

# Growth and Productivity Analysis of Paper & Paper Products Industry of Punjab

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{ GJMBR Classification (FOR)  
M11, O47, F43 & 140202 }

**Abstract-**The policies of liberalized regime have initiated a change in the small scale industrial sector of Punjab where efficiency and productivity have emerged as important agents of growth and survival. This piece of study is an attempt to investigate growth pattern and productivity trends of small scale paper products industry of Punjab. The growth of industry has been measured in terms of four variables namely: number of units, fixed investment, employment and production. Yearly growth rates have been computed to mirror year-to-year fluctuations in growth and compound annual growth rates (CAGRs) have been worked out to find the impact of the policies of liberalized regime on growth of this industry. Productivity trends have been explored in terms of capital intensity, capital output ratio and partial factor productivities. The study observed that the policies of liberalization have promoted capital investment, production and labour productivity, boosted technological up-gradation, but resulted in fall in growth of number of units and deceleration in the employment opportunities. Capital output ratio has declined which is a good sign but at the expense of partial productivity of capital. Till the year 2020, Production and employment are supposed to grow moderately along with snail slow growth of number of units. Capital investment will fall but capital productivity would show remarkable growth. Capital output ratio is expected to decline but labour productivity is expected to express good signs of growth at the expense of capital intensity.

**Keywords-** exponential smoothing, productivity, compound growth rate, forecasts, ACF.

## I. INTRODUCTION

The new millennium is going to be the millennium of the knowledge. So demand for paper would go on increasing in times to come. In view of paper industry's strategic role for the society and also for the overall industrial growth it is necessary that the paper industry performs well. Government of India regards the Indian paper industry as one of the 35 high priority industries in the country. It is 15<sup>th</sup> largest in world and provides employment to 1.3 million people directly as well as indirectly. The demand for upstream market of paper products, like, tissue paper, tea bags, filter paper, light weight online coated paper, medical grade coated paper, etc., is growing up India's per capita consumption of paper is around 4.00 kg, which is one of the lowest in the world. With the expected

increase in literacy rate and growth of the economy, an increase in the per capita consumption of paper is expected. These developments are expected to give fillip to the industry (<http://www.economywatch.com/business-and-economy/paper-industry.html>). Tracing the history, it is believed that Chinese were the first to make paper, from where the technology went to Samarkhad and then it eventually reached India. In India, the first paper industry was developed in Kashmir, established by Sultan Zaimal Abedin in 1417-67 AD. Soon, because of its quality, the Kashmiri paper was much in demand in the world. Then, with the rapid demand of writing materials, the paper making centers were developed in different parts of the country like Sialkot (now in Pakistan's Punjab), Arwal in Bihar, Murshidabad and Hoogly in Bengal, Ahmadabad, Khambat and Patan in Gujarat. Punjab has been the leading centre for white coloured and very stout paper (Tiwari, 2006). Now, Maharashtra, Karnataka, Andhra Pradesh and Tamilnadu, Gujarat, Uttarpradesh, Orrissa and Punjab are playing an important role in continuous growth and development of paper industry in country. (The Hindu, 2003). As far as paper industry of Punjab in particular is concerned, with 882 units in 1980-81, this industry provided employment directly to 3926 persons and produced material worth 33.36 Rs. Crore (at constant prices) but gained units to 3491 till 2005 providing employment to 18268 persons and producing worth 276.67 Rs. Crore at constant prices (Directorate of Industries, Punjab, 2005).

## II. OBJECTIVES OF THE STUDY

A sound industrial development strategy is obligatory to be framed on the basis of analysis of growth and productivity of concerned industry. In this study, an attempt has been made to dig the facts about paper products industry of Punjab which can be treated as a catalytic agent for policy formulation. The specific objectives of the study were:

1. To compute partial productivity of labour and capital, average capital output ratio and capital intensity.
2. To analyse the comparative picture of growth of number of units, fixed investment, direct employment and production during pre-liberalization and liberalization periods.
3. To generate short term forecasts of growth of paper and paper products industry in Punjab hence to predict the productivity profile of industry during forthcoming years till 2020.

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### III. DATA BASE AND METHODOLOGY

Present study is based on secondary data for the period of 25 years i.e. 1980-81 to 2004-05. (Due to change in classification of industries, it is not possible to get the data as per requirement for the next four years because that data will not be in uniformity with that for the last 25 years, still study finds data for the 25 years sufficient to draw various conclusions). The data relating to number of units, employment, fixed capital and production of small scale paper and paper products industry at aggregate level for the said period were culled from Directorate of Industries, Punjab. Since the figures of fixed capital and production were given at current prices, these have been converted into constant prices by deflating them with index number of the wholesale prices of manufactured products' total, taking 1993-94 as the base year. Yearly growth rates for all the four variables were computed to capture year-to-year fluctuations in growth. Partial productivities of labour and capital were obtained as O/L and O/K. For making an assessment of the extent of amount of units of capital that are needed to produce a certain level of output and capital intensity K/O and K/L ratios were also computed. Compound Annual Growth Rates (CAGRs) for overall period (1980-81 to 2004-05) and two sub-periods: pre-liberalization (1980-81 to 1991-92) and liberalization periods (1991-92 to 2004-05) for all the eight variables were estimated by fitting an exponential function of the following form (Gujarati, 2004, p. 175):

$$Y_i = \beta_1 X_i^{\beta_2} e^{u_i} \quad (1)$$

In logarithmic form

$$\text{Log } Y_i = \text{Log } \beta_1 + \beta_2 \text{Log } X_i + u_i \quad (2)$$

Where  $Y_i$  - dependent variable  
 $X_i$  - independent variable

$\beta_1$  and  $\beta_2$  are unknown parameters

$U_i$  - disturbance term.

Using the ordinary least square method, estimated values of  $\beta_1$  and  $\beta_2$  denoted by

$\hat{\beta}_1$  and  $\hat{\beta}_2$  have been calculated. Compound annual growth rate ( $Gr_c$ ) has been computed by taking the antilog of estimated regression coefficient, subtracting 1 from it and multiplying by 100. (Gujarati, 2004, p. 179)

$$Gr_c = A.L. (\hat{\beta}_2 - 1) \times 100 \quad (3)$$

Since  $\hat{\beta}_2$  is the estimate for  $\beta_2$

In order to check the significance of growth rate student's 't' test has been applied (Gujarati, 2004, p. 135).

$$t = \frac{\hat{\beta}_2}{S(\hat{\beta}_2)} \sim t_{(n-2)} \text{ d.f} \quad (4)$$

where  $S(\hat{\beta}_2)$  is the respective standard error. The forecasts

have been generated by applying Double Exponential Smoothing using Holt's approach. Since Double Exponential Smoothing model is best suited to address the type of data which exhibits either an increasing or decreasing trend over time. Moreover, in Double Exponential Smoothing model past observations are given exponentially smaller weights as the observations get older. In other words, recent observations are given relatively more weight in forecasting than the older observations. Exponential smoothing is frequently the only reasonable time series methodology in large forecasting systems (Gardner, 1985, p.23). Two equations associated with Double Exponential Smoothing are (<http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc434.htm>):

$$f_t = \alpha Y_t + (1-\alpha)(f_{t-1} + b_{t-1}) \quad (5)$$

$$b_t = \gamma(f_t - f_{t-1}) + (1-\gamma)b_{t-1} \quad (6)$$

where:

$Y_t$  is the observed value at time t.

$F_t$  is the forecast at time t.

$b_t$  is the estimated slope at time t.

$\alpha$  (Alpha) is the first smoothing constant, used to smooth the observations.

$\gamma$  (Gamma) is the second smoothing constant, used to smooth the trend. To adjust level at time t, the trend of the previous period  $b_{t-1}$ , is added to the last smoothed value of level component as shown by equation (5). Then equation (6) is used to update the trend component, which is expressed as the difference between the last two smoothed values. Since there might be some randomness remaining, the trend is modified by multiplying the trend in the past period ( $f_t - f_{t-1}$ ) with  $\gamma$  and adding that to the previous estimate of the trend multiplied by  $(1-\gamma)$  (Gupta and Kumar, 2008, p.30; <http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc434.htm>). The one-period-ahead forecast is given by:

$$F_{t+1} = f_t + b_t \quad (7)$$

The m-periods-ahead forecast is given by:

$$F_{t+m} = f_t + mb_t \quad (8)$$

Equation (7) is used to forecast the value for one period ahead and finally equation (8) was used to forecast ahead. For initialization process, grid search procedure was used on the software SPSS (version 7.5) and the values of two smoothing parameters  $\alpha$  and  $\gamma$  were obtained. Only those values of  $\alpha$  and  $\gamma$  were selected which corresponded to the lowest figure of accuracy measure used. The best value for the smoothing constant is the one that results in the smallest sum of the squared errors given by the following equation: Sum of Square of Errors (SSE)

$$= \sum e_t^2 = \sum (Y_t - \hat{Y}_t)^2 \quad (9)$$

#### IV. ADEQUACY OF THE DOUBLE EXPONENTIAL SMOOTHING

Before generating forecasts it is imperative to check the adequacy of the forecasting technique used. Present study confirms the appropriateness of DES model to generate forecasts by making use of two identification techniques namely autocorrelation function and Ljung-Box Test. Exponential smoothing when allied to appropriate identification technique constitute an even stronger competitor method to alternative univariate forecasting procedures (Chatfield, Koehler, Ord and Synder, 2001, p.158). To test the hypothesis of randomness as a mean to confirm the adequacy of the model used, autocorrelation coefficients and Ljung-Box Q statistic of residuals have been calculated.

##### 1) Autocorrelation Coefficient

The autocorrelation (Box and Jenkins, 1976) function has been used for the purpose of detecting non-randomness in data. Autocorrelations of residuals were worked out as under:

$$r_k(e) = \frac{\sum_{t=1}^{n-k} e_t \cdot e_{t+k}}{\sum_{t=1}^n e_t^2}; k=1,2,\dots,1 \quad (10)$$

Computed values of auto correlation coefficient,  $r_k(e)$  and the lag  $k$  were displayed graphically to depict autocorrelation function (ACF) also known as correlogram. The 95% confidence interval for residual ACF was obtained by using Bartlett's approximation while calculating standard errors (Bartlett, 1946; Gupta and Kumar, 2008, p.31; <http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc434.htm>). Residual ACF, which lies within the 95% interval taken as insignificant and insignificance of ACF, implies adequacy of DES to generated forecasts.

##### 2) Ljung-Box Test

Out of a large number of tests of randomness we have selected Ljung-Box test which can be used to test multiple autocorrelation coefficients and instead of testing randomness at each distinct lag, tests the overall randomness based on a number of lags. For this reason, it is often referred as portmanteau (French word which refers to a coat rack that can hold many items of clothing on its hook) test. In this test we have considered the whole set of the values all at a time to see whether they are significantly different from zero. Ljung-Box Q statistics was computed from the model's residuals by using the following equation:

$$Q = n(n+2) \sum_{k=1}^L \frac{r_k^2(e)}{n-k} \quad \text{For } i = 1 \text{ to } k \quad (11)$$

Where Q is Portmanteau test statistic, n is the sample size, L is the number of lags being tested. Non-significance of Q test is taken to imply that the generated residuals could be considered as white noise, thereby indicating the adequacy of estimated model (Gupta and Kumar, 2008, p.31; <http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc434.htm>).

#### V. RESULTS AND DISCUSSION

This section presents the results and discussion of the study. The first subsection is devoted to the analysis of compound annual growth rates of number of units, employment, fixed capital and production. Moreover yearly growth rates were also calculated to capture the year-to-year fluctuations. The second subsection is devoted to the profile of capital intensity, capital-output ratio and partial productivities of labour and capital in paper and paper products industry. The third subsection deals with generation of forecasts regarding different variables representing future assessment of productivities.

##### SECTION 1

#### VI. GROWTH PERFORMANCE

Measurement of growth has been one of the most extensively researched areas. The growth rate analysis provides the whole vision of growth performance. The year to year growth rates and compound annual growth rates (CAGRs) of number of units, fixed investment, employment and production of paper and paper products industry are shown in table I. The results have been discussed in brief under the following four sub heads:-

Table I  
Year to year and Compound Annual Growth Rates ( in percent)

Year	Number of units	Fixed investment (In Rs. Crore)	Direct Employment (in No.)	Production (In Rs. Crore)
1981-82	21.43	24.33	20.84	27.66
1982-83	18.67	7.12	16.82	7.91
1983-84	13.93	6.32	15.81	6.76
1984-85	12.15	4.99	12.06	4.96
1985-86	11.95	5.46	10.73	16.53
1986-87	7.76	6.71	11.83	5.25
1987-88	6.43	3.09	5.77	8.8
1988-89	10.22	-1.1	8.27	2.27
1989-90	7.66	-0.69	5.46	0.36
1990-91	5.54	-0.6	5.75	15.46
1991-92	5.67	3.57	6.88	6.31
1992-93	3.88	-2.56	3.94	1.5
1993-94	3.8	2.6	4.23	9.92
1994-95	3.46	1.12	4.14	5.79
1995-96	3.77	6.15	6.25	19.19
1996-97	3.26	15.62	5.48	10.6
1997-98	2.3	13.99	5.02	20.2
1998-99	1.99	10.23	3.52	4.87
1999-00	1.51	13.78	3.11	13.83
2000-01	1.43	5.4	2.5	10.2
2001-02	1.02	5.41	2.06	6.02
2002-03	-3.72	6.82	-2.32	14.12
2003-04	0.58	-2.61	2.01	2.93
2004-05	0.72	2.95	1.73	4.32



**CAGRs:-**

Pre Liberalization Period	10.42*	4.27*	10.36*	8.01*
Liberalization Period	1.83*	7.39*	3.36*	10.53*
Overall Period	5.27*	4.87*	6.02*	8.92*

\*Significant at 5 percent level of significance.

\*\*Insignificant at 5 percent level of significance.

Source: Calculated from the data supplied by Directorate of Industries, Punjab.

Note: - fixed investment and production figures are taken on 1993-94 constant prices to compute various growth rates.

**VII. NUMBER OF UNITS**

The year-to-year growth rates of number of units as compiled in column II of table I portrays a highest growth rate of 21.43 percent in the very initial year of the study i.e.1981-82. Thereafter the growth embarked on its steep downhill journey which continued uninterrupted till 1987-88 when it touched the level of 6.43 percent. The southward movement of the growth rates continued for the rest of the study period but fluctuations were also noticed at odd intervals. The growth rate even slipped in the negative zone in 2002-03(-3.72 percent) but managed to finish at the level of 0.72 percent in 2004-05. Further perusal of the column reveals that the liberalization period turned out to be a nightmare for the industry as the compound annual growth rate (CAGRs) for the liberalization period plummeted to 1.83 percent from the level of 10.42 percent belonging to the pre- liberalization. However, a CAGR of 5.27 percent was noticed for the over all period of the study.

**VIII. FIXED INVESTMENT**

A glance at column III of table I mirrors annual growth rates of fixed investment with a wide diversity and wild fluctuations. Commencing from a highest growth rate figure of 24.33 percent in 1981-82, nosedived to the level of 7.12 percent in 1982-83 and further declined in the following two years to touch the level of 4.99 percent in 1984-85. The growth recovered a little bit in the next two years to touch a level of 6.71 percent in 1986-87. the growth rate again slipped downward and entered the negative zone and remained there consecutively for three years till 1990-91. The period 1991-92 to 1999-2000 witnessed some minor and broad swings in the growth rates and finally touched the level of 13.78 percent in 1999-2000. In the rest of the study period, the growth rate again tumbled to touch the level of 5.40 percent in 2000-01 and after minor fluctuations slipped again in the negative zone to finally settle at -2.95 percent in 2004-05. The column further envisages a significant CAGR of 4.27 percent in the pre-liberalization period which jumped to 7.39 percent in the liberalization period.

However, a CAGR of 4.87 percent was observed for the overall period of the study.

**IX. DIRECT EMPLOYMENT**

The yearly growth rates of direct employment as sketched in column IV of table I reveals a discouraging trend in the employment growth. Starting from a highest growth rate of 20.84 percent in 1981-82, decelerated in the following years. Barring the year 1986-87, the growth rate continued declining till 1987-88 when it touched the level of 5.77 percent. The period 1988-89 to 1995-96 experienced minor fluctuations to reach at a level of 6.25 percent. During rest of the study period the growth rate turned bearish which continued till the end with the only exception of the year 2003-04, when it pulled itself out of the negative zone to touch the level of 2.01 percent. Further investigation of the column delineates a CAGR of 10.36 percent in the pre-liberalization which declined miserably to the level of 3.36 percent in the liberalization period. However, a CAGR of 6.02 percent was observed for the overall period of the study.

**X. PRODUCTION**

Investigation of the yearly growth rates of production as shown in the column V of table I demonstrates wild fluctuations at odd intervals. Starting from the highest growth rate of 27.66 percent in 1981-82, nosedived to the level of 7.91 percent in 1982-83, further declined in the following two years to touch the level of 4.96 percent in 1984-85. The growth rate shot up to mount a peak of 16.53 percent in 1985-86 followed by an equally sharp fall to the level of 5.25 percent in the year 1986-87. Almost similar mountain-valley kind of growth pattern was viewed during the rest of the study period. Further perusal of the column suggests a significant CAGR of 8.01 percent in the pre-liberalization period, which accelerated to 10.53 percent in the liberalization period. However, a CAGR of 8.92 percent was observed in the overall period of the study. The conclusion that springs out of the above discussion is that the policies of liberalization have brought mixed blessings for the small scale paper industry in Punjab. While the CAGR of number of units & direct employment in the liberalization period decelerated substantially over the pre-liberalization period, whereas that of fixed investment and production recorded upswing. Hence the policies of the liberalization period have turned a boon for the fixed investment and production in the small scale paper industry whereas it proved to be a bane for the employment generation and the number of units.

**SECTION-II****XI. PRODUCTIVITY ANALYSIS AND PROFILE OF RELATED VARIABLES.**

Productivity depends on the relationship between total output and related inputs such as labour and capital which have been used in production of that output. It is evident that the capacity of the economy to produce goods and services mainly depends on productivity of these factors.



Productivity can be enhanced through proper utilization of such resources. It is widely agreed that increasing productivity is a barometer of good health of a system which allows producing at lower cost and makes it competitive both in short as well as in long run. Table –II depicts the profile of capital intensity, capital output ratio and partial productivities of labour and capital of the paper products industry of Punjab. This table also highlights the compound growth rates of capital intensity, capital-output ratio and partial productivities of labour and capital for the pre-liberalization and liberalization period. The detailed column wise explanation of table II is discussed as under:

TABLE II  
Profile of Capital Intensity, Capital-Output Ratio and Partial Productivity of Capital and Labour

Year	AOLR (In Rs.Cr.)	DOM (In Rs.Cr.)	COR	AOCR
1980-81	0.0085	0.0066	0.78	1.28
1981-82	0.009	0.0068	0.76	1.31
1982-83	0.0083	0.0063	0.76	1.32
1983-84	0.0076	0.0057	0.75	1.33
1984-85	0.0072	0.0054	0.75	1.33
1985-86	0.0075	0.0051	0.68	1.47
1986-87	0.0071	0.0049	0.69	1.45
1987-88	0.0073	0.0048	0.65	1.53
1988-89	0.0069	0.0044	0.63	1.58
1989-90	0.0066	0.0041	0.63	1.6
1990-91	0.0072	0.0039	0.54	1.86
1991-92	0.0071	0.0037	0.52	1.91
1992-93	0.007	0.0035	0.5	1.98
1993-94	0.0073	0.0034	0.47	2.13
1994-95	0.0075	0.0033	0.45	2.22
1995-96	0.0084	0.0033	0.4	2.5
1996-97	0.0088	0.0037	0.42	2.39
1997-98	0.01	0.004	0.4	2.52
1998-99	0.0102	0.0042	0.42	2.4
1999-00	0.0112	0.0047	0.42	2.4
2000-01	0.0121	0.0048	0.4	2.51
2001-02	0.0125	0.005	0.4	2.52
2002-03	0.0146	0.0054	0.37	2.69
2003-04	0.0148	0.0052	0.35	2.85
2004-05	0.0151	0.0049	0.33	3.06

#### CAGRs:-

Pre-liberalization period	-2.11*	-5.46*	-3.48*	3.62*
Liberalization period	6.92*	3.97*	-2.77*	2.92*
Overall Period	2.73*	-0.03*	-3.70*	3.87*

Source: calculated from the data supplied by directorate of industries, Punjab.

Note : \*significant at 5 percent level of significance.

\*\* Insignificant at 5 percent level of significance

Terms used:

a) DOM: Degree of Mechanization (capital intensity):- it is fixed capital at constant prices per employee.

c) AOCR:- Average output capital ratio (Capital Productivity):- it is ratio of total production to total fixed capital (both deflated)

d) AOLR: - Average Output Labour Ratio (Labour Productivity):- it is total production of constant prices per employee.

#### 1) Labour productivity

The annual growth rates of labour productivity as compiled in column II of table II shows a figure of 0.0085 crores in the year 1980-81 which improved to the level of Rs.0.0090 crores in 1981-82. The period 1982-83 to 1992-93 experienced fluctuations, but with a negative bias, in the labour productivity and touched a level of Rs. 0.0070 crores in 1992-93. The period thereafter recorded a consistent upswing in the labour productivity and touched the peak of Rs. 0.0151 crores in 2004-05. The column further reveals that the CAGR for the liberalization period (6.92 percent) registered a remarkable improvement over the CAGR of (-2.11) belonging to the pre-liberalization period. However, a CAGR of 2.73 percent was observed for the overall period of the study.

#### 2) Capital Intensity (Dom)

The profile of annual growth rates of capital intensity as sketched in column III of table II demonstrates that the capital intensity which was Rs. 0.0066 crores in 1980-81 increased to the highest level of Rs.0.0068 crores in 1981-82. The period thereafter can broadly be classified into three phases. The first phase of 1982-83 to 1995-96 witnessed a consistent decline in capital intensity to touch the lowest level of Rs.0.0033 crores in 1995-96. The second phase of 1996-97 to 2002-03 observed consistent uptrend to touch the level of Rs. 0.0054 crores. In the remaining period of the study the capital intensity again started falling and finally reached a level of Rs.0.0049 crores in 2004-05. Further perusal of the column explains that the liberalization period recorded a substantial improvement in the CAGR (3.97 percent) when compared with the CAGR of pre-liberalization period (-5.46 percent). However, a CAGR of (-0.03 percent) was registered for the overall period of the study.

#### 3) Capital- output ratio

The column IV of table II portrays the profile of annual growth rates of capital output ratio. The capital output ratio is showing a clear and consistent downtrend right from the beginning till the end of the study period. Starting from a highest level of 0.78 in 1980-81 declined constantly and uninterruptedly till 1995-96 to touch the level of 0.40. Then after fluctuating in a narrow band till 2001-02, declined further in the rest of the study period to finish at the lowest

level of 0.33 in 2004-05. Further investigation of the column reveals that the CAGR of the pre-liberalization period which was -3.48 percent declined at a slower pace (-2.77 percent) in the liberalization period. However a CAGR of -3.70 percent was noticed for the overall period of the study.

#### 4) Capital productivity (AOCR)

The yearly growth rates of capital productivity as mirrored in column V of table II reflects almost clear uptrend during the entire study period. Commencing from a level of 1.28 in 1980-81, the capital productivity improved continuously till 1995-96 to touch the level of 2.50, with the only exception of the year 1986-87 when it marginally declined to the level of 1.45. After experiencing minor fluctuations during the brief period of 1996-97 to 1999-2000, the capital productivity resumed its upward march which continued unhindered till the end to touch the peak of 3.06 in 2004-05. Further perusal of the column reveals that the CAGR which was 3.62 percent in the pre-liberalization period drifted down to 2.92 percent in the liberalization period. However a CAGR of 3.87 percent was noticed for the overall period of the study. The above discussion leads us to the conclusion that the liberalization has encouraged mechanization and technological up gradation in the paper industry in Punjab. The policies of the liberalization have resulted in lower COR and higher DOM. And all these developments have hampered the growth of employment opportunities.

### SECTION— III

#### XII. FORECASTS

Future is highly uncertain but most people view the future as consisting of a large number of alternatives. Future research or forecasting is the best way of examining the different alternatives, identifying the most probable ones and thus reducing the uncertainty to the least. Forecasting is the best designed tool to help decision making and planning in the present (Walonick, 1993). Initially forecasting was confined to limited areas but these days one forecasts at every stage of life. Now it includes trade, commerce, welfare and industry too. Present study has made an attempt to generate the forecasts on the basis of study of past behavior assuming that it may help the policy makers to monitor the probable growth of this industry so that they may timely initiate the appropriate policies.

#### 1) Smoothing Parameters

The optimal values of smoothing parameters Alpha and Gamma in case of Number of units are 1.0 and 0.4, in case of Fixed Investment these are 0.8 and 1.0 whereas in case of Employment and Production are 1.0 and 0.4, 0.5 and 1.0 respectively as exhibited in Table III

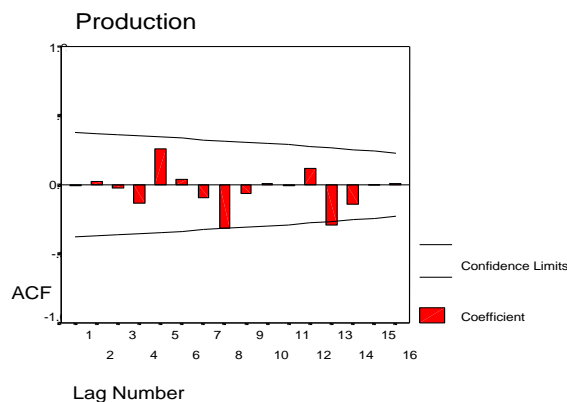
Table-III

Variable	F <sub>0</sub>	B <sub>0</sub>	α	γ	SSE
No. of Units	827.6 4583	108.708 33	1	0.4	73465. 85651
Fixed Investment	24.70 958	2.68083	0.8	1	189.95 942
Employment	3627. 20833	597.583 33	1	0.4	159992 5.823
Production	28.29 104	10.1379 2	0.5	1	1117.4 5461

The adequacy of the fitted model was tested by computing autocorrelation function of residuals and applying Ljung Box Q-statistics. Figure 1 depicts ACF among residuals and the values of Q-statistics for all the four variables for time lag of 16. Perusal of figure 1 shows that in case of Number of Units, the value of Q-statistics was 5.386 and the value of Q in case of Fixed Investment, Employment and Production were 14.547, 10.666 and 14.155 respectively. At 5 percent level of significance, all were found to be insignificant. Non-significance of Q-statistics ensures the adequacy of fitted model to generate forecasts.

figure-I

#### FORECASTS



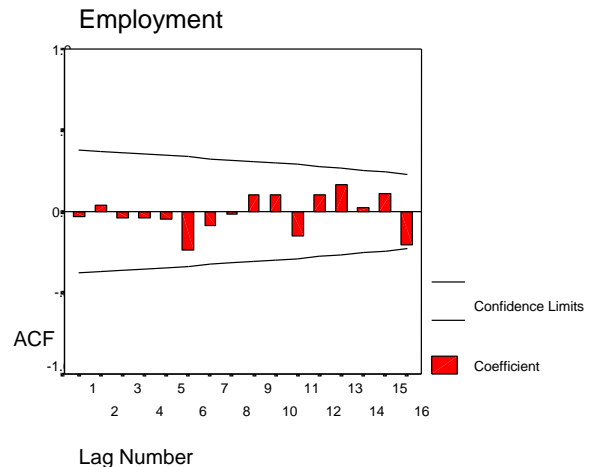
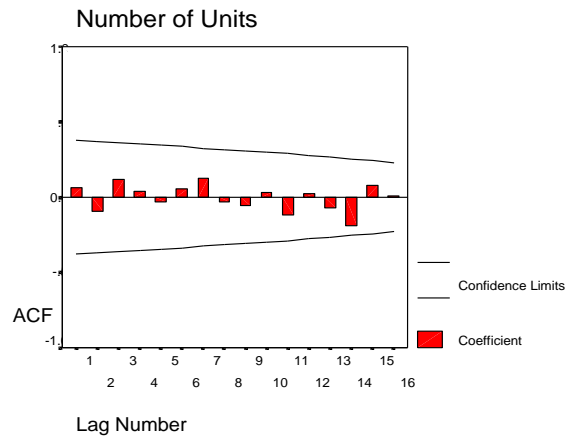
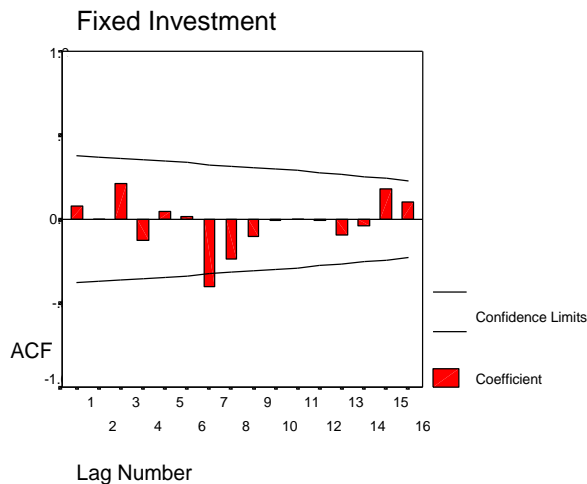
After ensuring the adequacy of DES model, the next step is to generate forecasts regarding growth and productivity of paper industry in the state of Punjab for ensuing decade till 2020. The forecasts for all the variables concerned are given in Table IV.

Table – IV

Year	Production(In Rs. Crore)	Fixed investment( In Rs. Crore)	Number of units	Direct Employment (in No.)	DOM(In Rs. Crore)	COR	AOCR	AOLR(In Rs.Crore)
2005-06	294.79	87.56	3498	18518	0.0047	0.30	3.37	0.0159
2006-07	307.40	84.00	3505	18769	0.0045	0.27	3.66	0.0164
2007-08	320.01	80.45	3512	19019	0.0042	0.25	3.98	0.0168
2008-09	332.62	76.89	3519	19270	0.0040	0.23	4.33	0.0173
2009-10	345.23	73.34	3526	19520	0.0038	0.21	4.71	0.0177
2010-11	357.84	69.79	3533	19771	0.0035	0.20	5.13	0.0181
2011-12	370.45	66.23	3540	20021	0.0033	0.18	5.59	0.0185
2012-13	383.06	62.68	3547	20271	0.0031	0.16	6.11	0.0189
2013-14	395.67	59.12	3553	20522	0.0029	0.15	6.69	0.0193
2014-15	408.28	55.57	3560	20772	0.0027	0.14	7.35	0.0197
2015-16	420.88	52.01	3567	21023	0.0025	0.12	8.09	0.0200
2016-17	433.49	48.46	3574	21273	0.0023	0.11	8.95	0.0204
2017-18	446.10	44.90	3581	21524	0.0021	0.10	9.93	0.0207
2018-19	458.71	41.35	3588	21774	0.0019	0.09	11.09	0.0211
2019-20	471.32	37.79	3595	22025	0.0017	0.08	12.47	0.0214
<b>CAGRs:</b>	<b>3.39*</b>	<b>-5.72</b>	<b>0.2*</b>	<b>1.25*</b>	<b>-6.85</b>	<b>-8.85</b>	<b>9.66*</b>	<b>2.12</b>

Source: Calculated from the data supplied by directorate of industries, Punjab.

Note \*significant at 5 percent level of significance. Perusal of Table IV reveals that the forecasts of degree of mechanisation ensure a slight upshot. In 2005-06, the forecasted figure is 0.0047 (Rs. Cr.), expected to be 0.0042 (Rs. Cr.) in 2007-08. Probably fall to 0.0023(Rs. Cr.) in 2016-17 and finally expected to reach the level of 0.0017 in 2019-20. The expected CAGR is -6.85 percent for coming decade.





Further examination of Table IV depicts that the forecasts for COR have depicted a declining growth which is a good sign for an industry because low level of COR is desirable everywhere. COR in paper and paper products industry was forecasted as 0.30 in the year 2005-06 would ensure fall in the next year and expected to dip to 0.25 in 2007-08, anticipated to decline till 2012-13 and finally expected to fall upto 0.08 in 2019-20. The expected CAGR is -8.85 percent for the ensuing decade till 2020. Perusal of Table IV shows that the AOCR is expected to rise from 3.37 in the year 2005-06 to 5.59 in the year 2011-12 and to 9.93 in 2017-18. It is further expected that AOCR figure would observe arise upto 11.09 in 2018-19 and then would probably reach upto 12.47 in 2019-20. The expected CAGR has found to be 9.66 percent for the lead time. Further glance at Table IV reveals that in case of AOLR, the growth forecasts have depicted an increasing trend. The forecasted figure for AOLR in this industry was 0.0159 (Rs. Cr.) in the year 2005-06, 0.0164 (Rs. Cr.) in 2006-07 and further expected to escalate to 0.0181 (Rs. Cr.) in the year 2010-11. It is expected that this upward tendency would continue till AOLR would probably climb to 0.0204 (Rs. Cr.) in 2016-17 and finally getting level of 0.0214 (Rs. Cr.) The expected CAGR is 2.12 percent for the ensuing decade. More examination of Table IV depicts that in case of Production, the growth forecasts have depicted an increasing trend. The forecasted figure for Production in this industry was 294.79 (Rs. Cr.) in the year 2005-06, 307.40 (Rs. Cr.) in 2006-07 and further expected to escalate to 357.84 (Rs. Cr.) in the year 2010-11. It is expected that this upward tendency would continue till this variable would probably climb to 433.49 (Rs. Cr.) in 2016-17 and finally getting level of 471.32 (Rs. Cr.) The expected CAGR is 3.39 percent for the ensuing decade. Glance at Table IV furnishes that that in case of Fixed capital investment, the forecasts have depicted a declining trend. The forecasted figure for investment in this industry was 87.56 (Rs. Cr.) in the year 2005-06, 84.00 (Rs. Cr.) in 2006-07 and further expected to fall to 69.79 (Rs. Cr.) in the year 2010-11. It is expected that this decreasing tendency would continue till this variable would probably dip to 48.46 (Rs. Cr.) in 2016-17 and finally getting level of 37.79 (Rs. Cr.) The expected CAGR is -5.72 percent for the days to come. Glance at Table IV indicates that the forecasts of Number of units ensure a snail slow growth. In 2005-06, the forecasted figure is 3498 expected to be 3512 in 2007-08. Probably rise to 3574 in 2016-17 and finally expected to reach the level of 3595 in 2019-20. The expected CAGR is 0.20 percent for for ensuing decade till 2020. Further perusal of Table IV reveals that the forecasts of Employment ensure a slight upshot. In 2005-06, the forecasted figure is 18518 expected to be 19019 in 2007-08. Probably rise to 21273 in 2016-17 and finally expected to reach the level of 22025 in 2019-20. The expected CAGR is -8.85 percent for coming decade

### XIII. CONCLUDING REMARKS

The entire discussion boils down to the conclusion that despite the problem of militancy in the pre-liberalization period, significant growth rate was observed in all the four variables namely: number of units, direct employment, fixed investment and production. On the other hand, the liberalization period also managed to record significant growth rate for all the aforesaid four variables, but the figures of CAGR for the pre-liberalization and liberalization period reveals discouraging growth rate for the direct employment and a dismal growth figure for the number of units. This clearly indicates that policies of the liberalized regime for the paper industry of Punjab are not very benign for its quantitative growth and direct employment. However, in the over all period of the study significant growth rate was measured for all the four variables. The profile of labour and capital productivity reveals that in absolute terms partial productivities of labour and capital has gone up significantly, while capital output ratio and capital intensity have fallen during over all period of the study. The comparative profile of pre-liberalization and liberalization period indicates that during liberalization period labour productivity and capital intensity showed a remarkable turnaround, capital productivity declined marginally while capital output ratio continued its declining spree. As far as expected growth of paper industry till 2020 is concerned, Production and employment are supposed to grow moderately with snail slow growth almost negligible regarding number of units. Capital investment will fall but capital productivity would show remarkable growth. Capital output ratio is expected to decline but labour productivity shows good signs of growth at the expense of capital intensity.

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