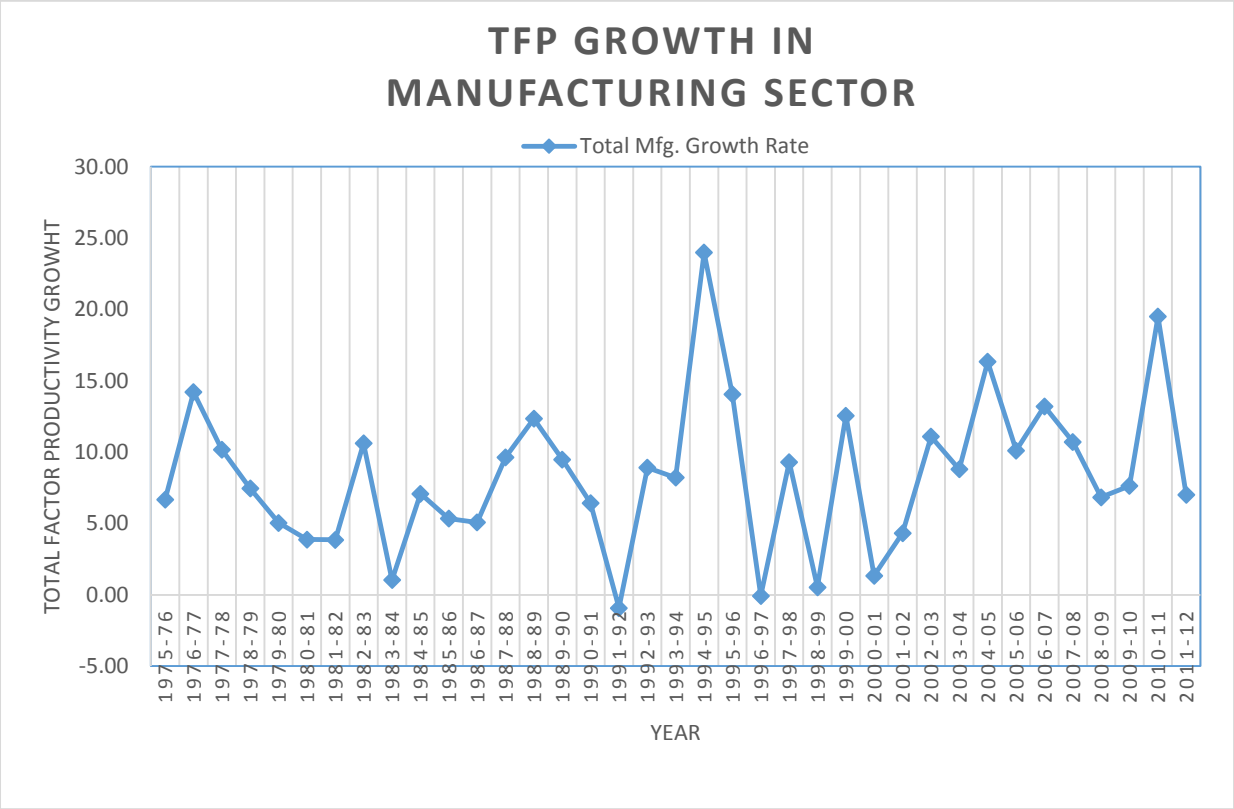
Chapter 4

Data Analysis and Interpretation

Total Factor Productivity Growth of Indian Manufacturing Sector

This section details the estimates of total factor productivity growth rate of the Indian manufacturing sector. In this section, present the empirical results pertaining to the organised manufacturing sector at aggregate level, using the translog production function approaches. The estimates presented in figure 4.1 is for the period 1975-76 to 2011-12 for aggregate manufacturing sector.

Figure 4.1 Total Factor Productivity Growth of Manufacturing Sector for the period of 1975-76 to 2011-12



Source: Author's calculation

The Figure 4.1 gives a synoptic view of the TFPG for the organised manufacturing sector. It can be seen from Figure 4.1 that the TFPG declining in seventies but in eighties TFPG shows increasing trend. Despite the fluctuations in TFPG after post liberalisation period, per annum

growth rate of TFP accelerated. The TFPG during the post-reform period, especially during 2000-01 to 20110-12, is very much evident.

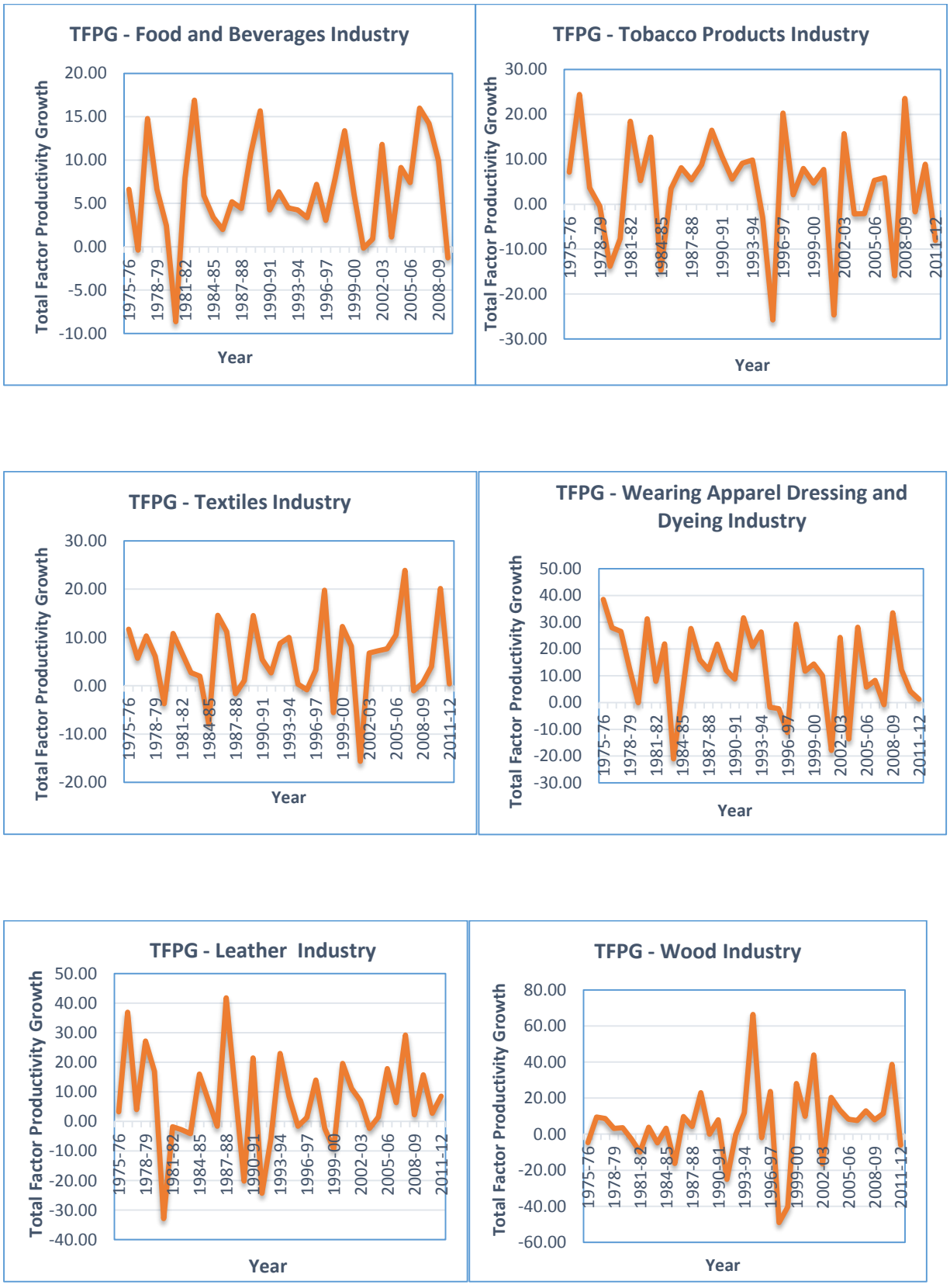
The year to year growth rate in productivity for all 22 2-digit sectors shows sharp fluctuations. But looking at the growth rate (figure 4.1), study observe distinct phases of growth of TFPG. In the 1990s, TFPG reached the highest growth in 1994-95 but started declining till 1996-97. The resurgence of TFPG growth after 2000-01 till 2004-05.

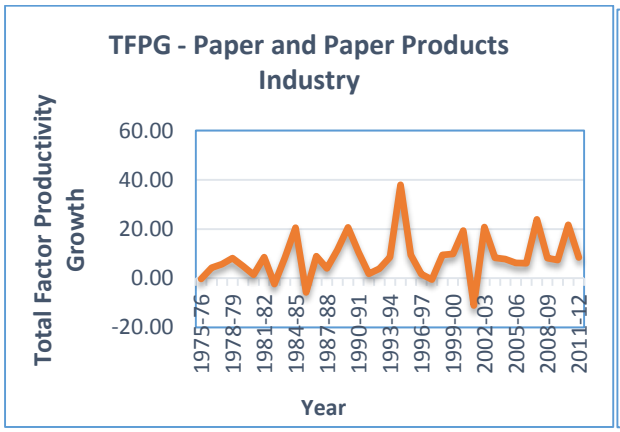
The below figure 4.2, the time paths of TFP growth, as these enable us to observe the TFPG movements across industries in a less rigid framework than in the framework of pre and post-reform period. We present the annual growth-path of TFP for the 22 industries of India. It can be seen from above Figures that in most of the industries shows high fluctuation in growth rate of total factor productivity, see appendix 4.1 for growth rate of productivity of 22 industries. TFP seems to be increase at a constant rate over the entire span of the study. After the post liberalization period, the TFP has been rising at a higher rate as compare with the pre liberalization period.

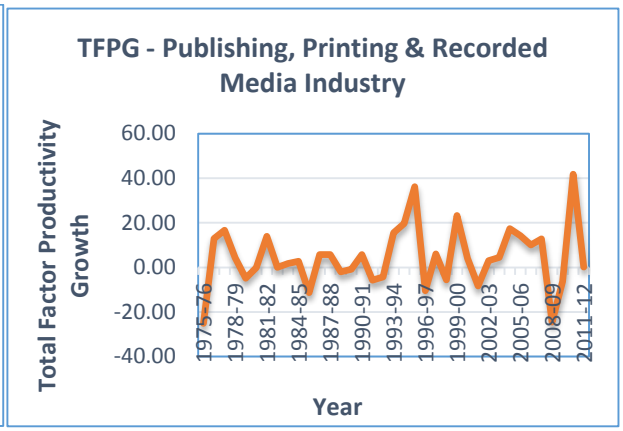
The industries which followed a similar pattern of growth were Food Products and Beverages (15), Textiles (17), Chemicals Products (24), Rubber and Plastic Products (25), Medical, Precision and Optical (33) (see below Figure 4.2). The two industries which did well in the last phase were cotton textile (23) and electrical machinery (36). Industry Fabricated Metal Products (28) after the 2^{nd} phase showing increasing tread in growth rate of productivity. Performance of Wood industry (20) was not good, in two phases, there was a negative productivity growth.

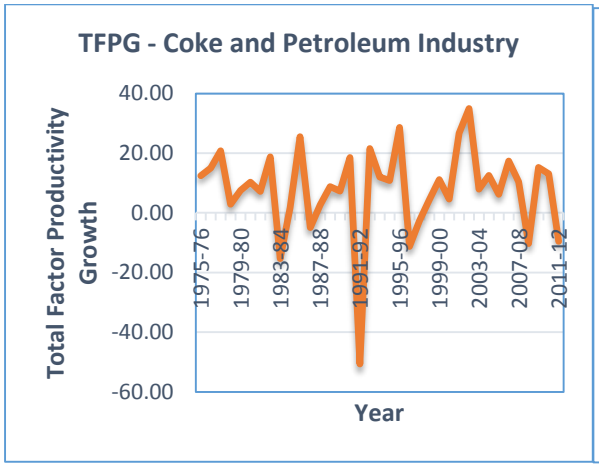
The industries which followed a very high fluctuation were Tobacco Product industry (16), Leather industries (19), Coke and Petroleum industries (23), Other Non-metallic Mineral industry (26) and Furniture industry (36).

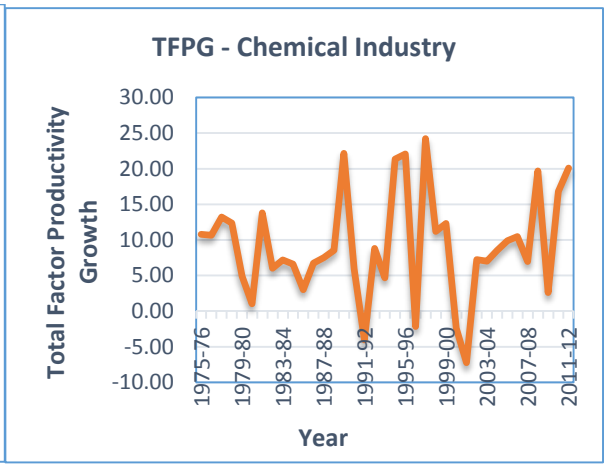
Figure 4.2 Total Factor Productivity Growth of 22 2-digit Indian Manufacturing Sector

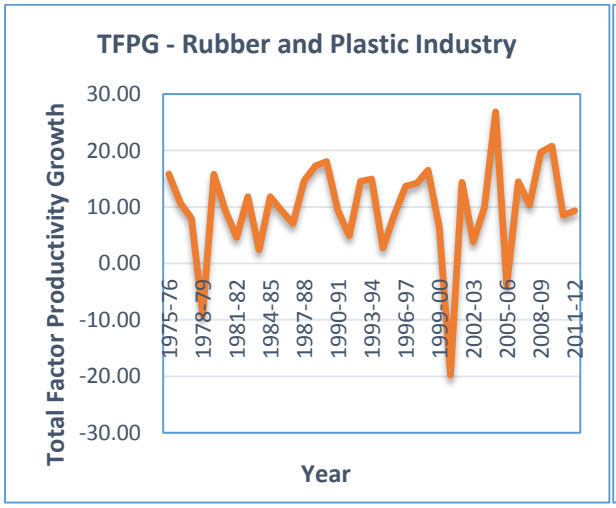


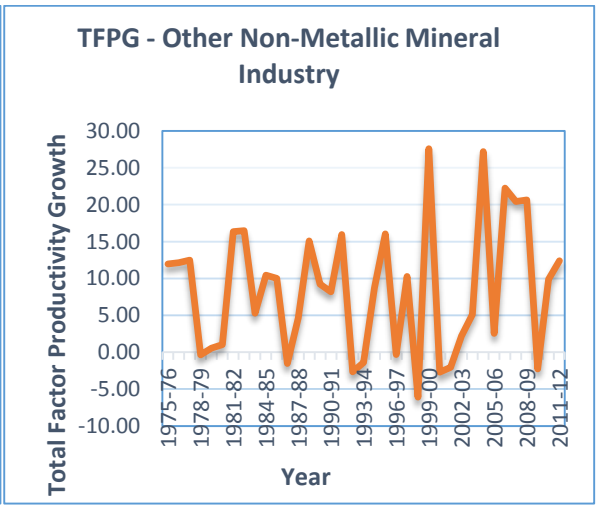

TFPG - Paper and Paper Products Industry
Total Factor Productivity Growth
60.00
40.00
20.00
0.00
-20.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

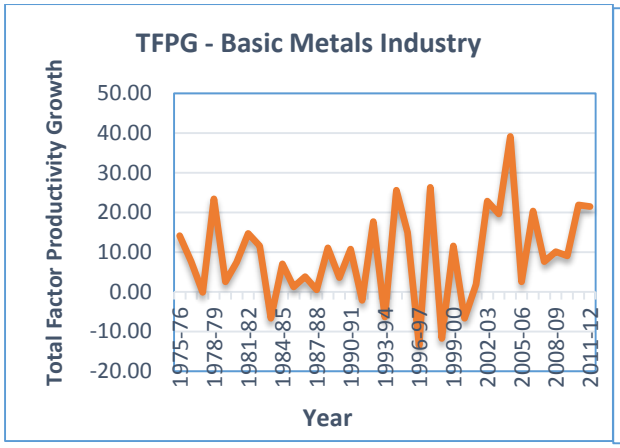

TFPG - Publishing, Printing & Recorded Media Industry
Total Factor Productivity Growth
60.00
40.00
20.00
0.00
-20.00
-40.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

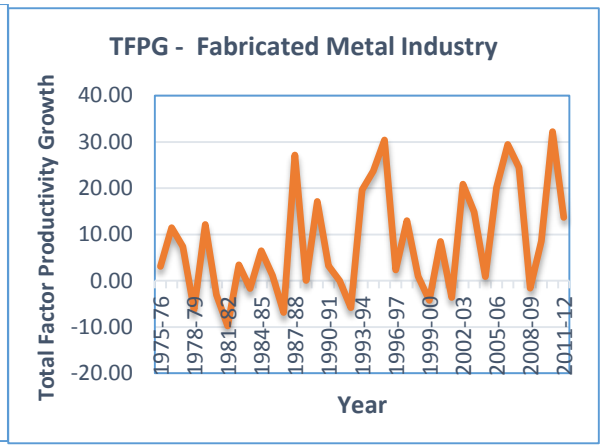

TFPG - Coke and Petroleum Industry
Total Factor Productivity Growth
40.00
20.00
0.00
-20.00
-40.00
-60.00
1975-76
1979-80
1983-84
1987-88
1991-92
1995-96
1999-00
2003-04
2007-08
2011-12
Year

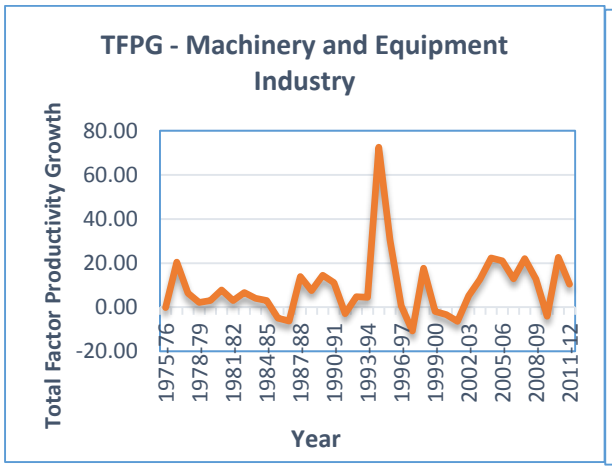

TFPG - Chemical Industry
Total Factor Productivity Growth
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
1975-76
1979-80
1983-84
1987-88
1991-92
1995-96
1999-00
2003-04
2007-08
2011-12
Year

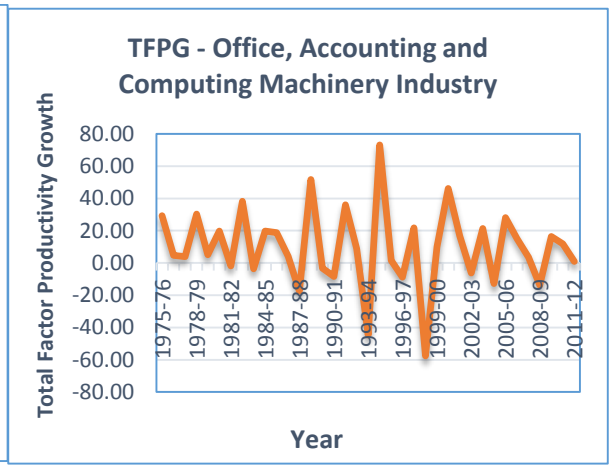

TFPG - Rubber and Plastic Industry
Total Factor Productivity Growth
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

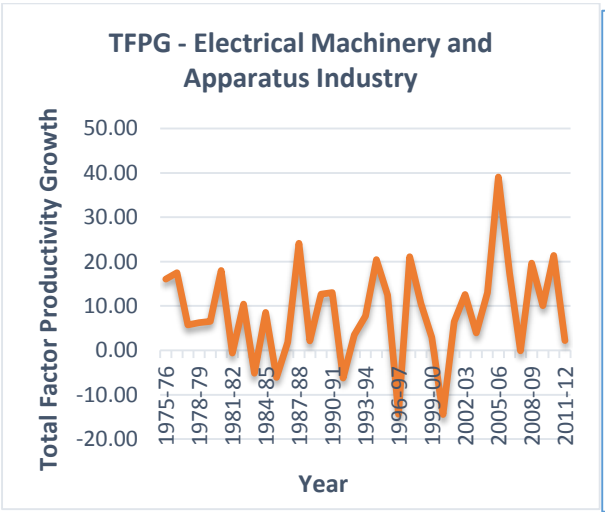

TFPG - Other Non-Metallic Mineral Industry
Total Factor Productivity Growth
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

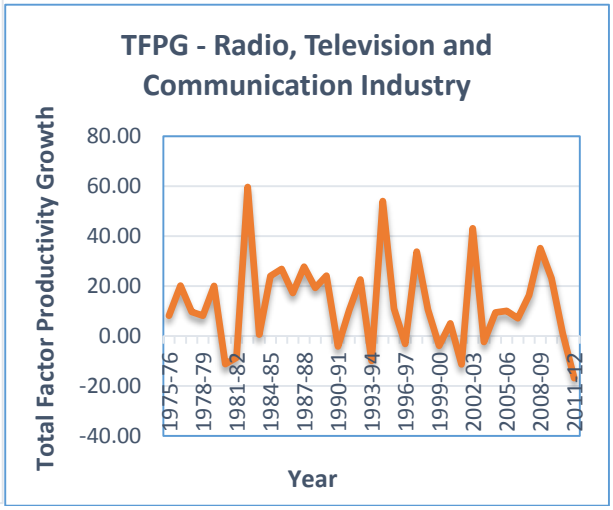

TFPG - Basic Metals Industry
Total Factor Productivity Growth
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

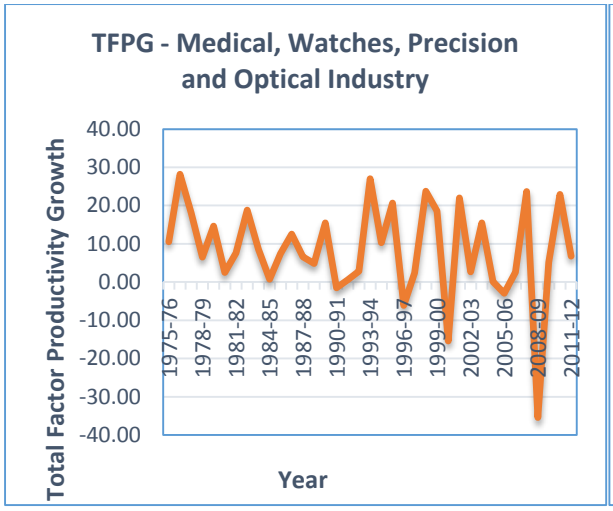

TFPG - Fabricated Metal Industry
Total Factor Productivity Growth
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

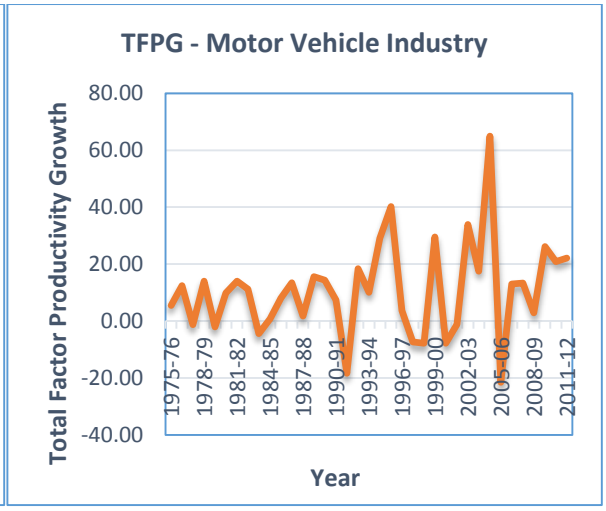

TFPG - Machinery and Equipment Industry
Total Factor Productivity Growth
80.00
60.00
40.00
20.00
0.00
-20.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

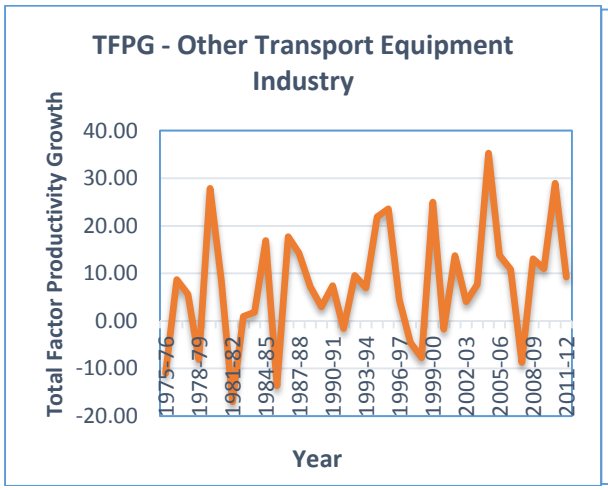

TFPG - Office, Accounting and Computing Machinery Industry
Total Factor Productivity Growth
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
-80.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year

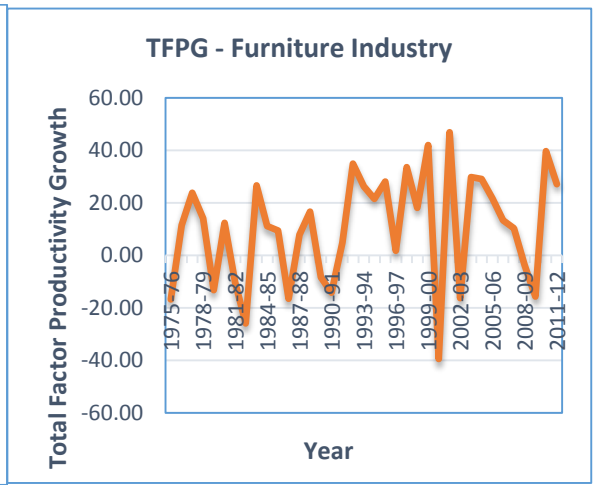

TFPG - Electrical Machinery and Apparatus Industry
Total Factor Productivity Growth
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year


TFPG - Radio, Television and Communication Industry
Total Factor Productivity Growth
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
Year









Total Factor Productivity Growth: Trends

In this sub-section, we first discuss the growth rates trend of TFP obtained using the growth accounting framework (i.e., discrete approximation of the translog production function). As mentioned earlier, opinions have differed over the inclusion of the year 1991-92 as a post or pre-reform year. In view of this, we have estimated productivity with two alternative pre and post reform periods. We also highlight the annual variations in TFPG which allow us to view the fluctuations in TFPG over the span of the study.

Table: 4.1 Total Factor Productivity Growth in Pre-liberalization and Post-liberalization period

NIC Code-2004	Classification of Industry	Pre-Liberalization Period TFPG	Post-Liberalization Period TFPG
15	Manufacture of Food Products and Beverages	6.24	7.65
16	Manufacture of Tobacco Products	5.31	2.46
17	Manufacture of Textiles	5.62	5.87
18	Manufacture of Wearing Apparel Dressing and Dyeing of Fur	15.92	10.15
19	Tanning and Dressing of Leather Manufacture	6.68	6.54
20	Manufacture of Wood and Products of Wood and Cork	2.05	7.87
21	Manufacture of Paper and Paper Products	6.58	9.97
22	Publishing, Printing and Reproduction of Recorded Media	1.32	6.79
23	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel	8.03	7.80
24	Manufacture of Chemicals and Products	8.97	9.27
25	Manufacture of Rubber and Plastic Products	9.85	10.03
26	Manufacture of Other Non-Metallic Mineral Products	8.25	8.72
27	Manufacture of Basic Metals	6.80	11.04
28	Manufacture of Fabricated Metal Products	4.14	11.44
29	Manufacture of Machinery and Equipments	5.41	11.56
30	Manufacture of Office, Accounting and Computing Machinery	13.28	7.26
31	Manufacture of Electrical Machinery and Apparatus N.E.C.	7.86	9.20
32	Manufacture of Radio, Television and Communication Equipments and Apparatus	16.39	10.94
33	Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks	10.87	6.64
34	Manufacture of Motor Vehicles, Trailers and Semi-Trailers	7.56	13.16
35	Manufacture of Other Transport Equipment	4.18	10.10
36	Manufacture of Furniture	2.85	15.47

Source: Author's calculation.

The growth rate of food and beverages, wood and wood products, paper and paper products, publishing, printing and reproduction of recorded media, chemicals and products, other non-metallic mineral products, basic metals, fabricated metal products, machinery and equipments, electrical machinery and apparatus, radio, motor vehicles, other transport, furniture industries show a high growth rate during post-liberalization period as compare with the pre-liberalization period. The growth rate of tobacco products, office, accounting and computing, wearing apparel, coke and petroleum, radio, television and communication equipments, medical, precision and optical industries show lower TFP growth during post liberalization than pre-liberalization period. The growth rate of textiles, leather, rubber and plastic products industries have a constant TFP growth in both the periods. The study find that in 15 out of 22 industries, productivity has increased after 1991 onwards[1].

Total Factor Productivity Growth: Estimates for Selected Indian Manufacturing Sectors

Most of the TFP growth estimates are either at the level of the whole economy or of broad sectors such as manufacturing. This study estimate of TFP growth for 2-digit sectors, using the Translog Index of Total Factor Productivity is a discrete approximation to the Divisia Index of Technical Change. To calculate the TFP growth, present study use four factor of production, namely, Labour, Capital, Material and Energy.

The estimate of the measures of aggregate total factor productivity growth are presented for the period 1975-76 to 2011-12 and seven sub-periods: 1075-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2006, 2007-2012. The aggregates of concern in this study refer to the selected 2-digit sectors for which we have industry level estimates. The 22 2-digit sectors are: food products and beverages (15), tobacco products (16), textiles (17), wearing apparel dressing and dyeing (18), leather product (19), wood products (20), paper products (21), printing and reproduction of recorded media (22), coke, refined petroleum products (23), chemicals products (24), rubber and plastic products (25), other non-metallic mineral products (26), basic metals (27), fabricated metal products (28), machinery and equipment (29), office, accounting and computing machinery (30), electrical machinery (31), radio, television and communication equipment (32), medical, precision and optical (33), motor vehicles (34), other transport equipment (35) and furniture (36).

[1] Parameswaran (2014) find out similar kind of result. He found out, 10 out of 12 industries, productivity has continuously increased from 1992-93 to 2005-06.

Table: 4.2 Aggregate Productivity Growth in 2-Digit Industries

Industry – As per NIC - 2004	Total Factor Productivity Growth Rate						
	1075-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006	2007-2012
15	6.02	5.09	7.61	4.53	7.52	5.03	12.99
16	4.19	3.26	8.47	6.47	1.87	-0.03	2.12
17	6.04	2.88	7.95	5.46	5.80	4.14	8.00
18	21.10	8.68	17.98	17.19	8.38	6.13	9.78
19	17.64	-5.13	7.52	4.54	0.40	9.10	10.78
20	4.04	-2.07	4.18	12.18	-7.93	13.21	12.11
21	4.56	7.33	7.86	12.54	5.97	8.54	12.60
22	0.82	3.66	-0.53	6.19	9.90	5.82	5.66
23	11.70	4.53	7.86	2.47	6.02	15.49	6.03
24	10.39	6.92	9.60	7.34	13.52	3.84	12.77
25	8.24	8.02	13.28	9.32	11.89	5.24	13.86
26	7.35	9.92	7.49	5.77	9.50	5.38	13.89
27	9.52	6.82	4.06	9.10	5.50	13.22	15.08
28	5.58	-0.91	7.74	8.14	8.49	10.28	17.79
29	6.39	4.90	4.96	17.98	7.25	8.57	12.79
30	14.66	14.44	10.74	12.99	-6.57	15.57	5.69
31	10.40	6.24	6.93	7.69	6.54	10.11	11.78
32	13.24	12.87	23.05	14.57	9.62	8.97	10.98
33	15.59	7.63	9.38	7.84	11.85	3.64	4.28
34	5.72	6.29	10.66	9.33	11.68	14.33	16.43
35	4.60	2.26	5.68	8.83	8.16	12.15	10.72
36	3.88	2.83	1.86	14.71	24.75	11.96	11.89

Source: Author’s calculation.

For the period 1975-80, we notice sharp deviation in TFP growth rates through the different 2-digit industries. All the industries exhibit positive growth rate in TFP. The industry group of wearing apparel dressing and dyeing, leather product, coke, refined petroleum products, chemicals products, office, accounting and computing machinery, electrical machinery, radio-television and communication equipment, medical-precision and optical registers a register a TFP growth of more than 10 per cent per annum. The average TFPG for the 22 industries turns out to be 8.71 per cent per annum. Dominant contribution coming from the wearing apparel dressing and dyeing, leather product, medical-precision and optical over 15 per cent per annum. Industry printing and reproduction of recorded media contribute less than 1 per cent growth rate during the same phase.

The second period of 1981-85, confirming the lowest productivity growth of among all phases. Manufacturing sector shows a marginal improvement in TFPG among paper products, printing and reproduction of recorded media, other non-metallic mineral products and motor vehicles. The performance of leather product, wood products and fabricated metal products industries was not good in this phase, which are recorded a negative TFP growth. Productivity growth of rest of the industries positive but it was decline as we compare with first phase. The average TFP growth for the period is around 5.29 per cent per annum and records a worsening over the first period.

The third period of 1986-90, confirming the partial liberalization of the Indian economy shows a marginal improvement as far as the number of sector recording higher growth in the productivity. Except printing and reproduction of recorded media industry, all other industry recorded positive TFP growth in same phase. Printing and reproduction of recorded media industry shows a negative TFP growth. Productivity growth rate of textiles, wearing apparel dressing and dyeing, leather product, wood products, other transport equipment industries shows twice as compared to second period. Productivity growth decline in other non-metallic mineral products, basic metals and fabricated metal products and furniture industries as compared with earlier phase. The average TFP growth for the period is around 8.38 per cent per annum which was higher than the previous phase.

The fourth period of 1991-95, government of India liberalized the Indian economy, which is favorable on manufacturing sector. The average growth during this phase was 9.33 per cent per annum. Productivity of wearing apparel dressing and dyeing, wood products, paper products,

machinery and equipment, office, accounting and computing machinery and medical and optical industries shows double digit growth rate. Food products and beverages, tobacco products, textiles, leather product, chemicals products, other non-metallic mineral products and medical and optical industries growth rate in productivity decline as compare with previous phase.

Fifth period (1996-2000) constitutes the period of major economic reforms that were started in the late-1980s and early 1990s. This period along with the earlier ones witnessed major overhauling of the trade and industrial business environment. The all-industry average, however, records a decline in TFP growth (7.28 per cent per annum) over the earlier period thereby reflecting the lagged impact of previous regimes found similar results to Das (2002). Negative productivity growth found in wood products and office, accounting and computing machinery industry.

The sixth sub period of 2001-06, only tobacco industry shows a negative productivity growth. The average TFP growth for the period is around 8.67 per cent per annum which was higher than fifth period. The final sub-period of the study, 2007-12, all industries shows a positive growth rate in this phase and higher than the previous phase. The average TFP growth for the period is around 10.82 per cent per annum.

Empirical Finding: Granger Causality Test:

Pearl defines “Causality” as the relationship between cause and effect. Basically, the term ‘causality’ suggests a cause and effect relationship between two sets of variables, say, Y and X. Recent advances in graphical models and the logic of causation have given rise to new ways in which scientists analyze cause-effect relationships (Awe, 2012).

Before analyzing the real exchange rate, the real effective exchange rate was employed. The difference between the two is that the real effective exchange rate is the weighted average of a country's currency relative to an index or basket of other major currencies adjusted for the effects of inflation, whereas the real exchange rate is the purchasing power of a currency relative to another.

Prior to testing causality, testing for order of integration for each variable is necessary. The unit root test is used to detect the stationarity of the three variables under study. The test is undertaken for two rational reasons. First, to avoid the problem of spurious regression. Second, a basic assumption underlying the application of causality test is that the time series in question should be stationary. In order to implement this test the Augmented Dickey–Fuller test is applied to detect the stationarity of the three variables.

Tests for Stationarity (Unit Root Tests)

The tests for unit roots are closely related to the investigation of stationarity in a time series. Unit root test like Augmented Dickey-Fuller (ADF) is employed to detect the stationarity of the three variables. The test is undertaken for two rational reasons.

1) To avoid the problem of spurious regression.
2) A basic assumption underlying the application of causality test is that the time series in question should be stationary. The test is applied to both the original of the data and to the first differences of the data. Further, both the models with intercept, with intercept and trend and with no intercept are attempted.

If the absolute value of the calculated t-statistics exceeds the absolute critical value, then the null hypothesis that the level of the series is not stationary must be rejected and accept the alternative hypothesis i.e. series is stationary. If the calculated t-statistics is less than the critical value, the null hypothesis of unit root cannot be rejected. It implies that the time series is non-stationary at the level and therefore it requires taking first or higher order difference of the level data to establish stationarity. The truncation lag parameters are determined following Schwarz procedure. Total period is divide into three phases:

I. 1975 to 1990 (Pre-liberalization period),
II. 1991 to 2012 (Post-Liberalization period) and
III. 1975-76 to 2011-12.

The results are reported in Table 4.3 to 4.5.

Table: 4.3 - Augmented Dickey-Fuller unit-root test results
Period of Study: 1975 to 1990 (Pre Liberalization Period)

Variables	t - Statistics		
	Intercept	Intercept and Trend	No Intercept
Levels			
Growth Rate Output	-5.569736	-5.290296	* -0.914922
Real Effective Exchange Rate	* -0.470773	* -0.963997	* -1.930881
Total Factor Productivity Growth	* 0.891772	* -1.66356	6.989629
1st Difference			
Growth Rate Output	-3.245082	-3.972006	-3.446313
Real Effective Exchange Rate	-3.216644	-5.337596	-3.090369
Total Factor Productivity Growth	-3.547225	-3.84351	-1.987916

*denotes that the null hypothesis of unit-root could not be rejected at the 5% and 10% significance level.
The choice of optimum lag for the ADF test was decided on the basis of minimizing the Schwarz Information Criterion.
Source: Compiled by the authors.

Table: 4.4 - Augmented Dickey-Fuller unit-root test results
Period of Study: 1991 to 2012 (Post Liberalization Period)

Variables	t - Statistics		
	Intercept	Intercept and Trend	No Intercept
Levels			
Growth Rate Output	-4.55388	-4.451315	* -1.765272
Real Effective Exchange Rate	* -1.779694	-4.403376	* -0.138849
Total Factor Productivity Growth	* 0.36767	* -1.786913	6.592878
1st Difference			
Growth Rate Output	-9.289107	-9.563783	-9.601918
Real Effective Exchange Rate	-4.957057	-4.746293	-5.068731
Total Factor Productivity Growth	-5.635532	-5.534846	-1.972514

*denotes that the null hypothesis of unit-root could not be rejected at the 5% and 10% significance level.
The choice of optimum lag for the ADF test was decided on the basis of minimizing the Schwarz Information Criterion.
Source: Compiled by the authors.

Table: 4.5 - Augmented Dickey-Fuller unit-root test results
Period of Study: 1975 to 2012

Variables	t - Statistics		
	Intercept	Intercept and Trend	No Intercept
Levels			
Growth Rate Output	-7.656991	-7.65594	* -0.738468
Real Effective Exchange Rate	* -1.966573	* -0.955503	* -1.44324
Total Factor Productivity Growth	-6.054984	-6.151405	* -0.821495
1st Difference			
Growth Rate Output	-6.097412	-6.068512	-6.202892
Real Effective Exchange Rate	-5.21398	-5.265481	-5.192719
Total Factor Productivity Growth	-12.30988	-12.16986	-12.4993

*denotes that the null hypothesis of unit-root could not be rejected at the 5% and 10% significance level.
The choice of optimum lag for the ADF test was decided on the basis of minimizing the Schwarz Information Criterion.
Source: Compiled by the authors.

Unit-root test results

The results of the Augmented Dickey-Fuller test suggest that all of the series (GRO, REER and TFP) are not stationary - hence they are integrated of order zero I(0). As we see from the Table 4.3 (1976 to 1990) indicates the values of the t-statistic obtained for each time-series both in level and in first difference, when we run ADF unit root test with no intercept, results show series is not stationary in case of GRO. The REER series is non-stationary in all the cases and TFPG time series is non-stationary with intercept and intercept with trend. But present study takes the first difference I(1) of all the time series data, all the series are stationary which is shown in table 1.

Table 4.4 (1991-2012), GRO series with no intercept is non-stationary at I(0), REER series is non-stationary at intercept and no intercept and TFPG series is non-stationary at intercept as well as intercept with trend. As time series of all variables after 1991, if they are converted into first difference I(1), all series are stationary. Table 4.5 (1976 to 2012), results shows with no intercept all the time series data are non-stationary and the series REER is non-stationary in all the cases. Here also first difference I(1) is use to convert all non-stationary series to stationary series.

In the multi-variate VAR models that are going to be estimated further in this research all the variables will be taken in their first difference. Selecting an optimal lag cab be arbitrary since different criteria do not always suggest one and only one optimal lag. The Granger-causality test is very sensitive to the number of lags included in the model, in order to determine the optimal lag length the sequential modified LR test statistic (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz-information Criterion (SC) and Hannan-Quinn Information Criterion (HQ) will be employed.

The values and their significance level of VAR lag length order selection criteria are presented in following tables. The three most common information criteria are the Akaike (AIC), Schwarz-Bayesian (BIC) and Hannan-Quinn (HQ). The AIC criterion asymptotically overestimates the order with positive probability, whereas the BIC and HQ criteria estimate the order consistently under fairly general conditions if the true order p is less than or equal to p_{max}. But this study using all five criterion[2].

Table 4.6: VAR Lag Order Selection Criteria: 1976-1990

Endogenous variables: DLOGTFP DLOGGRO DLOGREER
Sample: 1976-1990

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-23.11194	**NA***	**0.015600***	**4.351990***	**4.473217***	4.307108
1	-16.48987	8.829432	2.51E-02	4.748311	5.233218	4.568782
2	-6.12125	8.640515	0.030549	4.520208	5.368795	**4.206031***

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

[2] For further classification, see Dave and Rami, 2008 and Gaurang Rami, 2010

Table 4.7: VAR Lag Order Selection Criteria: 1991-2012

Endogenous variables: DLOGTFP DLOGGRO DLOGREER
Sample: 1991-2012

Lag	LogL	LR	FPE	AIC	SC	HQ
0	24.77333	NA	1.79E-05	-2.419258	**-2.270863***	-2.398797
1	31.05733	9.775111	2.47E-05	-2.117481	-1.523899	-2.035634
2	34.28966	3.950631	5.22E-05	-1.476629	-0.437862	-1.333397
3	42.32592	7.143347	7.80E-05	-1.369547	0.114406	-1.16493
4	74.62024	**17.94129***	**1.20e-05***	**-3.957805***	-2.028666	**-3.691802***

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 4.8: VAR Lag Order Selection Criteria: 1976-2012

Endogenous variables: DLOGTFP DLOGGRO DLOGREER
Sample: 1976-2012

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-62.16861	NA	0.021097	4.654901	4.797637	4.698537
1	-40.58659	**36.99775***	**0.008638***	3.756185	**4.327130***	3.930728
2	-38.09561	3.736461	0.014122	4.221115	5.220269	4.526566
3	-25.13887	16.65868	0.011375	3.93849	5.365852	4.374849
4	-18.97907	6.599787	0.0159	4.141362	5.996932	4.708628
5	-5.555947	11.50553	0.014714	3.825425	6.109204	4.523599
6	0.652399	3.99108	0.027284	4.024829	6.736816	4.85391
7	8.094575	3.189504	0.065153	4.136102	7.276298	5.096091
8	54.20008	9.87975	0.023051	**1.485709***	5.054114	**2.576606***

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

It can be seen from table 4.6 of VAR log order selection criteria that 4 out of 5 criteria (viz. LR, FPE, AIC and SC) indicate selection of lag order 0 and HQ criteria suggest selection lag

order 2. To run the Granger Causality test for the period of 1976 to 1990, this study take 2 lags and estimate a Granger causality test.

Table 4.7 show the VAR log order selection criteria for the period of 1990 to 2012. 4 out of 5 criteria (viz. LR, FPE, AIC and HQ) indicate selection of lag order 4 and SC criteria suggest selection lag order 0. To run the Granger Causality test for the period of 1991 to 2012, this study using optimal lag length of 4.

Table 4.8 show the VAR log order selection criteria for the period of 1976 to 2012, result indicate that 3 out of 5 (LR, FPE and SC) indicate selection of lag order 1 and 2 out of 5 (AIC and HQ) indicate selection of lag order 8. For the period of study form 1976 to 2012, I will estimate a Granger causality test with the optimal lag length of 8.

Following Table 4.9, Table 4.10 and Table 4.11 shows the results of the Granger Causality tests for the period of 1975-76 to 1990-91, 1990-91 to 2012 and 1975-76 to 2011-12.

Table 4.9: Pairwise Granger Causality Tests: 1976-1990

Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
GRO does not Granger Cause TFP	12	1.29317	0.3327
TFP does not Granger Cause GRO		0.02083	0.9795
REER does not Granger Cause TFP	12	0.60994	0.5699
TFP does not Granger Cause REER		1.06498	0.3946
REER does not Granger Cause GRO	12	0.16962	0.8474
GRO does not Granger Cause REER		0.38458	0.6943

Note: GRO: Growth Rate of Output; TFP: Total Factor Productivity Growth Rate and REER: Real Effective Exchange Rate
All the series first converted into Natural Log form and then take first difference to converted them into stationary.

Table 4.10: Pairwise Granger Causality Tests: 1991-2012

Lags: 4			
Null Hypothesis:	Obs	F-Statistic	Probability
GRO does not Granger Cause TFP	18	1.23702	0.3615
TFP does not Granger Cause GRO		0.65345	0.639
REER does not Granger Cause TFP	18	0.09942	0.9799
TFP does not Granger Cause REER		2.00554	0.1773
REER does not Granger Cause GRO	**18**	**8.84135**	**0.0035**
GRO does not Granger Cause REER		0.39410	0.8081

Note: GRO: Growth Rate of Output; TFP: Total Factor Productivity Growth Rate and REER: Real Effective Exchange Rate
All the series first converted into Natural Log form and then take first difference to converted them into stationary.

Table 4.11: Pairwise Granger Causality Tests: 1976-2012

Lags: 8			
Null Hypothesis:	Obs	F-Statistic	Probability
GRO does not Granger Cause TFP	28	0.5305	0.8112
TFP does not Granger Cause GRO		0.7471	0.6528
REER does not Granger Cause TFP	28	**3.3279**	**0.0343**
TFP does not Granger Cause REER		2.2007	0.1125
REER does not Granger Cause GRO	28	1.8618	0.1675
GRO does not Granger Cause REER		0.4022	0.8969

Note: GRO: Growth Rate of Output; TFP: Total Factor Productivity Growth Rate and REER: Real Effective Exchange Rate
All the series first converted into Natural Log form and then take first difference to converted them into stationary.

The results of Granger Causality test are given in Table 4.9, when testing if there is any relationship between these variables, F-statistics is statistically insignificant i.e. the results suggests that there is no unidirectional causality or bidirectional causality running between TFG, REER and GRO in pre liberalization period.

The results of Granger Causality test are given in Table 4.10, according to which there is no unidirectional causality or bidirectional causality running from GRO and TFP or REER and TFP or other way around. But in post liberalization phase present study found the unidirectional causality form REER to GRO, here F-Statistics is statistically significant at 5% level.

The results of Granger Causality test are given in Table 4.11, according to which there is no unidirectional causality or bidirectional causality running from GRO and TFP or GRO and REER or other way around. But present study found, at 5% statistically significant level, the unidirectional causality form REER to TFP.

4.3 Findings of Regression Analysis

Analysis of Regression Results (1975-76 to 1990-91)

Figures presented in Table 4.12 (1975-76 to 1990-91) produce the following observations.

The coefficient of K/L ratio is positive and statistically significant at 5% level for office, accounting and computing machinery industry. The tobacco industry exhibits negative and statistically significant impact of K/L on respective TFP. Because of high rate of effective rate of protection and NTBs, it is likely that K/L ratio negatively affects the TFP of tobacco industry. In case of tobacco industry, it is a labour intensive industry. Elasticity of total factor productivity with respect to capital labour ratio is -0.1 for tobacco industry and 0.19 for office, accounting and computing machinery industry. As K/L ratio increase, there is a displacement of labour for capital which reduces labour productivity. Ahluwalia (1991) gives two explanations for a negative relationship between capital intensity and TFPG. First, there must be certain other factors which may not be included in the specification of the equation, which are highly correlated with the capital-labour ratio and which have a negative effect on productivity growth. Second, the policy regime with its emphasis on discretionary licenses and permits encourage overcapitalization.

The coefficient of the CR is positive and statistically significant at 1% level for textiles industries and at 5% level for food products & beverages, publishing-printing & reproduction of recorded media, chemical, other non-metallic mineral products, office-accounting & computing machinery industries. Further, CR is positive and statistically significant at 10% level for paper & paper products industry. Elasticity of total factor productivity with respect to concentration ratio is 2.6 for food and beverage industry, 4.7 for textile industry, 1.21 for paper industry, 3.78 for publishing and printing industry, 2.42 for chemical industry, 0.43 for non-metallic mineral industry 2.69 for office and accounting industry, respectively. Increased

concentration means reduced production costs and increased efficiency, as larger firms apparently capitalize on economies of scale. The result suggests that a positive relationship could be expected between productivity and concentration as larger firms capitalize on economies of scale and size and thereby lower overhead cost.

The coefficient of Effective Rate of Protection (ERP) is positive and statistically significant at 1% level for textiles industry and at 5% level for wood and coke, refined petroleum industries. Further, the coefficient of ERP is positive and statistically significant at 10% level for rubber and plastic as well as machinery and equipments industries.

Clements and Williamson (2001) find a positive correlation between import tariffs and economic growth across countries. This study finds that protection was associated with growth because it allowed countries to accelerate the growth. These emerging sectors were characterized by learning effects. High rate of ERP means higher level of protection to the domestic industries and reduced foreign competition. Domestic industries enjoy a secured market. This increases production over time because of increase in domestic demand, which leads to increased productivity growth.

The ERP is higher in the pre-reform period and this should lead to lower TFP growth in view of the positive relationship found between ERP and TFPG in the regression analysis. The coefficient of ERP for tobacco, wearing apparel dressing and chemical industries is negative and statistically significant at 10% level. The elasticity of total factor productivity with respect to effective rate of protection is 0.39 for food and beverage industry, -0.44 for tobacco industry, 2.62 for textile industry, -20.6 for wearing apparel and dressing industry, 0.71 for wood industry, 0.85 for coke and refined petroleum industry, -0.17 for chemical industry, 0.86 for rubber and plastic industry and 0.55 for machinery and equipments industry, respectively. Before pre liberalization period, effective rate of protection positively impacted on productivity growth of some industries as well as negatively impacted productivity growth of some industries.

Table: 4.12 - Determinants of Productivity Growth of Manufacturing Industries
Dependent Variable: Total Factor Productivity (TFP)
Time period of study: 1975-76 to 1990-91

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F - Statistics
1	15	Manufacture of Food Products and Beverages	0.048	2.594	0.387	-0.986	-0.04	0.181	0.307		0.214	0.950	0.871	11.949
			0.512	2.639	2.114	-1.315	-1.06	1.034	2.433		1.212			
				**	***				***					0.007
2	16	Manufacture of Tobacco Products	-0.11	-1.48	-0.44			-0.029	0.334	-0.290	0.623	0.951	0.894	16.689
			-2.41	-1.07	-1.98			-4.332	4.544	-1.105	6.190			
			**		***			*	*		*			0.002
3	17	Manufacture of Textiles		4.709	2.617				-0.15	-0.48	0.292	0.727	0.557	4.268
				3.389	3.619				-0.86	-1.84	1.212			
				*	*					***				0.035
4	18	Manufacture of Wearing Apparel Dressing and Dyeing of Fur	0.073	4.096	-20.6		-0.33	0.125	0.360		0.327	0.841	0.656	4.548
			0.334	1.671	-2.28		-2.21	0.335	1.950		2.070			
					***		***		***		***			0.042

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F - Statistics
5	19	Tanning & Dressing of Leather Manufacture	-0.02	6.780	0.694		-0.09	-0.072	0.963	0.247	0.526	0.942	0.848	10.093
			-0.16	0.966	0.254		-2.12	-0.286	2.513	0.322	0.659			
							***		**					0.010
6	20	Manufacture of Wood and Products of Wood	-0.02		0.705				0.426			0.557	0.424	4.185
			-0.25		2.576				2.160					
					**				**					0.037
7	21	Manufacture of Paper and Paper Products	0.000	1.212	-0.04	1.657	0.169	0.165	0.558	-0.616	-0.16	0.978	0.928	19.503
			0.003	2.227	-0.25	1.263	4.666	1.122	9.149	-3.836	-1.14			
				***			*		*	*				0.006
8	22	Publishing, Printing and Reproduction of Recorded Media		3.783	1.480						0.475	0.578	0.451	4.565
				2.304	0.887						2.276			
				**							**			0.029
9	23	Manufacture of Coke, Refined Petroleum Products			0.854		0.106		0.279	-0.943		0.602	0.425	4.404
					2.280		0.829		2.992	-1.839				
					**				*	***				0.049

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F - Statistics
10	24	Manufacture of Chemicals and Products	0.126	2.415	-0.17						0.262	0.607	0.433	3.899
			1.153	2.329	-1.94						1.551			
				**	***									0.048
11	25	Manufacture of Rubber and Plastic Products			0.857		0.170				0.873	0.446	0.280	2.538
					2.009		2.622				2.351			
					***		**				**			0.042
12	26	Manufacture of Other Non-Metallic Mineral Products	-0.17	0.432						-0.361	-0.24	0.410	0.148	2.338
			-0.95	2.398						-1.244	-2.21			
				**							***			0.049
13	27	Manufacture of Basic Metals	-0.48	-1.48					0.518	-0.187	0.056	0.700	0.513	3.735
			-1.62	-0.87					3.338	-0.766	0.255			
									*					0.048
14	28	Manufacture of Fabricated Metal Products	-0.13		-0.27						0.566	0.486	0.332	3.551
			-0.66		-0.39						2.820			
											**			0.049

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F - Statistics
15	29	Manufacture of Machinery and Equipments	0.434		0.548	1.528	-0.26			-0.978	0.399	0.753	0.541	2.558
			1.788		2.672	3.835	-1.46			-2.740	1.960			
					**	*				**	***			0.047
16	30	Manufacture of Office,Accounting and Computing Machinery	0.186	2.685	-2.62	-0.85	-0.21	-0.027		0.213	0.500	0.983	0.955	35.812
			2.862	2.626	-1.39	-1.29	-4.48	-0.416		0.861	8.546			
			**	**			*				*			0.001
17	31	Manufacture of Electrical Machinery and Apparatus N.E.C.		1.667		0.378	-0.22		0.503	-0.019	0.317	0.781	0.592	4.150
				0.884		1.022	-2.43		2.022	-0.065	1.362			
							**		***					0.042
18	32	Manufacture of Radio, Television &Communication	0.049		1.874	-0.79	-0.18	0.199			0.417	0.834	0.693	5.881
			0.212		1.785	-1.97	-1.15	0.521			2.286			
						***								0.017
19	33	Manufacture of Medical, Precision and Optical	-0.21			0.087		-0.267		-0.601		0.536	0.396	3.846
			-1.56			0.785		-1.784		-2.073				
								***		***				0.046

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F - Statistics
20	34	Manufacture of Motor Vehicles, Trailers and Semi-Trailers	0.215	1.995			-0.09		0.254		0.436	0.770	0.626	5.360
			1.004	1.742			-1.85		1.924		2.458			
							***		***		**			0.019
21	35	Manufacture of Other Transport Equipment	-0.11	-3.45					0.448			0.332	0.276	5.954
			-1.23	-1.28					2.001					
									***					0.031
22	36	Manufacture of Furniture	-0.573	5.529							0.944	0.351	0.297	6.494
			-1.658	1.442							3.168			
											*			0.026

* - Significant at 1%, ** - Significant at 5% and *** - Significant at 10%

Table: 4.13 - Determinants of Productivity Growth of Manufacturing Industries
Dependent Variable: Total Factor Productivity (TFP)
Time period of study: 1991-92 to 2011-12

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
1	15	Manufacture of Food Products and Beverages				0.066	-0.09	0.187	0.483	0.156	0.342	0.535	0.349	2.879
						1.235	-2.18	1.753	2.974	0.858	1.960			
							**	***	***		***			0.045
2	16	Manufacture of Tobacco Products	0.157				0.005	-0.010	0.214	-0.26	0.741	0.541	0.358	2.948
			1.050				0.545	-0.639	2.375	-0.60	2.888			
									**		*			0.042
3	17	Manufacture of Textiles	0.318	0.802	-0.22	89.113		0.079			0.379	0.344	0.209	2.538
			2.047	0.945	-2.32	2.662		0.881			2.292			
			**		**	*					**			0.042
4	18	Manufacture of Wearing Apparel Dressing and Dyeing of Fur	0.242		-0.01	0.697		0.082	0.591	-0.80	0.074	0.680	0.521	4.257
			1.100		-0.03	1.396		0.248	3.633	-2.13	0.262			
									*	**				0.010
5	19	Tanning and Dressing of Leather			-0.01	-0.605	0.035	0.053	0.428	1.127		0.574	0.404	3.373
					-0.02	-0.874	0.922	0.344	2.573	3.114				
									**	*				0.026

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
6	20	Manufacture of Wood & Products of Wood	0.021	-5.01	0.001		0.426	-0.549	1.254	0.753	0.074	0.760	0.612	5.132
			0.087	-1.23	0.006		0.977	-1.035	2.835	0.987	0.141			
									*					0.005
7	21	Manufacture of Paper and Paper Products	0.145		0.024	0.013	-0.10	0.218	0.504		0.423	0.714	0.571	5.000
			2.011		0.360	0.173	-0.73	1.146	2.745		2.119			
			***						**		**			0.005
8	22	Publishing, Printing and Reproduction of Recorded Media	0.149		-0.10	-0.008	-0.19	0.371	0.113	0.472	0.313	0.567	0.439	4.421
			1.143		-1.16	-0.407	-1.78	1.532	0.774	1.694	2.482			
							***			***	**			0.002
9	23	Manufacture of Coke, Refined Petroleum Products	-0.086	1.143	0.014	-0.116	-0.44	0.078	0.741	1.340	-0.20	0.829	0.700	6.457
			-0.828	0.604	0.104	-0.961	-2.85	0.590	4.441	2.738	-0.77			
							*		*	**				0.002
10	24	Manufacture of Chemicals and Products	0.152		0.003		-0.02		0.589	0.472		0.541	0.397	3.764
			0.988		0.063		-0.17		3.142	1.972				
									*	***				0.019

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
11	25	Manufacture of Rubber and Plastic Products	0.067	-0.71	-0.12		0.021	0.071	0.695		0.006	0.659	0.500	4.141
			0.713	-0.62	-1.95		0.169	0.769	3.451		0.059			
					***				*					0.010
12	26	Manufacture of Other Non-Metallic Mineral Products	-0.077	0.450				-0.071		0.517	-0.06	0.492	0.334	3.102
			-0.748	3.917				-0.518		1.557	-0.50			
				*										0.038
13	27	Manufacture of Basic Metals	0.048	-0.96	0.034	-0.001	0.037	-0.117	0.755	0.138	0.057	0.834	0.710	6.707
			0.326	-0.70	0.525	-0.048	0.307	-0.432	5.419	0.401	0.358			
									*					0.002
14	28	Manufacture of Fabricated Metal Products	0.317	0.648	-0.01	-0.013		-0.155	0.536	0.619	0.298	0.742	0.583	4.663
			2.017	0.532	-0.07	-0.369		-0.667	2.670	1.822	2.064			
			***						**	***	***			0.007
15	29	Manufacture of Machinery and Equipments			0.034			-0.045		0.918	0.687	0.355	0.248	3.304
					0.236			-0.139		1.929	2.386			
										***	**			0.044

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
16	30	Manufacture of Office, Accounting and Computing Machinery	0.127	-1.78	0.071			0.081		0.637	0.869	0.589	0.424	3.576
			0.602	-0.42	0.322			0.368		0.679	4.063			
											*			0.021
17	31	Manufacture of Electrical Machinery and Apparatus N.E.C.	0.190	-1.53	-0.15		-0.02	0.117	0.685	0.072	0.183	0.786	0.654	5.954
			1.845	-1.37	-1.93		-0.19	0.499	5.083	0.232	0.993			
			**		**				*					0.002
18	32	Manufacture of Radio, Television & Communication	0.037	-1.87		0.152	-0.23	0.251	0.670	0.381	-0.02	0.725	0.556	4.293
			0.208	-0.90		1.192	-1.26	2.008	3.797	0.847	-0.14			
								***	*					0.010
19	33	Manufacture of Medical, Precision and Optical	-0.178		0.088	0.034	-0.56		0.431	0.336	0.505	0.805	0.708	8.262
			-1.697		1.185	1.715	-2.85		2.579	0.959	2.461			
						***	*		**		**			0.000
20	34	Manufacture of Motor Vehicles, Trailers	0.085	-0.50	0.067		-0.12		0.585	0.160	0.486	0.871	0.807	13.546
			0.831	-0.39	0.919		-1.15		4.308	0.420	1.963			
									*		***			0.000

Continued…

Sr. No.	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
21	35	Manufacture of Other Transport Equipment	0.097	-3.25	0.097			0.240			0.256	0.490	0.331	3.079
			0.911	-2.65	1.005			1.008			2.421			
				**							**			0.039
22	36	Manufacture of Furniture; Manufacturing	0.225		0.339	-0.125	0.009	-0.657	0.660	1.204	0.582	0.792	0.664	6.197
			1.434		1.402	-1.468	0.070	-1.938	2.273	2.180	2.460			
								***	**	**	**			0.002

* - Significant at 1%, ** - Significant at 5% and *** - Significant at 10%

Table: 4.14 - Determinants of Productivity Growth of Manufacturing Industries
Dependent Variable: Total Factor Productivity (TFP)
Time period of study: 1975-76 to 2011-12

Sr. No	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
1	15	Manufacture of Food Products and Beverages	0.135	0.939	0.013	0.024	-0.08	0.100	0.370	0.250	0.245	0.559	0.406	3.662
			(1.311)	(1.340)	0.395	0.437	-2.62	1.020	2.725	1.565	1.778			
							*		*		***			0.005
2	16	Manufacture of Tobacco Products	0.017	0.088		-0.07	0.000	-0.015	0.245	-0.22	0.692	0.610	0.495	5.281
			0.258	0.074		-0.66	-0.03	-1.461	3.795	-0.71	4.599			
									*		*			0.000
3	17	Manufacture of Textiles	0.318	0.802	-0.22	89.113		0.079			0.379	0.344	0.209	2.538
			2.047	0.945	-2.32	2.662		0.881			2.292			
			**		**	*					**			0.042
4	18	Manufacture of Wearing Apparel Dressing and Dyeing of Fur	0.154	1.775		0.970	-0.37	0.183	0.260	-0.22	0.154	0.780	0.715	11.974
			1.530	1.657		3.296	-5.14	1.075	2.281	-0.90	1.427			
				***		*	*		**					0.000

Continued…

Sr. No	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
5	19	Tanning & Dressing of Leather Manufacture	0.103	-0.08	-0.04	0.566	-0.05	0.051	0.452	0.179	0.484	0.646	0.523	5.268
			1.326	-0.05	-0.43	0.722	-1.55	0.396	2.452	0.542	1.819			
									**		***			0.000
6	20	Manufacture of Wood & Products of Wood	-0.01	-7.10	0.150	-0.703	-0.06	-0.427		0.424		0.387	0.234	2.530
			-0.04	-2.75	0.600	-0.562	-0.76	-1.432		0.704				
				*										0.038
7	21	Manufacture of Paper and Paper Products	0.191	0.805	-0.03	-0.048	-0.09	0.071		0.430	0.580	0.447	0.283	2.723
			2.884	0.906	-0.4	-0.554	-1.04	0.351		2.008	3.395			
			*							**	*			0.024
8	22	Publishing, Printing and Reproduction of Recorded Media	0.149		-0.10	-0.008	-0.19	0.371	0.113	0.472	0.313	0.567	0.439	4.421
			1.143		-1.16	-0.407	-1.78	1.532	0.774	1.694	2.482			
							***			***	**			0.002
9	23	Manufacture of Coke, Refined Petroleum Products		-0.79		-0.087	-0.29	0.053	0.454	0.793		0.578	0.490	6.607
				-0.52		-0.709	-2.68	0.577	3.886	2.186				
							*		*	**				0.000

Continued…

Sr. No	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
10	24	Manufacture of Chemicals and Products	0.255	1.545		0.024	-0.04		0.091	0.219	0.433	0.453	0.317	3.317
			2.199	1.845		0.384	-0.74		0.651	1.197	3.095			
			**	***							*			0.011
11	25	Manufacture of Rubber and Plastic Products			-0.38	-0.247	0.074		0.158	-0.17	0.141	0.338	0.201	2.467
					-2.26	-1.697	1.244		1.097	-0.76	1.415			
					**	***								0.047
12	26	Manufacture of Other Non-Metallic Mineral Products	-0.07	0.213			0.021	-0.045	0.313	0.141	-0.03	0.467	0.333	3.502
			-0.89	1.672			0.398	-0.448	1.909	0.658	-0.26			
				***					***					0.008
13	27	Manufacture of Basic Metals	-0.21	2.419	0.016	-0.039				0.247	0.481	0.365	0.234	2.779
			-1.30	1.932	0.212	-1.244				0.843	3.202			
				***							*			0.029
14	28	Manufacture of Fabricated Metal Products	0.191	0.871			-0.08	-0.178	0.500	0.425	0.339	0.585	0.481	5.637
			1.501	0.805			-1.08	-0.714	3.323	1.747	2.735			
									*	***	*			0.000

Continued…

Sr. No	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
15	29	Manufacture of Machinery and Equipments N.E.C		-1.20	-0.09					0.539	0.472	0.263	0.168	2.771
				-0.88	-0.92					1.651	2.305			
										***	**			0.044
16	30	Manufacture of Office, Accounting and Computing Machinery	-0.01	-1.91	-0.03	-0.01	-0.20	0.124	0.425	0.325	0.304	0.840	0.785	15.215
			-0.06	-1.05	-0.28	-0.316	-1.16	1.319	2.802	0.903	2.568			
									*		*			0.000
17	31	Manufacture of Electrical Machinery and Apparatus N.E.C.	0.293	-0.41	-0.07	0.160	-0.22	0.227		0.413	0.372	0.415	0.242	2.395
			2.475	-0.36	-0.59	0.738	-2.32	0.835		1.515	1.957			
			**				**				***			0.043
18	32	Manufacture of Radio, T.V. & Communication	0.020				-0.20				0.325	0.348	0.287	5.692
			0.137				-1.52				2.649			
											*			0.003
19	33	Manufacture of Medical, Precision & Optical	-0.01		0.069	0.033	-0.14	0.154	0.152	0.127	0.616	0.502	0.354	3.398
			-0.11		0.876	1.386	-1.05	0.915	1.088	0.417	3.019			
											*			0.008

Continued…

Sr. No	NIC Code 1998	Manufacturing Industry Groups	K/L Ratio	CR	ERP	ICR	IPR	NPWPE	Y/N	REER	RW	R^2	Adjusted R^2	F – Statistics
20	34	Manufacture of Motor Vehicles, Trailers and Semi-Trailers	0.099	0.560	0.073	-0.083	-0.16	0.181		0.378	0.399	0.598	0.479	5.028
			0.788	0.423	0.725	-0.674	-1.88	0.390		1.114	2.157			
							***				**			0.001
21	35	Manufacture of Other Transport Equipment	-0.06	-2.82		0.023	0.005	0.119	0.508	0.083	-0.06	0.480	0.326	3.113
			-0.86	-2.43		0.827	0.161	0.581	3.331	0.287	-0.49			
				**					*					0.013
22	36	Manufacture of Furniture	0.160	0.709	0.079		-0.18	-0.682		0.616	0.559	0.503	0.379	4.055
			1.094	0.342	0.592		-2.01	-1.846		1.232	2.920			
							**	***			*			0.003

* - Significant at 1%, ** - Significant at 5% and *** - Significant at 10%

A negative relationship between ERP and TFP growth was found by Goldar (1986) in a cross-industry regression analysis for Indian manufacturing for 1960-70. Econometric analysis of TFP growth in Indian manufacturing industries undertaken in the studies of Goldar (1986) and Ahluwalia (1991) has indicated an adverse effect of import substitution policy on productivity growth. A link between negative relationship between ERP and TFP is that with reduction in ERP, domestic industries face competition with foreign firms which increases the efficiency of domestic industries to avoid any potential closure. As efficiency increases it leads to better utilization of the exiting capacity which finally increases production and quality of the products due to utilization of better and sophisticated technology which finally serves to increase TFP.

The coefficient of Import Coverage Ratio (ICR) is positive[3] and statistically significant at 1% level for machinery and equipment. An increase in the Import Coverage Ratio leads to greater protection for domestic firms, and hence in domestic market power and ceteris paribus, domestic prices. Thus, in case of machinery and equipment industry, the higher degree of protection and reduced competition reflected through a higher ICR has led to increased production and thereby productivity growth.

The coefficient of ICR is negative[4] and statistically significant at 10% level for radio-television & communication industry. Negative and significant coefficient of ICR signifies that with lowering of non-tariff barriers, there emerges a boosting-up effect on imports through more capitalistic and sophisticated technology. The results of the present study supports Ahluwalia (1991) who also finds a negative relationship between productivity growth and import substitution in the Indian manufacturing sector over the period 1960-1980, thus providing support for the hypothesis that decline in import substitution orientation would lead to an improvement in productivity growth. Das (2003) also shows that the reduction in non-tariff barriers as measured by import coverage ratios leads to a rise in total factor productivity. Elasticity of productivity growth with respect to

[3] This may be interpreted as showing that the effect of tariff reform on productivity is stronger if there is less quantitative restriction on import.
[4] For detail explanation read pp no. 333 to 337 of India: Industrialisation in a Reforming Economy – Essays for K.L. Krishna

coverage ratio is 1.53 for machinery & equipment whereas, -0.79 for radio, television and communication industry.

In case of IPR, coefficient is positive and statistically significant at 1% level for paper industry, whereas coefficient is positive and statistically significant at 5% level for rubber and plastic industry. From a theoretical point of view, several channels might explain the existence of a positive effect of trade and trade liberalization on productivity growth. A growth in market competition may stimulate firms to reduce their x-inefficiencies or even lead the less productive firms to leave the market. Other important channels consider the increased availability of foreign intermediate inputs with lower price or higher quality and their effects on technological innovation, as well as the effects of a greater market size due to scale economies and selection effects. This leads to increase productivity growth.

The coefficient is negative at 1% statistically significant level for office, accounting and computing industry, whereas negative and statistically significant 5% for electrical industry. A negative relationship with TFP is found for wearing apparel dressing, leather and motor vehicles industries at 10% significant level. The negative and significant association between change in import penetration ratio and productivity growth is consistent with the view that lowering of quantitative restrictions on imports introduces competitive pressures which, in turn, cuts cost or increases productivity growth in capital goods industries. The elasticity of total factor productivity with respect to import penetration ratio is -0.09 for tanning and dressing industry, 0.17 for paper industry as well as rubber and plastic industry, -0.21 for office accounting and computer industry, -0.22 for electrical machinery industry, -0.09 for motor vehicles industry.

The coefficient of NPWPE is negative and statistically significant at 1% for tobacco industry, whereas for medical, precision and optical industry, the coefficient of NPWPE is negative and statistically significant at 10% level. A higher degree of bureaucratic control is observed when there are a higher number of non-production employees per worker. It can hinder productivity of the particular industry. Moreover, recruitment of non-production employees is in accordance to the political pressure exuded by the ruling party to provide employment to its party forces. The

elasticity of total factor productivity with respect to non-production worker to production employees is -0.03 for tobacco product and -0.27 for medical, precision and optical industry.

The coefficient of Y/N is positive and statistically significant at 0.1% level for paper industry whereas positive and statistically significant at 1% level for tobacco and coke, refined petroleum and basic metal industries. Further, the coefficient is positive and statistically significant at 5% level for leather and wood industries whereas positive and statistically significant at 10% level for food products & beverages, wearing apparel dressing, electrical machinery, motor vehicles and other transport equipment industries.

The elasticity of total factor productivity growth with respect to output per factory is 0.31 for food and beverage industry, 0.33 for tobacco industry, 0.36 for wearing apparel and dressing industry 0.96 for tanning and dressing industry, 0.43 for wood industry, 0.56 for paper industry 0.28 for coke and petroleum industry 0.52 for basic metal industry, 0.50 for electrical machinery, 0.25 for motor vehicle industry and 0.45 for other transport industry. With capacity diversification and capital utilization, a larger firm is able to exploit economies of scale and generate higher TFPG relative to smaller firms. In the context of Indian manufacturing, it appears, the relationship between productivity growth and output growth through the lowering of costs and prices will be much weaker than the relationship resulting from differential technological progress and scale economies.

The coefficient of REER is negative and statistically significant at 1% for paper & paper products industry whereas negative and statistically significant at 5% level for machinery and equipment industry. The coefficient is negative and statistically significant at 10% level for textile, petroleum and medical, precision and optical industries. The supply side consequences of a sustained real exchange rate depreciation argues that it can contribute to lower productivity growth and a larger productivity gap between the depreciating country and the leading countries. Domestic price level and import demand all have an inverse relationship with exchange rate. The elasticity of total factor productivity with respect to exchange rate is -0.48 for textile industry, -0.62 for paper and paper product industry, -0.94 for coke and petroleum industry, -0.98 for machinery & equipment industry and -0.60 for medical and optical industry.

Rise in real wage (RW) is seen to have a favorable influence on TFPG of tobacco products and office, accounting & computing machinery industries, because the coefficient of W is positive and statistically significant at 1% level respectively. The coefficient is positive and statistically significant at 5% level for publishing-printing & reproduction, rubber & plastic, fabricated metal and motor vehicle industries, whereas, it is positive and significant at 10% level for wearing apparel dressing, machinery and equipment and furniture industries. The elasticity of total factor productivity growth with respect to real wage rate for tobacco industry is 0.62, for wearing apparel and dressing is 0.33, for publishing and printing industry is 0.48, for rubber and plastic industry 0.87, for non-metallic mineral industry is -0.24, for fabricated metal product is 0.57, for machinery and equipment is 0.40, for office accounting and computing industry is 0.50, for motor vehicle industry is 0.44 and for furniture industry is 0.94.

A direct relationship between wages and productivity is linked to value addition by a firm and process of substitution between labour and capital. If wage rate is appropriately high for any industry group, time skilled workers can be attracted towards that industry and considering skill as a positive determinants of TFPG, it can be argued that as real wage increases through the involvement of skilled workers in the production process productivity increases. The coefficient is positive and significant at 10% level for other non-metallic mineral industries.

Analysis of Regression Results (1991-92 to 2011-12)

Figures presented in Table 4.13 (1991-92 to 2011-12) produce the following observations.

The coefficient of K/L ratio is positive[5] and statistically significant at 5% level for textile and electrical machinery industries. Further, for paper & paper product and Fabricated Metal Product industries, coefficient of K/L ratio is positive and statistically significant at 10% level. New capital may lead to better organization, management, and the like. This may be true even if no new technology is incorporated in the capital equipment. There are positive interactions between capital

[5] Wolff (1991) show a positive correlation of 0.79 between the rate of TFP growth and the capital-labour ratio over the 1880-1979 period.

accumulation and technological advance. There are several avenues through which capital formation and total factor productivity growth may be associated. The elasticity of total factor productivity growth with respect to capital labour ratio is 0.32 for textile industry, 0.15 for paper industry, 0.32 fabricated metal industry and 0.19 for electrical machinery industry.

The coefficient of the CR is positive and statistically significant at 1% level for other non-metallic mineral industry. Increased concentration means reduced production costs and increased efficiency, as larger firms apparently capitalize on economies of scale. The result suggests that a positive relationship could be expected between productivity and concentration as larger firms capitalize on economies of scale and size and thereby lower overhead cost. The coefficient of the CR is negative and statistically significant at 5% level for other transport industry. A high concentration ratio is expected to diminish competitive rivalry among industries with the likelihood of under-utilizing the production capacity of resources. The elasticity of total factor productivity with respect to concentration ratio is 0.45 for other non-metallic mineral industry and -3.25 for other transport industry.

The coefficient of ERP for textile and electrical machinery are negative and statistically significant at 5% level and for rubber & plastic industry is negative and statistically significant at 10% level. A negative relationship between ERP and TFP growth was found by Goldar (1986) in a cross-industry regression analysis for Indian manufacturing for 1960-70. Econometric analysis of TFP growth in Indian manufacturing industries undertaken in the studies of Goldar (1986) and Ahluwalia (1991) has indicated an adverse effect of import substitution policy on productivity growth. A negative link between ERP and TFP is due to the fact that with reduction in ERP, domestic industries face competition with foreign firms which increases the efficiency of domestic industries to avoid any potential closure. As efficiency increases it leads to better utilization of the exiting capacity which finally increases production and quality of the products due to utilization of better and sophisticated technology which finally serves to increase TFP. The elasticity of total factor productivity growth with respect to effective rate of protection is -0.22 for textile industry, -0.12 for rubber and plastic industry and -0.15 for electrical machinery industry, respectively.

The coefficient of ICR is positive and statistically significant at 1% level for textile industry, whereas ICR is positive and statistically significant at 10% level for medical, precision & optical industry. The elasticity of total factor productivity growth with respect to ICR is 8.91 for textile industry and 0.03 for medical and optical industry. An increase in the Import Coverage Ratio leads to greater protection for domestic firms, and hence in domestic market power and ceteris paribus, domestic prices. The higher degree of protection and reduced competition reflected through a higher ICR leads to increased production and thereby productivity growth.

In case of IPR, the coefficient is negative and statistically significant at 1% level for medical, precision & optical and coke, refined petroleum industries. It is negative at 5% statistically significant level for food products and beverages industry, whereas negative and statistically significant coefficient at 10% level for printing and reproduction of recorded media industry. The negative and significant association between change in import penetration ratio and productivity growth is consistent with the view that lowering of quantitative restrictions on imports introduces competitive pressures which, in turn, cuts cost or increases productivity growth in capital goods industries. The elasticity of total factor productivity growth with respect to import penetration ratio is -0.09 for food and beverages industry, -0.19 for publishing and printing industry and -0.44 for coke and petroleum industry.

The coefficient of NPWPE is positive and statistically significant at 10% level for food products and beverages and radio, television and communication industries. NPWPE helps to increase in TFPG of the industry group because the combination of non -production employees and production worker is effective to foster TFPG. For Medical, precision and optical industry, the coefficient of NPWPE is negative and statistically significant at 10% level. A higher degree of bureaucratic control is observed when there are a higher number of non-production employees per worker. It can hinder productivity of the particular industry. Moreover, recruitment of non-production employees is in accordance to the political pressure exuded by the ruling party to provide employment to its party forces. The elasticity of total factor productivity growth with respect to non-production workers to production employees is 0.19 for food and beverages industry, 0.25 radio, television and communication industry and -0.66 for furniture industry.

The coefficient of Y/N is positive and statistically significant at 1% level for coke, refined petroleum, basic, electrical machinery and motor vehicle, wearing apparel dressing, wood & products of wood, chemical, wood and wood product and radio, television & communication industries. The coefficient is positive and statistically significant at 5% level for tobacco, leather paper, fabricated metal, medical, precision and optical and furniture industries whereas it is positive and statistically significant at 10% level for food products & beverage industry. With capacity diversification and capital utilization, a larger firm is able to exploit economies of scale and generate higher TFPG relative to smaller firms. In the context of Indian manufacturing, it appears, the relationship between productivity growth and output growth through the lowering of costs and prices will be much weaker than the relationship resulting from differential technological progress and scale economies.

The elasticity of total factor productivity growth with respect to output per factory is 0.48 for food and beverage industry, 0.21 for tobacco industry, 0.59 for wearing apparel and dressing industry, 0.43 for tanning and dressing industry, 1.25 for wood industry, 0.50 for paper and paper product industry, 0.74 for coke and petroleum industry, 0.59 for chemical industry, 0.70 for rubber and plastic industry, 0.76 for basic metal industry, 0.54 for fabricated metal industry, 0.69 for electrical machinery industry, 0.67 for radio, television and communication industry, 0.59 for motor vehicles industry, 0.66 for furniture industry, respectively.

The coefficient of REER is positive and statistically significant at 1% for leather industry and 5% level for Coke, Refined Petroleum and furniture industries. Further, the coefficient is negative and statistically significant at 10% level for printing & reproduction of recorded media, chemical, fabricated metal and machinery & equipment industries. Exchange rate depreciations lift imports and export-competing output. Dynamic scale economies and increased capacity utilization of fixed inputs would result in positive productivity consequences of short run output effects. In many macro models of the New-Keynesian variety with nominal inflexibilities, a positive demand shock can increase measured productivity growth through learning-by-doing effects, increased factor utilization or increasing returns to scale. The demand for commodities of trade increases with a real exchange rate depreciation and such depreciation would be inclined to have similar effects.

These are among the situations which make productivity growth faster during real exchange rate depreciations as emphasized by competitiveness approach[6].

The coefficient of REER is observed to be negative and statistically significant at 5% level for wearing apparel dressing industry. The supply side consequences of a sustained real exchange rate depreciation argues that it can contribute to lower productivity growth and a larger productivity gap between the depreciating country and the leading countries. Domestic price level and import demand all have an inverse relationship with exchange rate. During this period, elasticity of total factor productivity growth with respect to real effective exchange rate is -0.80 for wearing apparel dressing industry, 0.47 for publishing and printing industry, 1.34 for coke and petroleum industry, 0.47 for chemicals industry, 0.62 for fabricated metal industry, 0.92 for machinery and equipment industry and 1.20 for furniture industry.

The coefficient of RW is positive and statistically significant at 1% level for tobacco, office, accounting and computing machinery industries and at 5% level for textile, paper, printing & reproduction of recorded media, machinery & equipment, medical, precision & optical, other transport and furniture industries. The coefficient is positive and significant at 10% level for food products & beverage, fabricated metal and motor vehicle industries. During this period, elasticity of total factor productivity growth with respect to real wage rate is 0.34 for food and beverages industry, 0.74 for tobacco industry, 0.38 for textile industry, 0.42 for paper industry, 0.31 for publishing and printing industry, 0.30 for fabricated metal industry, 0.69 for machinery and equipment industry, 0.87 for office, accounting and computing machinery, 0.51 for medical and optical industry, 0.49 motor vehicles industry, 0.26 for other transport industry and 0.58 for furniture industry.

A direct relationship between wages and productivity is linked to value addition by a firm and process of substitution between labour and capital. If wage rate is appropriately high for any industry group, skilled workers can be attracted towards that industry and considering skill as a

[6] The competitiveness approach emphasizes that real exchange rate depreciations accelerate productivity growth in certain circumstances. This would be consistent with a substantial theoretical literature on the pro-cyclical productivity effects of demand shocks.

positive determinants of TFPG, it can be argued that as real wage increases through the involvement of skilled workers in the production process productivity increases.

Analysis of Regression Results (1975-76 to 2011-12)

Figures presented in Table 4.14 (1975-76 to 2011-12) produce the following observations.

The coefficient of the Capital-Labour (K/L) ratio is positive and statistically significant at 1% level for paper and paper product industry and at 5% level for textile, chemicals and electrical machinery & apparatus industries. Domestic firms that imported technology through royalty payments and used capital intensive methods emerged more efficient than the rest of the firm. It may be argued that with reduction in non-tariff barriers and effective rate of protection, there is a decrease in relative cost of imported capital goods; as a result, there is a rise in capital-labor ratio supporting the technological progress and which in turn, facilitates TPFG of respective industry groups. During this period, elasticity of total factor productivity growth with respect to capital labour ratio is 0.32 for textile industry, 0.91 for paper industry, 0.26 chemical industry and 0.29 electrical machinery industry.

The coefficient of the Concentration ratio (CR) is negative and statistically significant at 1% level for wood industry and at 5% level for other transport industry. A high concentration ratio is expected to diminish competitive rivalry among industries with the likelihood of under-utilizing the production capacity of resources. Further, CR is positive and statistically significant at 10% level for wearing apparel dressing, chemical, other non-metallic mineral and basic metal industries. The elasticity of total factor productivity with respect to concentration ratio is 1.78 for wearing apparel industry, -7.10 for wood industry, 1.55 for chemicals industry, 0.21 for other non-metallic mineral industry, 2.42 for basic metals industry and -2.82 other transport industry.

Although there are advantages of big size and secured market for innovation, an industry which has a relatively high degree of concentration need not experience a relatively high growth rate in TFP. In a situation that is less competitive there is less inducement to reduce cost and improve technology. Thus, TFP growth rate will vary directly or inversely with the degree of concentration depending on the relative strength of these two opposing forces. There is a similar indeterminacy

about the relationship between TFP growth and the rate of change in the concentration ratio. A marked rise in the concentration ratio will generally be associated with a decline in competition (lowering productivity) and with an increase in the proportion of output being produced in units which are large in size and hence in a position to exploit scale economies and employ technologically advanced machinery (raising productivity). Here again, the net effect will depend on the relative strength of these two opposing forces (Goldar, 1986).

The coefficient of Effective Rate of Protection (ERP) is negative and statistically significant at 5% level for textiles and rubber & plastic industries. A link between negative relationship between ERP and TFP is that with reduction in ERP, domestic industries face competition with foreign firms which increases the efficiency of domestic industries to avoid any potential closure. As efficiency increases it leads to better utilization of the exiting capacity which finally increases production and quality of the products due to utilization of better and sophisticated technology which finally serves to increase TFP. The elasticity of total factor productivity with respect to effective rate of protection is -0.22 for textile industry and -0.38 for rubber and plastic industry, respectively.

The coefficient of Import Coverage Ratio (ICR) is positive and statistically significant at 1% level for textile and wearing apparel dressing industries, whereas ICR is negative and statistically significant at 10% level for rubber and plastic industry. Elasticity of total factor productivity growth with respect to import coverage ratio is 8.91 for textile industry, 0.97 for wearing apparel industry and -0.25 for rubber and plastic product industry.

In case of IPR, coefficient is negative and highly statistically significant at 1% level for food products, wearing apparel dressing and coke, refined petroleum industries. At 5% statistically significant level found in Electrical Machinery and furniture industries whereas at negative and statistically significant coefficient at a level 10% found in publishing, printing and reproduction of recorded media and motor vehicles, trailers and semi-trailers industries. The elasticity of total factor productivity with respect to import penetration ratio, -0.08 for food and beverages industry, -0.37 for wearing apparel industry, -0.19 for publishing and printing industry, -0.29 for coke and

petroleum industry, -0.22 for electrical machinery industry, -0.16 for motor vehicles industry and -0.18 for furniture industry, respectively.

The coefficient of NPWPE is negative and statistically significant at 10% for furniture industry. It can be argued that reduction of internal bureaucracy by lowering the number of non-production employees can be resulted to increase in TFP. On the other hand, the sole industry group - publishing, printing and reproduction of recorded media captures positive impact of NPWPE on TFPG with low statistical significance of at 13%. Here NPWPE helps to increase in TFPG of the industry group because the combination of non -production employees and production worker is effective to foster TFPG. The elasticity of total factor productivity with respect to non-production employees per production worker is -0.68 for furniture industry.

The coefficient of Y/N is positive and statistically significant at 1% level for tobacco, food products & beverages, fabricated metal and office, accounting & computing machinery, coke & refined petroleum industries and other transport. Further, coefficient positive and statistically significant at 5% level found in wearing apparel dressing and tanning & dressing of leather industries whereas, coefficient positive and statistically significant at 10% level other non-metallic mineral industry. The elasticity of total factor productivity with respect to output per factory is 0.37 for food and beverages industry, 0.25 for tobacco industry, 0.26 for wearing apparel industry, 0.45 for tanning and dressing industry, 0.45 for coke and petroleum industry, 0.31 for rubber and plastic industry, 0.50 for fabricated metal industry, 0.43 for office accounting and computing industry and 0.51 for other transport industry, respectively.

The coefficient of REER is statistically significant at 5% for paper & paper products and coke, refined petroleum products industries whereas coefficient is statistically significant at 10% level for publishing, printing & reproduction of recorded media, fabricated metal products and machinery and equipments industries. To realize the effect of reduction in ERP on TFPG, the coefficient of REER is expected to be positive and it is rightly so for the above industry groups. Actually, depreciation in REER will offset the effects of tariff reduction. The elasticity of total factor productivity with respect to real effective exchange rate is 0.43 for paper and paper industry,

0.47 for publishing and printing industry, 0.79 for coke and petroleum industry, 0.43 for fabricated metal industry and 0.54 for machinery and equipment industry, respectively.

Increase in RW may have a favorable effect on TFPG of tobacco, paper & paper products, chemical, basic metals, office-accounting & computing machinery, radio-television & communication, medical-precision & optical and furniture industries, because the coefficient of W is positive and statistically significant at 1% level respectively. The coefficient of RW is positive and statistically significant at 5% level for textiles, publishing-printing & reproduction of recorded media, machinery & equipment, motor vehicles industries whereas 10% level for food products & beverages tanning & dressing of leather and electrical machinery industries. The elasticity of total factor productivity growth with respect to real wage rate is 0.25 for food and beverages industry, 0.69 for tobacco industry, 0.38 for textile industry, 0.48 for tanning and dressing industry, 0.58 for paper industry, 0.31 for publishing and printing industry, 0.43 for chemicals industry, 0.48 for basic metal industry, 0.34 for fabricated metal industry, 0.47 for machinery and equipment industry, 0.30 for office accounting and computing industry, 0.37 for electrical machinery industry, 0.33 for radio, television and communication industry, 0.62 for medical and optical industry, 0.40 for motor vehicle industry and 0.56 for furniture industry, respectively.

Findings of Panel Regression Analysis

Basic panel regression model run for the 22 2-digit industry for the period of 1975-76 to 2011-12. The first panel regression shown in the table regression (1) is for the period of pre-liberalization (1975-76 to 1990-91), panel regression (2) is for the period of post-liberalization (1991-92 to 2011-12) and panel regression (3) is for whole period (1975-76 to 2011-12). The estimates shown in the table 4.15, it is for the Fixed Effects (FE) panel regression mode, which is preferred estimates as compared to Random Effects (RE) panel regression and Ordinary Least Square (OLS). Multicollinearity is absent among the explanatory variables.

Table: 4.15 Determinants of Productivity Growth: Panel Data Analysis

Dependent Variable: TFPG

Explanatory Variables	Regressions		
	1975-76 to 1990-91	1991-92 to 2011-12	1975-76 to 2011-12
	(1)	(2)	(3)
CLR	0.0128	0.1332	0.0891
	0.5074	4.1612	4.0463
		*	*
CR	0.6008	-0.4204	-0.0760
	1.3097	-1.0409	-0.2534
ERP	0.0848	0.0287	0.0183
	1.2501	1.1760	0.9037
ICR	-0.0018	0.002106	0.0013
	-0.0153	0.17875	0.1273
IPR	-0.0084	-0.0260	-0.0104
	-1.7674	-2.2747	-2.0033
	***	**	**
NPWPE	-0.0075	-0.0116	-0.0102
	-0.4504	-0.5508	-0.7193
OPF	0.2595	0.1126	0.1291
	7.4099	6.5183	8.8267
	*	*	*
REER	-0.2047	0.3766	0.2198
	-2.3444	3.4366	3.0720
	**	*	*
RW	0.3411	0.4797	0.4682
	7.7768	10.6851	14.5678
	*	*	*
R^2	0.500672	0.387927	0.366266
Adjusted R^2	0.446594	0.346838	0.340539
F-Statistics	9.258201*	9.441303*	14.23682*
No. of industries	22	22	22
Total Observation	308	462	770

CLR= Capital-Labour Ratio; CR= Concentration Ratio; ERP= Effective Rate of Protection; ICR= Import Coverage Ratio; IPR= Import Penetration Ratio; NPWPE= Non-Production Worker to Production Employees; OPF= Output per Factory; REER= Real Effective Exchange Rate; RW= Real Wage Rate

* - Significant at 1 %, ** - Significant at 5% and *** - Significant at 10%

The coefficient of the CLR for the pre-liberalization period is found to be positive, but statistically insignificant. However, the coefficient of the CLR for the post-liberalization period is found to be positive and statistically significant at 0.1 per cent level. The estimated elasticity of TFP growth with respect to CLR is about 0.13 for the same period and for the entire period, the coefficient is positive and statistically significant at 0.1 per cent level and elasticity of TFP growth with respect to CLR is about 0.09 per cent. This implies that 10% increase in capital-labour ratio, productivity growth increased by 1.33% in the post liberalization period. But there is no significant impact of CLR on productivity during the pre-liberalization period. During the period of 1975-76 to 2011-12, a 10% increase in CLR it increase productivity by only 0.89%, the significant impact is lower than the post-liberalization period.

The coefficient of CR is positive for the pre-liberalization period but statistically insignificant, whereas the coefficient of CR is negative for the post-liberalization period and entire period but it is also statistically insignificant for both the period. For all the three periods, the coefficient of ERP found to be positive but statistically insignificant. The coefficient of ICR is negative for the pre-liberalization period but statistically insignificant, whereas the coefficient of ICR is positive for the post-liberalization period and entire period but it is also statistically insignificant for both the period.

The coefficient of the IPR for the pre-liberalization era is found to be negative and statistically significant at 10 per cent level and estimated elasticity of TFP growth with respect to IPR is -0.008. As we compare this results with post-liberalization era, there is an improvement in significant level as well as elasticity of an IPR. During post-liberalization era, the coefficient of the IPR is negative and statistically significant at 5 per cent level and its elasticity is about -0.03 per cent. For the entire period, the coefficient of the IPR is found to be negative and statistically significant at 10 per cent level and estimated elasticity of the TFP growth with respect to IPR is -0.01. This implies that, for the period of 1975-76 to 2011-12, a fall in IPR by 10%, productivity growth increased by 0.01%. During pre-liberalization era, a 10% reduction in ICR, it increased productivity growth by 0.08%. But during the post-liberalization period, decrease in ICR by 10%, productivity growth increased by 0.26%, which is more significant as we compared this to pre-liberalization period as well as entire period.

The coefficient of the NPWPE for the pre-liberalization period, post-liberalization period and entire period is found to be negative, but statistically insignificant.

There is a significant positive relationship between output per factory growth and TFP growth. The coefficient of the output growth is positive and statistically significant at the 0.1 per cent level in all the equations estimated. Such a relationship between output growth and productivity growth has been found in a large number of earlier studies, including studies for Indian industries (Goldar 1986a, Ahluwalia 1991, Goldar and Kumari 2002, Ghose & Biswas 2009 and Choudhury, 2010). In the results presented in Table 4.15, the estimated elasticity of TFP growth with respect to output growth is about 0.26 for the period of pre-liberalization, in post-liberalisation period elasticity of TFP growth with respect to output growth is 0.11 and for the entire period it is about 0.13. Here, we can say that the role of output in pre-liberalization period is more than post-liberalization period. This implies that 10% increase in output per factory, productivity growth increased by 2.6% in the pre-liberalization period. During the post-liberalization period, output of a firm increase by 10%, it stimulate productivity growth by 1.13%. Whereas, during the period of 1975-76 to 2011-12, a 10% increase in output of a firm, it increase productivity by 1.29%, the significant impact is lower than the post-liberalization period. After the reform, importance of the variable output per factory reduced because before the reform the elasticity of TFP growth with respect to OPF is 0.26, which is only 0.11 during the post-liberalization period.

There is a negative relationship found in case of REER and TFP growth during the pre-liberalization period. The coefficient is negative and statistically significant at 5 per cent level and the estimated elasticity of TFP growth with respect to REER is about -0.2 per cent. But after the post-liberalization period, there is a positive relationship between TFP growth and REER. The coefficient of REER is turn out to be positive and statistically significant at 0.1 per cent level. The elasticity of TFP growth with respect to REER is 0.38, this indicate that the role of exchange rate after the post liberalization era plan an important role to improve the productivity of manufacturing sector. Results shows in table 4.15 implies that, during the pre-liberalization period, a 10% depreciation of REER, reduced the productivity growth by 2%. But the role of REER has been change during the post-liberalization period. A depreciation of exchange rate by 10%, it increased

productivity growth by 3.8%. Here we can say that the importance of REER is highly significant after the reform. For the entire period, 10% exchange rate depreciation leads to productivity growth increased by 2.2%

Real wage (RW) is an important determinant of the TFP growth of manufacturing sector, as we can see from the Table 4.15, all the three phase, it is found that, the coefficient of RW is statistically significant at 0.1 per cent level and there is a positive relationship between RW and TFP growth. The estimated elasticity of TFP growth with respect to RW in pre-liberalization, post-liberalization and entire period is 0.34, 0.48 and 0.47 respectively. During the pre-liberalization period, if real wage rate increase by 10%, it stimulate productivity growth by 3.4%. Whereas, during the period of 1975-76 to 2011-12, a 10% increase in real wage, it increase productivity by 4.68%, the significant impact is higher than the pre-liberalization period. After the reform, importance of the real wage rate has been more significant because before the reform the elasticity of TFP growth with respect to RW is 0.34, which is 0.48 during the post-liberalization period. In other word, if real wage rate increased by 10%, total factor productivity increased by 4.48%.