run-equilibrium. The short-run dynamics are captured through the individual co-efficient of the difference in terms. A significant co-efficient implies that past equilibrium errors play a role in determining the current outcomes.

Results of error correction model for the relationship between labour productivity and real wage during pre and post reform period at the disaggregated and aggregated level for the manufacturing sector of Southern states of India is shown in Table-24.

TABLE – 24

RESULTS OF ERROR CORRECTION MODEL

LABOUR PRODUCTIVITY AND REAL WAGE

Pre Reform Period				Post Reform Period		
Andhra Pradesh						
Regressor	**Co-efficient**	**SE**	**T-Ratio[Prob]**	**Co-efficient**	**SE**	**T-Ratio[Prob]**
Δlog LP(-1)	0.4481	0.0875	5.1185[.810]	-0.4045	0.1025	-3.945[.001]
Δlog LP(-2)	0.0045	0.0789	1.5697(568)	-0.1889	0.1891	-0.2473(.225)
ecm(-1)	-0.1863	0.0444	-4.1937[.001]	0.0731	0.0436	1.6741[.110]
Δlog RW(-1)	1.3533	0.2643	5.1185[.000]	-1.1132	0.2821	-3.9451[.001]
Δlog RW(-2)	0.1693	0.1495	0.4086(0.255)	-0.0666	0.1635	-0.4707(0.686)
ecm(-1)	-0.0070	0.0216	-.3255[.749]	-0.1474	0.0860	-1.7138[.102]
Karnataka						
Δlog LP(-1)	0.6682	0.1537	4.3455[.000]	0.6887	0.2697	2.553[.019]
Δlog LP(-2)	0.1819	0.4452	0.4086(0.145)	0.7628	0.0427	0.7910(0.486)
ecm(-1)	-0.1663	0.0613	-2.712[.014]	-0.5565	0.2002	-2.779[.012]
Δlog RW(-1)	0.7875	0.1812	4.3455[.000]	0.0454	0.0501	0.9053[.376]
Δlog RW(-2)	0.2935	0.1425	2.0589(0.084)	0.0023	0.0991	0.2221(.423)
ecm(-1)	-0.0119	0.0259	-.4611[.650]	-0.0669	0.067	-0.9985[.330]
Kerala						
Δlog LP(-1)	0.0172	0.0267	0.6448[.527]	1.3500	1.2124	1.1135[.279]
Δlog LP(-2)	0.0921	0.0155	0.8867(.395)	0.5581	0.0540	0.0568(.452)
ecm(-1)	-0.1270	0.0630	-2.0170[.059]	-0.2570	0.1474	-1.743[.097]
Δlog RW(-1)	0.1042	0.0730	1.4259[.171]	0.0020	0.0034	0.5834[.566]
Δlog RW(-2)	0.0147	0.0423	1.1522(559)	0.0531	0.0445	0.2744(532)
ecm(-1)	-0.0240	0.0288	-.8349[.415]	-0.0580	0.0275	-2.1101[.048]
Tamil Nadu						
Δlog LP(-1)	0.7038	0.1085	6.485[.000]	0.3201	0.2107	1.5190[.144]
Δlog LP(-2)	0.1921	0.0055	0.9467(.385)	0.6582	0.1540	0.0668(.952)
ecm(-1)	-0.1159	0.0317	-3.656[.002]	-0.2651	0.1598	-1.6585[.113]
Δlog RW(-1)	1.0118	0.1560	6.4850[.000]	0.1342	0.0772	1.7392[.097]
Δlog RW(-2)	0.0147	0.0056	1.223(0.316)	0.0229	0.0040	0.4455(.777)
ecm(-1)	-0.0045	0.0169	-.2673[.792]	-0.1963	0.0974	-2.0158[.057]
Southern States						
Δlog LP(-1)	0.7914	0.1328	5.9564[.000]	0.5730	0.3778	1.5164[.145]
Δlog LP(-2)	0.0694	0.0250	0.0278(208)	0.0089	0.2352	0.2991(.767)
ecm(-1)	-0.1668	0.0355	-4.6919[.000]	-0.2656	0.1464	-1.8138[.085]
Δlog RW(-1)	0.8542	0.1434	5.9564[.000]	0.0024	0.0158	0.1553[.878]
Δlog RW(-2)	0.0056	0.0042	0.4433(303)	0.2319	0.0009	0.8866(0.750)
ecm(-1)	-0.0105	0.0135	-.7784[.446]	-0.0337	0.0399	-0.8430[.409]

Source: Calculations are based on ASI data

The results of ECM during pre-reform period showed that the ecm (-1) for causal relationship existing between labour productivity and wage was negative for the states of

Andhra Pradesh, Karnataka, Tamil Nadu and Southern states respectively -0.1864, -0.1663, -0.1159 and -0.1668 which signified that labour productivity, converge to long run equilibrium level in relation to wage during pre-reform period since the co-efficient was significant at 1 percent level. In other words, 18.64 percent, 16.63 percent, 11.59 percent and 16.68 percent of disequilibrium from previous periods shock conveyed back to the long run equilibrium in the current period respectively in the above said manufacturing sectors. Also, when there is deviation from the long term equilibrium, the error correction term has an opposite adjustment effect and the deviation degree were reduced. Whereas, under post reform the significant the co-efficient of the individual variables indicated that the past equilibrium errors played in determining the current outcomes and there is a need for short run adjustments for the relationship existing between labour productivity and wage and wage and labour productivity in the manufacturing sector of Andhra Pradesh.

2. Relationships between Labour Productivity and Inflation

The causal relationship between labour productivity and inflation for manufacturing sector of southern states of India is discussed step wise as follows:

a) Long run relationships between labour productivity and inflation

The maximum Eigen value and trace test were used to determine the rank of the co-integrating vectors and for testing existence long run relationship existing between the variables labour productivity and inflation during pre-reform and post reform period for the Southern states of India and the results are presented in Table-25 and Table-26.

TABLE – 25

UNRESTRICTED COINTEGRATION RANK TEST – LABOUR PRODUCTIVITY AND INFLATION (PRE REFORM PERIOD)

States	Hypothesized No. of CE (s)	Eigen value	Trace Statistic	Critical Value	Prob**
Andhra Pradesh	None *	0.5360	17.7971	15.4947	0.0221
	At most 1	0.1552	3.2065	3.8414	0.0733
Karnataka	None *	0.6078	21.6482	15.4947	0.0052
	At most 1 *	0.1839	3.8618	3.8414	0.0494
Kerala	None*	0.5857	27.8680	15.4947	0.0004
	At most 1 *	0.4431	11.1242	3.8414	0.0009
Tamil Nadu	None*	0.7945	30.5553	15.4947	0.0001
	At most 1	0.0253	0.4877	3.8414	0.4849
Southern States	None *	0.5812	20.4333	15.4947	0.0083
	At most 1 *	0.1852	3.892031	3.8414	0.0485
States	**Hypothesized No. of CE (s)**	**Eigen value**	**Max-Eigen Statistic**	**Critical Value**	**Prob.****
Andhra Pradesh	None *	0.5360	14.5905	14.2646	0.0444
	At most 1	0.1552	3.2065	3.8414	0.0733
Karnataka	None *	0.6078	17.7863	14.2646	0.0133
	At most 1 *	0.1839	3.8618	3.8414	0.0494
Kerala	None	0.5857	16.7438	14.2646	0.0199
	At most 1	0.4431	11.1242	3.8414	0.0009
Tamil Nadu	None	0.7945	30.0676	14.2646	0.0001
	At most 1*	0.0253	0.4877	3.8414	0.4849
Southern States	None *	0.5812	16.5412	14.2646	0.0215
	At most 1 *	0.1852	3.8920	3.8414	0.0485

Source: Calculations are based on ASI data

Foot note: *denotes rejection of the hypothesis at the 0.05 level

**Mackinnon-Haug-Mchelis (1999) ρ-values

TABLE – 26

UNRESTRICTED COINTEGRATION RANK TEST – LABOUR PRODUCTIVITY AND INFLATION (POST REFORM PERIOD)

States	Hypothesized No. of CE (s)	Eigen Value	Trace Statistic	Critical Value	Prob.**
Andhra Pradesh	None *	0.6345	23.565	15.4947	0.0025
	At most 1	0.1092	2.4284	3.8414	0.1192
Karnataka	None *	0.7053	38.4743	15.4947	0.0000
	At most 1 *	0.4567	12.8151	3.8414	0.0003
Kerala	None*	0.7716	31.4356	15.4947	0.0001
	At most 1 *	0.0200	0.4251	3.8414	0.5144
Tamil Nadu	None*	0.4196	17.1350	15.4947	0.0281
	At most 1	0.2380	5.7081	3.8414	0.0169
Southern States	None *	0.4680	13.2548	15.4947	0.1058
	At most 1 *	7.62E-06	0.00016	3.8414	0.9915
States	**Hypothesized No. of CE (s)**	**Eigen Value**	**Max-Eigen Statistic**	**Critical Value**	**Prob.****
Andhra Pradesh	None *	0.6345	21.1366	14.2646	0.0035
	At most 1	0.1092	2.4284	3.8414	0.1192
Karnataka	None *	0.7053	25.6591	14.2646	0.0005
	At most 1 *	0.4567	12.8151	3.8414	0.0003
Kerala	None	0.7716	31.0104	14.2646	0.0001
	At most 1 *	0.0200	0.4251	3.8414	0.5144
Tamil Nadu	None*	0.4196	11.4269	14.2646	0.1341
	At most 1	0.2380	5.7081	3.8414	0.0169
Southern States	None *	0.4680	13.2546	14.2646	0.0717
	At most 1 *	7.62E-06	0.00016	3.8414	0.9915

Source: Calculations are based on ASI data

Foot note: *denotes rejection of the hypothesis at the 0.05 level

**Mackinnon-Haug-Mchelis (1999) ρ-values

Based on the trace statistic and Eigen value during pre-reform period there was sufficient evidence to reject the null hypothesis in favour of alternative hypothesis. The test results clearly suggested all the test statistics are significant at 5 percent level indicating long

run relationship. Both the statistics indicated 2 co-integrating equations for Karnataka, Kerala and for the southern sector at 0.05 level indicating two linear combination of the variable and one co-integrating equation for Andhra Pradesh and Tamilnadu.

Under post reform period based on the trace statistic and Eigen value supporting evidence to reject the null hypothesis was confirmed for Andhra Pradesh Karnataka, Kerala and Tamilnadu. Both the statistics indicated 2 co-integrating equations for Karnataka and one co-integrating equations for Andhra Pradesh, Kerala and Tamil Nadu long run relationship was established between labour productivity and inflation for the manufacturing sector.

b) Short run causal relationship between labour productivity and inflation

The standard Granger causality test was applied to determine the short run causal relationship (direction) between the variables Labour Productivity (LP) and Inflation (INF) for the manufacturing sector of southern states of India during pre and post reform period. The results of the same are reported in Table-27.

TABLE – 27

CAUSALITY BETWEEN LABOUR PRODUCTIVITY AND INFLATION

States	Null Hypothesis	Pre reform period		Post reform period	
		F-Statistic	Prob(0.05)	F-Statistic	Prob(0.05)
Andhra Pradesh	Δlog LP does not Granger cause Δlog INF	0.6816	0.5218	1.0766	0.3642
	Δlog INF does not Granger cause Δlog LP	0.1564	0.8567	7.3572	0.0054
Karnataka	Δlog LP does not Granger cause Δlog INF	1.0953	0.3614	0.4155	0.6669
	Δlog INF does not Granger cause Δlog LP	0.3912	0.6834	12.6581	0.0005
Kerala	Δlog LP does not Granger cause Δlog INF	2.6840	0.1031	5.8964	0.0121
	Δlog INF does not Granger cause Δlog LP	3.5678	0.0559	6.7921	0.0073
Tamil Nadu	Δlog LP does not Granger cause Δlog INF	1.0609	0.3724	2.5133	0.1124
	Δlog INF does not Granger cause Δlog LP	1.0650	0.3710	2.4602	0.1171
Southern States	Δlog LP does not Granger cause Δlog INF	1.7968	0.2020	8.4355	0.0032
	Δlog INF does not Granger cause Δlog LP	0.41870	0.6659	3.7923	0.0449

Source: Calculations are based on ASI data

A perusal of the above table indicated that during pre-reform period the null hypothesis Labour Productivity (LP) does not granger cause Inflation (INF) and Inflation

(INF) does not granger cause Labour Productivity (LP) could not be rejected for all the states and southern states because of the reason that there was no evidence of causality flowing either from labour productivity to inflation and inflation to labour productivity.

On the other hand during post reform period bi-directional causality was observed between these two variables i.e. inflation and labour productivity in the manufacturing sector of Kerala and Southern states while in the other 3 states there existed unidirectional causality. A unidirectional flow of causality running from productivity to inflation in the Southern states as a whole proved the standard theoretical view productivity growth is exogenous and increases in workers' productivity bring about decreases in the rate of inflation by raising the economy's aggregate supply. Inflationary pressure may be reduced by productivity growth. In other words, according to this view, changes in productivity precede changes in inflation rate.

c) Error Correction Mechanism (ECM) –labour productivity and real wage

Results of error correction model for the relationship between labour productivity and inflation during pre and post reform period at the disaggregated and aggregated level for the manufacturing sector of southern states of India is shown in Table-28.

TABLE – 28

RESULTS OF ERROR CORRECTION MODEL

LABOUR PRODUCTIVITY AND INFLATION

Pre Reform Period				Post Reform Period		
Andhra Pradesh						
Regressor	**Co-efficient**	**SE**	**T-Ratio[Prob]**	**Co-efficient**	**SE**	**T-Ratio[Prob]**
Δlog LP(-1)	-0.1658	0.0740	-2.2393[.038]	0.0116	0.0053	2.1693[.042]
Δlog LP(-2)	-0.1172	0.3367	0.6387(765)	0.0056	0.0004	1.6513(.498)
ecm(-1)	-0.1646	0.0498	-3.2995[.004]	-0.0350	0.0326	-1.0733[.296]
Δlog INF(-1)	-1.0873	0.2885	-3.7685[.001]	-0.0144	0.0541	-0.2674[.792]
Δlog INF (-2)	-0.2172	0.8367	0.7387(765)	0.0156	0.0014	1.6513(.498)
ecm(-1)	0.1832	0.0256	7.1528[.000]	0.1372	0.0082	16.5428[.000]
Karnataka						
Δlog LP(-1)	-0.4473	0.1359	-3.2904[.004]	0.0246	0.0327	.7540[.460]
Δlog LP(-2)	-0.5172	0.7367	0.9387(765)	0.0176	0.0114	1.6513(.598)
ecm(-1)	-0.1371	0.0481	-2.8514[.011]	-0.2065	0.1852	-1.1151[.278]
Δlog INF(-1)	-0.8697	0.2643	-3.2904[.004]	0.0322	0.0876	.3675[.717]
Δlog INF (-2)	-1.0477	0.4454	-3.0374[.017]	0.0720	0.1163	0.1253[.802]
ecm(-1)	0.1434	0.0084	16.9993[.000]	0.1281	0.0175	7.3234[.000]
Kerala						
Δlog LP(-1)	-0.3350	0.1105	-3.0294[.007]	0.6293	0.0759	8.2847[.000]
Δlog LP(-2)	-0.0174	0.2368	0.1387(.865)	0.0258	0.0604	1.6513(.998)
ecm(-1)	-0.1108	0.0320	-3.4591[.003]	-0.0011	0.0250	0.0001(0.993)
Δlog INF(-1)	-1.0465	0.3454	-3.0294[.007]	0.0020	0.0163	0.1253[.902]
Δlog INF (-2)	-0.4172	0.5367	0.6387(.165)	0.5156	0.5014	1.6513(.428)
ecm(-1)	0.13194	0.0081	16.2180[.000]	0.1370	0.0133	10.2431[.000]
Tamil Nadu						
Δlog LP(-1)	-0.2978	0.0831	-3.5836[.002]	-0.0033	0.0047	-0.7077[.487]
Δlog LP(-2)	-0.0184	0.0118	0.2387.(875)	-0.0158	0.0604	1.6513(.298)
ecm(-1)	-0.1206	0.0289	-4.1651[.001]	-0.0060	0.0396	-.1520[.881]
Δlog INF(-1)	-1.4451	0.4032	-3.5836[.002]	-0.0364	0.0902	-0.4042[.690]
Δlog INF (-2)	-0.2451	0.3332	-1.5836[.556]	-0.0784	0.0807	-0.4042[.609]
ecm(-1)	0.1521	0.0082	18.3925[.000]	0.1526	0.0122	12.4950[.000]
Southern states						
Δlog LP(-1)	-0.3716	0.1151	-3.2265[.005]	0.0258	0.0950	.2717[.789]
Δlog LP(-2)	-0.4452	0.8397	0.7307(365)	0.0015	0.5514	0.6513(.828)
ecm(-1)	-0.1409	0.0344	-4.0914[.001]	-0.1729	0.3366	-0.5136[.613]
Δlog INF(-1)	-1.0221	0.3167	-3.2265[.005]	-0.0109	0.0379	-0.2893[.775]
Δlog INF (-2)	-0.0531	0.0170	-0.0265[.099]	-0.0027	0.0879	-0.1093[.975]
ecm(-1)	0.1514	0.0069	21.7972[.000]	0.1430	0.0122	11.7156[.000]

Source: Calculations are based on ASI data

The results of ECM during pre-liberalisation period showed that the ecm (-1) for causal relationship existing between labour productivity and inflation was negative for all

states and aggregate manufacturing sector of southern states The ecm (-1) of -0.1646, -0.1371, -0.1108, -0.1206 and -0.1409 respectively in the manufacturing sector of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and southern states bring out the fact that 16.46 percent, 11.08 percent,12.06 percent and 14.09 percent of disequilibrium from previous periods shock convey back to the long run equilibrium in the current period respectively in the above said manufacturing sectors. The significant co-efficient of the individual variables indicated that the past equilibrium errors played in determining the current outcomes and there is a need for short run adjustments for the relationship existing between labour productivity and inflation in the manufacturing sector of Andhra Pradesh and Kerala during post reform period.

3. Relationships between Real Wage and Inflation

The causal relationship between real wage and inflation for manufacturing sector of southern states of India is discussed step wise as follows:

a) Long run relationships between real wage and inflation

The maximum Eigen value and trace test were used to determine the rank of the co-integrating vectors and for testing existence long run relationship existing between the variables real wage and inflation during pre reform and post reform period for the southern states of India and the results are presented in Table-29 and Table-30.

TABLE – 29

UNRESTRICTED COINTEGRATION RANK TEST – REAL WAGE AND INFLATION

(PRE REFORM PERIOD)

States	Hypothesized No. of CE (s)	Eigen value	Trace Statistic	Critical Value	Prob.**
Andhra Pradesh	None *	0.3928	11.5890	15.4947	0.1777
	At most 1 *	0.1049	2.1074	3.8414	0.1466
Karnataka	None *	0.4901	17.1038	15.4947	0.0284
	At most 1 *	0.2027	4.3055	3.8414	0.038
Kerala	None	0.4736	13.7914	15.4947	0.888
	At most 1 *	0.0805	1.5964	3.8414	0.2064
Tamil Nadu	None	0.7830	31.2163	15.4947	0.001
	At most 1	0.1084	2.1818	3.8414	0.1396
Southern States	None *	0.3409	8.9114	15.4947	0.3736
	At most 1 *	0.0506	0.9879	3.8414	0.3202
States	**Hypothesized No. of CE (s)**	**Eigen value**	**Max-Eigen Statistic**	**Critical Value**	**Prob.****
Andhra Pradesh	None *	0.3928	9.4815	14.2646	0.2483
	At most 1 *	0.1049	2.1074	3.841	0.1466
Karnataka	None *	0.4901	12.7982	14.2646	0.0841
	At most 1 *	0.2027	4.3055	3.8414	0.038
Kerala	None	0.4736	12.1949	14.2646	0.1035
	At most 1 *	0.0805	1.5964	3.8414	0.2064
Tamil Nadu	None	0.7830	29.0345	14.2646	0.001
	At most 1	0.1084	2.1818	3.8414	1.396
Southern States	None *	0.3409	7.9234	14.2646	0.3865
	At most 1 *	0.0506	0.9879	3.8414	0.3202

Source: Calculations are based on ASI data

Foot note: *denotes rejection of the hypothesis at the 0.05 level

**Mackinnon-Haug-Mchelis (1999) ρ-values

TABLE – 30

UNRESTRICTED COINTEGRATION RANK TEST –REAL WAGE AND INFLATION

(POST REFORM PERIOD)

States	Hypothesized No. of CE (s)	Eigen value	Trace Statistic	Critical Value	Prob.**
Andhra Pradesh	None *	0.5187	18.8362	15.4947	0.0151
	At most 1	0.1526	3.4790	3.8414	0.0621
Karnataka	None *	0.5733	19.0476	15.4947	0.0139
	At most 1 *	0.0537	1.1598	3.8414	0.2815
Kerala	None*	0.5944	20.5133	15.4947	0.0080
	At most 1 *	0.0716	1.5622	3.8414	0.2113
Tamil Nadu	None*	0.2883	9.4716	15.4947	0.3235
	At most 1	0.1049	2.3287	3.8414	0.1270
Southern States	None *	0.3536	11.6884	15.4947	0.1725
	At most 1 *	0.1132	2.5229	3.8414	0.1122
States	**Hypothesized No. of CE (s)**	**Eigen value**	**Max-Eigen Statistic**	**Critical Value**	**Prob.****
Andhra Pradesh	None *	0.5187	15.3571	14.2646	0.0335
	At most 1	0.1526	3.4790	3.841	0.0621
Karnataka	None *	0.5733	17.8878	14.2646	0.0128
	At most 1 *	0.0537	1.1598	3.8414	0.2815
Kerala	None	0.5944	18.9511	14.2646	0.0084
	At most 1 *	0.0716	1.5622	3.8414	0.2113
Tamil Nadu	None*	0.2883	7.1429	14.2646	0.4724
	At most 1	0.1049	2.3287	3.8414	0.1270
Southern States	None *	0.3536	9.1655	14.2646	0.2726
	At most 1 *	0.1132	2.5229	3.8414	0.1122

Source: Calculations are based on ASI data

Foot note: *denotes rejection of the hypothesis at the 0.05 level

**Mackinnon-Haug-Mchelis (1999) ρ-values

During pre-reform period based on the Trace statistic and Eigen value supporting evidence to reject the null hypothesis was confirmed for the state of Karnataka and Tamilnadu at 5 percent level of significance indicating linear combination of the variables of 2 co-integrating equation for Karnataka at 10 percent level and one co-integrating equation for Tamilnadu at one percent level. There was sufficient evidence to reject the null hypothesis in favour of alternative hypothesis for the states of Andhra Pradesh, Karnataka and Kerala during post reform period indicating long run relationship at 5 percent level of significance between real wage and inflation. Also, both the statistics indicated one co-integrating equations for the above mentioned states based on the Trace statistic and Eigen value.

b) Determination of the short run causal relationship between real wage and inflation

The standard Granger causality test was applied to determine the short run causal relationship (direction) between the variables real wage (RW) and inflation (INF) for the manufacturing sector of southern states of India during pre and post reform period. The results of the same is reported in table-31

TABLE – 31

CAUSALITY BETWEEN REAL WAGE AND INFLATION

States	Null Hypothesis	Pre Reform Period		Post Reform Period	
		F-Statistic	Prob (0.05)	F-Statistic	Prob (0.05)
Andhra Pradesh	Δlog RW does not Granger cause Δlog INF	0.1745	0.8416	0.2183	0.8062
	Δlog INF does not Granger cause Δlog RW	0.0862	0.9179	2.7223	0.0960
Karnataka	Δlog RW does not Granger cause Δlog INF	0.5464	0.5909	0.2399	0.7895
	Δlog INF does not Granger cause Δlog RW	0.3632	0.7018	0.2922	0.7505
Kerala	Δlog RW does not Granger cause Δlog INF	0.17882	0.8381	0.5570	0.5836
	Δlog INF does not Granger cause Δlog RW	0.0999	0.9055	1.1711	0.3352
Tamil Nadu	Δlog RW does not Granger cause Δlog INF	0.1694	0.8458	0.5460	0.5897
	Δlog INF does not Granger cause Δlog RW	0.3059	0.7413	0.0461	0.9551
Southern States	Δlog RW does not Granger cause Δlog INF	1.4466	0.2685	0.2540	0.7787
	Δlog INF does not Granger cause Δlog RW	0.2433	0.7872	0.6146	0.5531

Source: Calculations are based on ASI data

Based on the above evidence it was concluded that there was absence of causal relationship between the variables in log difference form during pre and post reform period between real wage and inflation in all the southern states and at the aggregate level during the reference period under study.

c) Error Correction Mechanism (ECM) – real wage and inflation

Results of error correction model for the relationship between real wage and inflation during pre and post reform period at the disaggregated and aggregated level for the manufacturing sector of Southern states of India is shown in Table-32.

TABLE – 32
RESULTS OF ERROR CORRECTION MODEL
REAL WAGE AND INFLATION

Pre Reform Period				Post Reform Period		
Andhra Pradesh						
Regressor	**Co-efficient**	**SE**	**T-Ratio[Prob]**	**Co-efficient**	**SE**	**T-Ratio[Prob]**
Δlog RW(-1)	-0.4186	0.1110	-3.7685[.001]	-0.0035	0.0072	-.4917[.628]
Δlog RW(-2)	-0.0183	0.0810	-0.7080[.955]	-0.0275	0.0872	-.4917[.571]
ecm(-1)	0.0034	0.0419	.0828[.935]	-0.0240	0.0521	-.4613[.650]
Δlog INF(-1)	-1.3731	0.6131	-2.2393[.038]	-0.0201	0.0645	-.3124[.758]
Δlog INF (-2)	-0.0241	0.0123	-2.2393[.539]	-0.0012	0.0948	-.3124[.399]
ecm(-1)	0.1704	0.0156	10.9068[.000]	0.1391	0.0124	11.1685[.000]
Karnataka						
Δlog RW(-1)	-0.3429	0.1730	-1.9817[.063]	0.0038	0.0048	.7934[.437]
Δlog RW(-2)	-0.0527	0.0744	-0.5017[.499]	0.0012	0.0003	.0324[.297]
ecm(-1)	0.0109	0.0438	0.2508[.805]	-0.0320	0.0371	-.86452[.398]
Δlog INF(-1)	-0.5472	0.2761	-1.9817[.063]	0.0107	0.0916	.11748[.908]
Δlog INF (-2)	-0.0629	0.0711	-1.0817[.363]	0.0010	0.0956	.11748[.763]
ecm(-1)	0.14905	0.0175	8.4745[.000]	0.1324	0.0136	9.7078[.000]
Kerala						
Δlog RW(-1)	-0.36727	0.1280	-2.8674[.010]	0.0016	0.0025	0.6477[.525]
Δlog RW(-2)	-0.36727	0.1280	-2.8674[.210]	0.0016	0.0025	0.6477[.415]
ecm(-1)	0.0125	0.0285	0.4395[.665]	-0.0591	0.0274	-2.1536[.044]
Δlog INF(-1)	-0.8876	0.3095	-2.867[.010]	-0.0319	0.0828	-0.3855[.704]
Δlog INF (-2)	-0.1176	0.0915	-0.867[.055]	-0.0115	0.0927	-0.3855[.688]
ecm(-1)	0.1364	0.0148	9.1919[.000]	0.1404	0.0082	17.0124[.000]
Tamil Nadu						
Δlog RW(-1)	-0.3937	0.0927	-4.2453[.000]	0.1342	0.0772	1.7392[.097]
Δlog RW(-2)	-0.2223	0.1227	-1.0453[.560]	0.0209	0.0932	1.7392[.427]
ecm(-1)	-0.0074	0.0249	-.2991[.768]	-0.1963	0.0974	-2.0158[.057]
Δlog INF(-1)	-1.3071	0.3078	-4.2453[.000]	-0.0303	0.1199	-.2526[.803]
Δlog INF (-2)	-1.1031	0.5088	-0.2453[.881]	-0.0094	0.0655	-.0564[.770]
ecm(-1)	0.1598	0.0131	12.1568[.000]	0.1515	0.0125	12.0797[.000]
Southern states						
Δlog RW(-1)	-0.4213	0.1212	-3.4756[.003]	0.0008	0.0034	.2530[.803]
Δlog RW(-2)	-0.0811	0.6912	-1.4756[.433]	0.0101	0.1054	.1511[.603]
ecm(-1)	0.0085	0.0254	.3372[.740]	-0.0338	0.0307	-1.1014[.284]
Δlog INF(-1)	-0.9859	0.2836	-3.4756[.003]	-0.0165	0.0605	-.2727[.788]
Δlog INF (-2)	-0.1899	0.2989	-0.4756[.563]	-0.0098	0.1775	-.2727[.753]
ecm(-1)	0.1595	0.0124	12.8653[.000]	0.1413	0.0075	18.6971[.000]

Source: Calculations are based on ASI data

The results of ECM in relation to the relationship existing between real wage and inflation showed that ecm (-1) during pre-reform and post reform period was positive which

showed that there was no evidence for the influence of past equilibrium errors playing a role in determining the current outcome and also convergence to long run equilibrium position in all the four states and southern states as whole.

From the analysis of the above the hypothesis framed as “theoretical causal relationship existing among labour productivity, real wage and inflation are not proved in the manufacturing sector of southern states of India before and after reform period” was rejected only for the causal relation existing between among labour productivity and real wage, and real wage and inflation. It was accepted for causal relation existing between real wage and inflation.

D. Production Function Estimates

Cobb-Douglas production function was applied to estimate factor intensity, returns to scale, share of inputs, marginal productivity of capital, marginal productivity of labour and marginal rate of technical substitution of labour for capital taking in to account real wage, fixed capital as independent variables and gross output as dependent variable during pre and post reform period under study. To perform the pre-test, investigator employed Augmented Dickey Fuller Test (ADF), having the null hypothesis that there is unit root for all the variables selected for the southern states of India. The results are shown in Table-33.

TABLE – 33

RESULTS OF AUGMENTED DICKEY FULLER TEST

Pre Liberalization Period			
State	**Real Wage**	**Gross Output**	**Fixed Capital**
Andhra Pradesh	-4.7765*	-3.0559*	-2.7349**
Karnataka	-5.6314*	-5.2248*	-2.5746**
Kerala	-4.9240*	-3.6075*	-6.0526*
Tamil Nadu	-6.0806*	-5.2248*	-6.6220*
Southern States	-5.2724*	-5.9007*	-5.2912*
Post Liberalization Period			
Andhra Pradesh	-5.1864*	-5.4018*	-5.9478*
Karnataka	-5.9798*	-5.0035*	-4.0906*
Kerala	-6.8903*	-7.5359*	-11.1171*
Tamil Nadu	-3.9515*	-4.8665*	-3.0603*
Southern States	-5.2382*	-6.7738*	-5.8756*

Source: Calculations are based on ASI data

Foot Note: * Stationary at first difference

** Stationary at second difference

Based on the above results, the null hypothesis of a unit-root process could be rejected for all the variables in their first difference and second difference at five percent level indicating that the variables were stationary. The Table-34 and Table-35 exhibits details on the trends MP_K ratios during pre and post reform period state-wise.

TABLE – 34

GROWTH OF MP_K RATIOS – PRE REFORM PERIOD

States / Year	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Southern States
1970-71	0.4168	0.4626	1.2048	1.6495	1.8170
1971-72	0.4167	0.5783	1.2595	1.7108	1.9604
1972-73	0.5397	0.6048	0.7942	1.7734	1.8493
1973-74	0.5500	0.6011	0.7904	2.0140	1.8866
1974-75	0.6438	0.6667	1.0960	2.7391	2.3584
1975-76	0.6686	0.6183	1.1627	2.7691	2.4313
1976-77	0.6436	0.6225	1.1590	2.9514	2.4345
1977-78	0.5646	0.6570	1.2348	3.0548	2.4423
1978-79	0.5721	0.6441	1.2763	3.1467	2.4810
1979-80	0.5070	0.6917	1.2701	3.2899	2.4476
1980-81	0.5123	0.6785	1.6200	3.4862	2.6803
1981-82	0.5279	0.7276	1.6526	3.3664	2.7520
1982-83	0.5902	0.7140	1.4346	3.4669	2.7231
1983-84	0.5770	0.7142	1.1876	2.9412	2.4857
1984-85	0.5806	0.7109	1.2475	3.0251	2.5456
1985-86	0.5948	0.7094	1.2185	2.6996	2.4661
1986-87	0.5648	0.7229	1.2940	2.6897	2.4839
1987-88	0.5930	0.7223	1.4213	2.6882	2.5800
1988-89	0.5521	0.7244	1.4783	2.4606	2.5149
1989-90	0.5281	0.8523	1.5972	2.7422	2.6953
1990-91	0.3084	0.8706	1.4170	2.6052	2.1490
$\bar{X}$	0.5453	0.6807	1.2770	2.7271	2.3897
σ	0.0829	0.0885	0.2255	0.5487	0.2877
C.V	15.20	13.00	17.66	20.12	12.04
Trend rate (β_1)	-.001 (-.290)	.013* (8.800)	.023* (3.471)	.038 (2.059)	.029* (3.514)

Source: Calculations are based on ASI data

Foot note: Figures in parentheses indicate 't' values of the estimates

*Significant at 1% level

TABLE – 35

GROWTH OF MP_K RATIOS – POST REFORM PERIOD

States / Year	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Southern States
1991-92	1.1037	0.8510	3.3542	-2.1042	0.1940
1992-93	1.1939	0.6972	3.4341	-2.0915	0.1884
1993-94	1.2101	0.6800	2.9649	-1.9683	0.1790
1994-95	1.4295	0.6531	2.8041	-1.8598	0.1796
1995-96	1.8019	0.6592	3.1424	-1.9831	0.1958
1996-97	1.6263	0.5819	4.2368	-1.8540	0.1888
1997-98	1.7562	0.4617	3.1082	-2.0305	0.1691
1998-99	1.8080	0.3399	4.4729	-1.8595	0.1496
1999-00	2.0461	0.4221	5.0864	-2.1587	0.1889
2000-01	2.2097	0.4721	5.0527	-2.3675	0.2044
2001-02	2.0164	0.4687	4.2406	-2.2498	0.1845
2002-03	2.4347	0.5337	5.0652	-2.1274	0.2049
2003-04	2.2904	0.6129	5.9323	-2.3956	0.2224
2004-05	2.7541	0.7625	6.3044	-2.676	0.2586
2005-06	2.8471	0.8069	7.2616	-2.6946	0.2737
2006-07	2.9369	0.8790	7.6389	-2.9301	0.2959
2007-08	2.6951	0.8257	7.8481	-2.8635	0.2831
2008-09	2.7084	0.7000	7.6990	-2.6327	0.2547
2009-10	1.7073	0.6504	15.9936	-2.4201	0.2670
2010-11	2.0356	0.7070	6.9422	-2.7309	0.2475
2011-12	1.4604	0.8043	9.3206	-3.2317	0.2530
2012-13	1.4983	0.7397	8.9183	-2.8445	0.2391
2013-14	1.6767	0.7143	7.2235	-2.1383	0.2160
$\overline{X}$	1.9673	0.6532	6.0020	-2.3571	0.2190
σ	0.5582	0.1467	2.9631	0.3963	0.0408
C.V	28.37	22.46	49.37	-16.81	18.63
Trend rate(β_1)	0.035 (2.141)	0.007 (1.541)	0.341* (5.740)	0-.044* (-5.317)	0.004* (4.824)

Source: Calculations are based on ASI data

Foot note: Figures in parentheses indicate 't' values of the estimates

*Significant at 1% level

There had been increase in the MP_K ratios during pre-reform period from the beginning of the period to the end of the period excepting the manufacturing sector of Andhra Pradesh both at the aggregated and at disaggregated level. The ratios had grown at a rate of 1.3 percent, 2.3 percent, 3.8 percent respectively in the in the manufacturing sectors of Karnataka, Kerala, Tamil Nadu. No doubt this had made the southern states as whole to grow at the rate of 2.9 percent. The growth rate MPK ratios of Kerala had shown a decline of 1 percent. It was positive for all the states, which implied that capital had contributed positively to output by all the manufacturing sectors of southern states. With regard to the stability in the growth of these ratios based on the C.V figures it was more for Karnataka (13.00 percent), followed by Andhra Pradesh (15.20 percent), Kerala (17.66 percent) and Tamil Nadu (20.12 percent). Around 12 percent was observed for the southern states as whole.

The post reform had positively influenced average MPK ratios of manufacturing sector of Kerala. It was obvious based on the average figure that it was high among the four southern states of India with 34.1 percent which was statistically significant. But this growth rate was not stable because of high co-efficient of variation compared to all other states. Post reform had adversely affected the growth of MP_K ratios of Tamil Nadu, showing negative growth rate to the extent of 4.4 percent. This was due to the reason that in this state labour was the main factor positively influencing the output during the period under study. Excluding Tamil Nadu all the other states were responsible for the slow growth of the MP_K ratios in the southern states of India.

The trends in the growth of Marginal Productivity of Labour (MP_L) ratio is presented in Table-36 and Table-37 for the reference period under study state wise.

TABLE – 36

GROWTH OF MP_L RATIOS – PRE REFORM PERIOD

States / Year	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Southern States
1970-71	0.5444	0.6031	-0.1795	-0.5471	-0.8447
1971-72	0.5203	0.5889	-0.1727	-0.5461	-0.8214
1972-73	0.5384	0.5938	-0.1958	-0.5294	-0.8498
1973-74	0.5496	0.5505	-0.1546	-0.5327	-0.7914
1974-75	0.6246	0.5941	-0.2128	-0.5971	-0.9301
1975-76	0.6089	0.6270	-0.2033	-0.5733	-0.9158
1976-77	0.5418	0.6683	-0.2299	-0.6344	-0.9470
1977-78	0.5060	0.6369	-0.2353	-0.7156	-0.9551
1978-79	0.4698	0.6808	-0.2231	-0.6582	-0.9211
1979-80	0.4767	0.6816	-0.2279	-0.6919	-0.9380
1980-81	0.4761	0.6784	-0.2509	-0.7111	-0.9728
1981-82	0.4763	0.7625	-0.2536	-0.7369	-1.0233
1982-83	0.5130	0.6542	-0.2537	-0.7520	-0.9941
1983-84	0.5187	0.6212	-0.2149	-0.6724	-0.9162
1984-85	0.5017	0.5814	-0.2082	-0.7150	-0.8977
1985-86	0.5495	0.6353	-0.2197	-0.7304	-0.9609
1986-87	0.5524	0.6536	-0.2214	-0.7373	-0.9711
1987-88	0.5435	0.6921	-0.2277	-0.7282	-0.9851
1988-89	0.5766	0.6907	-0.2415	-0.7491	-1.0263
1989-90	0.5765	0.7925	-0.2536	-0.8078	-1.0913
1990-91	0.6238	0.8554	-0.2360	-0.8236	-1.1230
$\overline{X}$	0.5376	0.6592	-0.2198	-0.6757	-0.9465
σ	0.0464	0.0737	0.0272	0.0901	0.0820
C.V	8.6310	11.1802	12.3749	13.3343	8.6635
Trend rate (β_1)	0.001 (0.608)	0.008* (3.968)	-0.003* (-3.883)	-0.013* (-10.312)	-0.011* (-6.310)

Source: Calculations are based on ASI data

Foot note: Figures in parentheses indicate 't' values of the estimates

*Significant at 1% level

TABLE – 37

GROWTH OF MP_L RATIOS – POST REFORM PERIOD

States / Year	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Southern States

1991-92	0.0196	0.3048	-2.0494	2.9340	0.8542
1992-93	0.0198	0.2603	-2.0689	3.2342	0.8412
1993-94	0.0212	0.2937	-2.0138	3.6061	0.9042
1994-95	0.0194	0.2819	-1.6051	3.5989	0.8356
1995-96	0.0183	0.2850	-2.2409	3.4172	0.8668
1996-97	0.0197	0.3026	-2.2337	3.3409	0.8951
1997-98	0.0228	0.3229	-2.4007	3.3536	0.9650
1998-99	0.0252	0.3712	-3.0196	3.6310	1.1034
1999-00	0.0257	0.3494	-3.0199	4.4243	1.1464
2000-01	0.0254	0.3716	-3.0100	4.1914	1.14767
2001-02	0.0259	0.4103	-2.7165	3.9822	1.1410
2002-03	0.0290	0.4891	-3.4441	4.4017	1.3291
2003-04	0.0326	0.5693	-3.7455	5.0508	1.5109
2004-05	0.0355	0.6322	-3.8578	5.5098	1.6397
2005-06	0.0357	0.6588	-4.2489	5.7373	1.7086
2006-07	0.0429	0.6501	-4.6296	6.0849	1.8394
2007-08	0.0406	0.6487	-4.7089	6.0317	1.8142
2008-09	0.0410	0.7161	-5.0793	5.1752	1.8361
2009-10	0.0384	0.6473	-10.1186	5.2131	2.0811
2010-11	0.0423	0.6502	-4.3002	5.5626	1.7736
2011-12	0.0405	0.7545	-5.2042	6.4904	2.8535
2012-13	0.0458	0.6026	-5.1702	5.7247	1.8133
2013-14	0.0474	0.6162	-4.8478	5.5266	1.8011
$\overline{X}$	0.0311	0.4865	-3.7275	4.6184	1.4218
σ	0.0098	0.1697	1.8142	1.1002	0.5100
C.V	31.51	34.88	48.67	23.82	36.57
Trend rate (β_1)	.001* (16.791)	0.023* (10.791)	-0.206* (-5.546)	0.148* (10.111)	0.069* (9.278)

Source: Calculations are based on ASI data
Foot note: Figures in parentheses indicate 't' values of the estimates
*Significant at 1% level

Trends in the growth of MP_L ratios during pre-reform period showed that additional productivity made to the total production of labour by the manufacturing sector was negative in the states of Kerala, Tamil Nadu and which made the southern states as a whole to be negative in terms of marginal productivity of labour during pre-reform period. Trend rate calculated showed that for whole period compared to Andhra Pradesh the performance interms of marginal productivity of Karnataka was 8 percent which was statistically

significant. A decline was noted at the rate of 3 percent, 13 percent and 11 percent respectively in Kerala, Tamil Nadu and southern states. The key reason may be that the variable input was being changed while all other factors of production may be held constant.

During post reform period excepting Kerala the performance of manufacturing sectors of southern states in terms of marginal productivity of labour were positive throughout the reference period under study during post reform period. Calculated trend rate showed that it was high for Tamil Nadu (14.8 percent) followed by Karnataka (2.3 percent) and Andhra Pradesh (1 percent). These states were held responsible for 6.9 percent growth rate in the southern states as a whole. But it was found based on co-efficient of variation that there was instability in the growth of marginal productivity of labour to the extent of 31.51 percent, 34.88 percent and 23.82 percent in the above mentioned states. The overall picture for southern states as a whole was 36.57 percent.

In micro-economic theory, the Marginal Rate of Technical Substitution (MRTS) or Technical Rate of Substitution (TRS) is the amount by which the quantity of one input has to be reduced when one extra unit of another input is used, so that output remains constant. In other words the MRTS shows the rate at which one input (e.g. capital or labour) may be substituted for another, while maintaining the same level of output. An analysis of Marginal Rate of Technical Substitution of Labour for capital ($MRTS_{LK}$**)** was carried out .The results are presented state wise and for the southern states as a whole in Table-38 and Table-39.

TABLE – 38
$MRST_{LK}$ RATIOS – PRE REFORM PERIOD

States / Year	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Southern States
1970-71	1.3062	1.3038	-0.1489	-0.3316	-0.4648
1971-72	1.2484	1.0183	-0.1371	-0.3191	-0.4189
1972-73	0.9975	0.9819	-0.2465	-0.2985	-0.4595
1973-74	0.9992	0.9158	-0.1956	-0.2644	-0.4195

1974-75	0.9700	0.8912	-0.1941	-0.2180	-0.3943
1975-76	0.9107	1.0139	-0.1748	-0.2070	-0.3766
1976-77	0.8418	1.0736	-0.1983	-0.2149	-0.3889
1977-78	0.8962	0.9694	-0.1905	-0.2342	-0.3910
1978-79	0.8210	1.0570	-0.1747	-0.2091	-0.3712
1979-80	0.9401	0.9854	-0.1794	-0.2103	-0.3832
1980-81	0.9293	0.9998	-0.1548	-0.2039	-0.3629
1981-82	0.9023	1.0479	-0.1534	-0.2188	-0.3718
1982-83	0.8692	0.9162	-0.1768	-0.2169	-0.3650
1983-84	0.8988	0.8697	-0.1809	-0.2286	-0.3685
1984-85	0.8639	0.8177	-0.1669	-0.2363	-0.3526
1985-86	0.9239	0.8955	-0.1802	-0.2705	-0.3896
1986-87	0.9779	0.9040	-0.1710	-0.2741	-0.3909
1987-88	0.9165	0.9581	-0.1602	-0.2708	-0.3818
1988-89	1.0442	0.9534	-0.1633	-0.3044	-0.4080
1989-90	1.0918	0.9297	-0.1587	-0.2945	-0.4048
1990-91	2.0225	0.9825	-0.1665	-0.3161	-0.5225
$\overline{X}$	1.0177	0.9755	-0.1749	-0.2544	-0.3994
σ	0.2606	0.0995	0.0230	0.0429	0.0404
C.V	25.61	10.20	-13.15	-16.86	-10.12
Trend rate (β_1)	0.008 (0.797)	-0.008* (-2.421)	0.001 (1.324)	-0.001 (-0.380)	0.001 (0.365)

Source: Calculations are based on ASI data

Foot note: Figures in parentheses indicate 't' values of the estimates

*Significant at 1% level

TABLE – 39

$MRST_{LK}$ RATIOS –POST REFORM PERIOD

States / Year	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Southern States
1991-92	0.0178	0.3582	-0.6110	-1.3943	4.4012
1992-93	0.0166	0.3734	-0.6024	-1.5463	4.4649
1993-94	0.0175	0.4319	-0.6792	-1.8320	5.0494
1994-95	0.0136	0.4316	-0.5724	-1.9351	4.6514
1995-96	0.0101	0.4324	-0.7131	-1.7231	4.4262
1996-97	0.0121	0.5200	-0.5272	-1.8019	4.7410

1997-98	0.0130	0.6994	-0.7723	-1.6516	5.7036
1998-99	0.0139	1.0920	-0.6751	-1.9526	7.3735
1999-00	0.0125	0.8277	-0.5937	-2.0495	6.0669
2000-01	0.0115	0.7871	-0.5957	-1.7703	5.6139
2001-02	0.0128	0.8754	-0.6406	-1.7699	6.1828
2002-03	0.0119	0.9164	-0.6799	-2.069	6.4838
2003-04	0.0142	0.9289	-0.6313	-2.1083	6.7932
2004-05	0.0129	0.8291	-0.6119	-2.059	6.3400
2005-06	0.0125	0.8164	-0.5851	-2.1291	6.2419
2006-07	0.0146	0.7395	-0.6060	-2.0766	6.2156
2007-08	0.0150	0.7855	-0.6000	-2.1063	6.4074
2008-09	0.0151	1.0230	-0.6597	-1.9657	7.2074
2009-10	0.0225	0.9952	-0.6326	-2.1540	7.7921
2010-11	0.0208	0.9196	-0.61943	-2.0369	7.1656
2011-12	0.0277	0.9380	-0.5583	-2.0083	11.2770
2012-13	0.0305	0.8146	-0.5797	-2.0125	7.5818
2013-14	0.0282	0.8627	-0.6711	-2.5844	8.3353
$\overline{X}$	0.0164	0.7564	-0.6269	-1.9451	6.3703
σ	0.0057	0.2216	0.0546	0.2436	1.5636
C.V	34.83	29.30	-8.72	-12.52	24.54
Trend rate (β_1)	0.001* (3.566)	0.024* (5.055)	0.001 0.674	-0.028* (-5.575)	0.188* (6.475)

Source: Calculations are based on ASI data
Foot note: Figures in parentheses indicate 't' values of the estimates
*Significant at 1% level

During pre-reform period it was very clear that in the states of Karnataka and Kerala there was no need for capital input to be to be reduced for the sake of maintaining the same level of output since the ratios were negative in the sense it had to further increase the quantum if capital input. On the other hand the positive ratios in other two states showed that there was some amount of sacrifice. In other words the substitution ratio of 1:1.0177 for Andhra Pradesh and 1: 0.9755 for Karnataka for the aggregate period showed that to maintain the same level of output the capital input has to be reduced to the extent of 1.0177 and 0.9755 units respectively.

During post reform period in the manufacturing sectors of Kerala and Tamil Nadu, there was no need for capital input to be reduced for the sake of maintaining the same level of output since the ratios were negative in the sense it had to further increase the quantum of capital input. On the other hand the positive ratios in other two states namely Andhra Pradesh

and Karnataka showed that there is some minimum amount of sacrifice. In other words, the substitution ratio of 1:0.0164 for Andhra Pradesh and 1: 0.7564 for Karnataka. Hence the manufacturing sector of Andhra Pradesh and Karnataka will have sacrifice 0.0164 units and 0.7564 units respectively of capital input to maintain the output level over the reference period under study. The trend rate of substitution was only 1 percent for Andhra Pradesh where as it was 24 percent for Tamil Nadu and Karnataka with lower inconsistency compared with Andhra Pradesh, Kerala and southern states as a whole. Substitution possibilities during the reference period were missing in these states. And looking at the substitution possibilities of the southern states as whole, it was surprising to note that the rate was 1:6.3703, which indicated during post reform period the capital input to the extent of 6.3703 units to be reduced to maintain the same level of output.

Estimates relating to organizational efficiency, returns to scale, percentage share of factor inputs and nature of technology during pre-reform period for the southern states of India along with the aggregate figure are shown in Table-40.

TABLE – 40

ESTIMATES OF PRODUCTION FUNCTION –PRE REFORM PERIOD

States	A	Capital(β1)	Wage(β2)	Economies of scale(S)	R^2	D.W Statistics	β1/S	β2/S
Andhra Pradesh	0.2359* (4.2642)	0.5444* (4.4016)	0.4168* (3.2295)	0.9612	0.8814	1.998	0.5664	0.4336
Karnataka	0.2943 (1.7676)	0.6031 (0.9500)	0.4626 (0.7796)	1.0657	0.7012	2.011	0.5660	0.4341
Kerala	0.2945 (1.8232)	-0.1795 (-0.3238)	1.2048 (2.2962)	1.0253	0.7886	1.999	-0.1750	1.175
Tamil	0.0522	-0.5471	1.6495*	1.1024	0.8034	2.030	-0.4962	1.4962

Nadu	(0.4014)	(-1.5964)	(4.7412)					
Southern States	0.9934 (0.7282)	-0.8447 -1.0385	1.8170 (2.3763)	0.9723	0.9023	2.100	-0.8687	1.8687

Source: Calculations are based on ASI data

Foot note: Figures in parentheses indicate t-values

*Significant at 1% level

Efficiency parameter 'A' or the organizational efficiency was positive and significant in the manufacturing sector of Andhra Pradesh. This implied that the contribution of entrepreneurship to output was positive. Capital co-efficient β1 was positive in Andhra Pradesh which implied that there existed positive and statistically significant relationship between output and capital and also between output and wage in this state. Wage co-efficient β2, was also positive and statistically significant for Andhra Pradesh and Tamil Nadu which implied that there existed positive relationship between inputs -output. The sum of co-efficient (s) β1and β2 showed increasing returns to scale in the states Karnataka, Kerala and Tamil Nadu. The percentage share of factor inputs presented indicated that the percentage share of wage was higher in 2 out of 4 states than capital in the manufacturing sector of Kerala and Tamil Nadu.

The results asserts the importance of skilled labour component in the states such as Kerala, Tamil Nadu and for the whole of southern states, with regard to the type of technology adopted by the states, it could be observed that the manufacturing sector of Andhra Pradesh and Karnataka were adopting capital intensive technology since the coefficients of (β_1) was greater than wage co-efficient (β_2). The manufacturing sector of Tamil Nadu, Kerala and southern states as whole was known for Labour intensive technology based on the coefficients ($\beta_2 > \beta_1$).

Production function estimates relating to organizational efficiency, returns to scale, percentage share of factor inputs and nature of technology during post reform period for the southern states of India along with the aggregate figure is shown in Table-41.

TABLE – 41

ESTIMATES OF PRODUCTION FUNCTION –POST REFORM PERIOD

States	A	Capital (β1)	Wage (β2)	Economies of scale(S)	R^2	D.W Statistics	β1/S	β2/S

Andhra Pradesh	0.3157 (1.3995)	0.0197 (0.0499)	1.1038 (2.5305)	1.1235	0.7212	2.0010	0.0175	0.9825
Karnataka	0.098 (0.4826)	0.3049 (0.7277)	0.8511 (1.4561)	1.156	0.8147	2.0020	0.2638	0.7362
Kerala	0.2924 (1.3635)	-2.0495 (-1.704)	3.3543* (2.7571)	1.3048	0.8003	2.0273	-1.5707	2.5707
Tamil Nadu	-0.1089 (-0.5817)	2.9341* (4.0341)	-2.1042* (-2.642)	0.8299	0.7612	1.9990	3.5356	-2.5356
Southern States	0.157 (0.4305)	0.8542 (1.1593)	0.1941 (0.2211)	1.0483	0.9210	2.0001	0.8149	0.1851

Source: Calculations are based on ASI data

Foot note: Figures in parentheses indicate t-values

*Significant at 1% level

Efficiency parameter 'A' or the organizational efficiency was positive in the manufacturing sector of Andhra Pradesh, Karnataka, Kerala and for the aggregate sector of southern states during post reform period which implied that the contribution of entrepreneurship to output was positive. Increasing returns to scale was observed based on the sum of individual co-efficient of labour and wage for 3 out of four sectors including the whole of southern states excepting Tamil Nadu. With regard to the type of technology adopted by these states, it was noticed that Andhra Pradesh, Karnataka and Kerala known for labour intensive technology while Tamil Nadu was adopting capital intensive technology.

The hypothesis framed as "Significant differences are not observed in the growth of marginal productivity of labour, capital and marginal rate of technical substitution of labour for capital in the manufacturing sector of southern states of India before and after reform period" was rejected and the alternative hypothesis was accepted.