Growth of Output and its Determinants in Indian Pharmaceutical Industry: Evidence from a Panel Regression

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Abstract

The paper tried to identify the major determinants of growth of output of Indian Pharmaceutical using state level data. Modern time series technique of Sen (2003) is applied to obtain the growth rate of output of 17 major states for the period 1983-84 to 2007-08. For finding out the determinants of growth of output, only those states have been taken whose growth rates are found to be statistically significant for the entire sample period. A panel regression analysis has been done under a seemingly unrelated regression framework. The result suggests that 9 states like Assam, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Orissa and Punjab showed statistically significant growth rate for the entire sample period. For assessing the performance of 9 states, state dummy variables for each state have been introduced taking PU, state with minimum growth rate for the entire sample period, as the benchmark. It may be mentioned that the estimated equations are found to be non-linear. It is found that large sized firms, right composition of work-force and increase in wage rate as well as the trade related variables like export intensity, import intensity and net export intensity enhances growth of output.

1. Introduction

1.1 Indian Pharmaceutical industry (IPI) having started from repackaging and formulating imported drugs, now has progressed to integrated manufacturing complexes. The growth of IPI is governed not only by the domestic business environment but is also shaped by the changing global scenario. The evolution of IPI needs mention of three time points- (i) 1900 to 1970 signifies the dominance of multinationals and followed by the Patent Act of 1911. On one hand, because of lack of competition, drug prices in India was very high and on the other hand, in 1970s India was dependent on imports for many of the essential bulk drugs. (ii) 1970 to 1990 experienced the amendment of the Patent Act of 1911 in 1970 which came into force in 1972. This change brought a renaissance to the IPI. Large scale production of bulk drugs was started by the indigenous sector in the late 1970's particularly in the 1980's. The development of the bulk drug led to the transformation of the industry. As bulk drugs began to be produced in the country on a large scale, imports were replaced and consumption increased significantly leading to the unprecedented growth in formulation activity. Exports also started increasing steadily. (iii) During 1990s significant changes occurred in Pharmaceutical sector with introduction of trade liberalization measures. In 1994 government of India signed the TRIPS agreement. All those drugs which were reserved for the production by the public sector were delicenced in two stages. One immediate impact of this delicensing of the drugs was that production increased manifold besides increase in the competition among the domestic firms and foreign companies in 1990s. The delicencing of the drugs and the policy of the government to allow subcontracting or loan licensing system resulted in an uneven growth of domestic pharmaceutical industry.

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Lack of adequate funds for modernization, increased competition from private sector resulting from removal of protection and high cost of production resulted in the decline of the public sector in 1990s. With the decline of the public sector, investment in R&D also declined from this sector. However, there occurred rapid growth of private sector pharmaceutical companies and hence the growth of pharmaceutical industries in general. Both production and export grew remarkably fast. Because of the rapid growth and structural transformation in the last three decades or so, India now occupies an important position in the international pharmaceutical industry. It ranked third in volume and fourteenth in value in the global pharmaceutical market. The indigenous sector has developed tremendous strength in developing cost efficient process from basic stages and setting up manufacturing plants for producing drugs satisfying international quality norms. What contributed to the success of the indigenous pharmaceutical sector was not only the revision of the patent acts but also the introduction of agreement on Trade Related aspects of Intellectual Property Rights (TRIPS), which came into existence with WTO. Since 2005, India has started full-fledged product patent regime in pharmaceuticals and are to develop new drugs themselves or to collaborate with the MNCs as manufacturing or marketing partners for the new drugs developed by the MNCs (Chaudhuri 2005).

1.2 The study of the growth pattern of IPI and also the factors affecting growth of output are essential given the changed scenario of IPI.

Given the high growth of this industry the following questions about pharmaceuticals industry in the major states of India can be raised:

- What is the growth rate of output?
- What are the major factors affecting growth of output?

1.3 Given the changed scenario of IPI, measurement of growth of output and identification of factors affecting it is essential. Few studies attempted to analyze the growth performance of IPI (Nagarajan and Barthwal (1990), Chaudhuri (2005), Ghose and Chakraborty (2008), etc). But none of them considered the growth of Pharmaceutical industry output in major states of India. The present paper contributes to the literature from the above perspective.

1.4 The objectives of the present paper are to study the growth rate of output of IPI at the state level and to identify the major factors affecting such growth. Such analysis will identify the states which lag behind in growth performance and to formulate appropriate growth policies.

1.5 The format of the present study is as follows: Section 2 gives the methodology and data sources. Section 3 presents the result of analysis. In Section 3.1 analysis of the growth rate of output of different states considered are presented whereas identification of major factors affecting growth of output is presented in Section 3.2. Section 4 summarizes the conclusion of this study.

2. Methodology and Data Source

For growth analysis it is important to specify the methodology for finding out growth rate and the determinants of growth which are described in the next subsections 2.1 and 2.2 respectively.

2.1. Methodology for estimating growth rate of the major states

2.1.1 Nelson and Plosser (1982) suggested that the nature of macroeconomic data follows two types of process: Difference Stationary (hereafter, DS) and Trend Stationary (hereafter, TS). The conclusion about the growth rate must be based on TS series, because DS series basically implies stochastic trend where variability of the series depends on time. The test for detecting DS or TS type series is called unit root test (Dickey-Fuller (1979, 1981) or Augmented Dickey fuller test). Perron (1989) proved that in the presence of structural break the standard unit root test is not consistent against TS and has suggested a procedure for testing unit root in presence of one time structural break in the series. Zivot and Andrews (1992) criticized Perron's procedure for finding out the break point, as it was based primarily on visual inspection of data and argued that break point should be endogenously determined. Sen (2003) proved that the power of Zivot and Andrews (1992) test procedure is low and it can be improved by considering maximum 'F' statistic instead of taking minimum 't' statistic i.e. among the different regressions one can choose that year as break year which gives the maximum value of the 'F' statistic.

2.1.2 The present paper adopts Sen (2003) approach for measuring growth rate. The following equation which admits both changes in the level and growth of the series have been employed:

$$\ln Y_t = a + bDU_t + ct + gDT_t + d\ln Y_{t-1} + \sum e_j \Delta \ln Y_{t-j} + e_t \qquad \text{...(1)}$$

In this equation (1), c i.e the coefficient of time represents growth rate for the entire sample period if g, the coefficient of DT_t is not statistically significant. But if g is statistically significant, c represents growth rate for the period before structural break whereas the growth rate after structural break is captured by the term c+g.

$DU_t = 1$ if $t > T\gamma$

$= 0$ otherwise

$DT_t = t - T\gamma$ if $t > T\gamma$

$= 0$ otherwise

Here T stands for total time period and γ stands for time break, i.e., $\gamma = T_B/T$, T_B being break point. To determine the nature of the series, the test criteria is to select the series as TS if the estimated value of F is significant at the chosen level (compared with the critical values provided by Sen (2003)) and is DS otherwise.

2.2 Methodology for finding out determinants of growth of output: Panel Regression

2.2.1 As state specific regressions for finding out the determinants of growth of output do not produce uniform results, to find out the factors influencing growth of output and to get a comprehensive picture about the possible determinants, a panel regression analysis using state level panel data from 1983-84 to 2007-08 has been done under a seemingly unrelated regression (SUR) framework where each regression was adjusted for contemporaneous correlation (across units) and cross section heteroscedasticity is adopted.

2.2.2 The dependent variable of the model is taken as lnY (i.e. log of the level of output). As possible determinants of growth of output, explanatory variables like firm size, degree of mechanisation, composition of work-force and wage rate have been considered along with the trade related variables like export intensity, import intensity and net export intensity.

2.2.3 For finding out the determinants of growth of output, only those states have been taken whose growth rates are found to be statistically significant for the entire sample period. But the growth rates for these states may be same or different for the period before and after structural break.

2.2.4 SUR is appropriate when all the right hand side regressors X are assumed to be exogenous, and the errors are heteroscedastic and contemporaneously correlated so that the error variance matrix is given by $V = \sum \otimes I_T$. Zellner's SUR estimator of β takes the following form:

$$b_{SUR} = (X^{/} (\hat{\Sigma} \otimes I_T)^{-1} X)^{-1} X^{/} (\hat{\Sigma} \otimes I_T)^{-1} y$$

where $\hat{\Sigma}$ is a consistent estimate of Σ with typical element s_{ij}, for all i and j. If autoregressive terms are included in the equation, then the following equation is estimated:

$$y_{jt} = X_{jt} \beta_j + \left[\sum_{r=1}^{p_j} p_{jr} \left(y_{j(t-r)} - X_{j(t-r)} \right) \right] + \epsilon_{jt}$$

where ε_j is assumed to be serially independent, but possibly correlated contemporaneously across equations.

2.2.5 Now, one can estimate GLS specifications that account for various patterns of correlation between the residuals. In this paper contemporaneous covariances is taken into the consideration.

2.2.6 Cross Section SUR or Contemporaneous Covariances:

2.2.6.1 This class of covariance structures allows for conditional correlation between contemporaneous residuals for cross section "i" and "j", but restricts residuals in different periods to be uncorrelated, specifically that:

$$\mathrm{E}(\in_{it} \in_{jt} / x_t^*) = \sigma_{ij}$$

$$\mathrm{E}(\in_{is} \in_{jt} / x_t^*) = 0$$

For all "i", "j", "s" and "t" with s≠t. The error terms may be thought of as cross-sectionally correlated. Alternatively, this error structure is sometimes referred to as clustered by period since observations for a given period are correlated.

Using the period specific residual vectors one may rewrite this assumption as:

$$\mathrm{E}(\in_t \in_t^{/} / x_t^*) = \Omega_M$$

For all t, where

$$\Omega_M = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1M} \\ \vdots & \ddots & \vdots \\ \sigma_{M1} & \cdots & \sigma_{MM} \end{bmatrix}$$

2.2.6.2 This is a cross section specification because it involves covariances across cross section as in a seemingly unrelated regression type framework. Cross section SUR generalized least squares on this specification is simply the feasible GLS estimator for systems where the residuals are both cross sectionally heteroskedastic and contemporaneously correlated. Eviews employs residual from first stage estimates to form an estimate of Ω_M. In the second stage, they perform feasible GLS.

2.2.7 White Cross-Section or Cross Section Heteroscedasticity:

2.2.7.1 The White Cross-Section method assumes that the errors are contemporaneously (Cross-Sectionally) correlated (Period Clustered). The method treats the pool regressions as a multivariate regression (with an equation for each cross section) and computes robust standard errors for the system of equations. The coefficient covariance estimator is as follows:

$$\left(\frac{N^*}{N^* - K^*}\right)\left(\sum_t X_t' X_t\right)^{-1}\left(\sum_t X_t' \widehat{\epsilon_t}\, \widehat{\epsilon_t'}\; X_t\right)\left(\sum_t X_t' X_t\right)^{-1}$$

where the leading term is a degree of freedom adjustment depending on the total number of observations in the stacked data, N^* is the total number of stacked observations and K^* is the total number of estimated parameters.

2.2.8 State dummy variables: In India each state has its own special characteristics that persuade the growth and performance of industries in several counts. Also the spread of type of industries in different states is different. Every state has its own industrial policy and although there is a wide concurrence in the policies of states, their approaches may be different. Hence the growth and performance of industries in different states do not always move in the same track.

2.2.9 Since this paper is not resorted to state specific regressions, to account for such type of heterogeneity for the growth performance of output, one can introduce intercept state dummy variables, S_i's while performing panel regression. The intercept state dummy variables defined for each major state, which distinguishes the industry located in different major states considered and the state having the minimum growth rate for the entire sample period is taken as the benchmark state.

2.2.10 The dependent variable of the model is taken as lnY (i.e. log of the level of output) and the possible determinants of growth of output considered are firm size, degree of mechanisation, composition of work-force and wage rate.

2.2.11 The justification for inclusion of the different explanatory variables are as follows:

2.2.11.1 Firm size (MF): A larger firm can be able to exploit economies of scale and generate higher growth relative to smaller firms. Alternatively, since size is correlated with market power (Shepherd 1986) and market power helps to develop X-inefficiencies, it can lead to relatively inferior performance (Leibenstein 1966). Therefore, theory does not show any bias towards larger firm or smaller firm to growth. The empirical literature on this issue suggests that the studies vary both with respect to choice of the indicators specifying firm size and the conclusions arrived at regarding positive, negative or no impact of firm size on growth (Ahluwalia (1991), Biesebroeck (2005), Castany et al (2007), Majumder (1997), Mukherji (1963)). The alternative measures of firm size are number of workers, log value of sales, assets of the firm, amount of intermediate inputs consumed like material and fuel, capital stock per factory, etc. This paper uses amount of material and fuel consumed (MF) as measure of firm size.

2.2.11.2 Degree of mechanization (K/L): K/L serves as a technological variable and gives an idea about the relative degree of mechanization. A positive relationship between K/L and growth of output is normally expected.

2.2.11.3 Composition of work-force (E/L): This variable is measured by (non-production) employees per production worker (E/L). It is also a technological variable and is related to composition of work-force. A higher number of employees per worker generally signify a higher degree of bureaucratic control within the firm that can hinder growth. On the other hand, a positive relation between (E/L) and growth indicates that the combination of work-force is just right to operate production process efficiently and promote growth.

2.2.11.4 Wage rate (W): If wage rate is sufficiently high for any industry then skilled workers can be attracted towards that industry and considering skill as a positive determinant of growth of output, it can be argued that as W increases, growth of output may increase through the involvement of more skilled workers in the production process.

2.2.11.5 One of the important characteristics of IPI is that they re-engineer the imported technology and then re-export the product. Export plays a very important role for the growth in the pharmaceutical sector. [Theoretical and empirical literature supporting positive role of exports (Sun, Hone and Doucouliagos (1999), Driffield and Kambhampati (2003), Goldar et. al. (2004), Ray (2006)]. The findings of Indian studies are mixed and industry-specific, even during post-reform period. The pharmaceutical firms also have to do a lot of imports. Evidence suggests that the imported intermediary good is an important channel through which technological diffusion takes place (Tybout 2000); theories of import-led growth due to Grossman and Helpman, (1991).

2.2.11.6 Given the fact that both exports and imports may have favourable effect on growth of output, natural question is what is the relative role of exports vis-à-vis imports in explaining the growth process of output. The major shortcoming of many empirical studies is their inability to separate the impact of exports and imports. Some focus on the one and neglect the other.

2.2.11.7 It may be relevant to mention here that in trade-growth literature, to take into account the total effect of exports and imports on economic growth some studies used sum of exports and imports to estimate the relationship between trade and economic growth (Frank and Romer (1999) and Harision (1996)). But the limitation of total trade measure is that it embodies an underlying assumption that exports and imports contribute equally to the promotion of economic growth. Also it assumes import-intensity of exports to be zero. Whereas Zhang, Ondrich and Richardson (2003), while evaluating how cross coun-try differences in exports and imports openness in 1990 affected the level of real per capita income, used net exports (exports minus imports), which in turn imply dis-tinct exports and imports effects. Their results support the conjecture that income is associated with net trade. In tune with this literature the present study uses (X-M) to find the net effect of exports over imports.

2.2.11.8 Thus it will also be interesting to check whether growth of output of IPI measured by log of the level of output is affected by trade related variables, X/Y, M/Y and (X-M)/Y or not.

2.2.11.9 Export intensity (X/Y): IPI exports (X) a lot (Chaudhuri 2005). There is a common opinion that international export enhances economic growth of involved firms (see Balassa, 1988). Economic policies under export-led growth strategy have been widely supported on the argument that exposure to international market through export helps to increase growth of exporters. Similarly, advocates of endogenous growth theory believe that export plays a crucial role by improving productivity and hence growth through innovation (Grossman and Helpman, 1991) and technology transfer (Barro and Sala-i-Martin, 1995). Through participation in export, growth can occur as a result of many factors such as capital accumulation, adoption of new technologies, research and development, changes in the organization of firms, etc.

2.2.11.10 Import intensity (M/Y): IPI also imports (M) a lot of goods especially intermediate goods. The imported intermediary good is an important channel through which technological diffusion takes place (see, Tybout 2000); this may affect productivity and growth favorably. Imports allow countries to take advantage of other countries technology embodied in imported inputs. Suffice here to mention theories of import-led growth due to Grossman and Helpman (1991). The removal of quantitative restrictions on imports and lowering of customs duties in the post liberalization era of the Indian economy should have improved access of imported raw materials and capital goods. Imports of materials embodying latest technologies should foster productivity, efficiency and the growth of the firms. Goldar et al.(2004) and Mazumder et al(2010) reported positive relation between efficiency and imports.

2.2.11.11 Net Export intensity ((X-M)/Y): As both X and M affect growth, the question arises what is the relative role of exports vis a vis imports in fostering growth of output? Thus ((X-M)/Y) is considered as one of the possible determinants of growth of output.

2.2.12 Thus four models have been formulated and estimated: Model A- Model without trade related variable and Model with trade related variables namely X/Y, M/Y and (X-M)/Y in Models B, C and D respectively.

2.3 Data Source

2.3.1 The sample consists of 17 major selected states namely Andhra Pradesh (AP), Assam (AS), Bihar (BI), Gujarat (GU), Haryana (HA), Himachal Pradesh (HP), Jammu & Kashmir (JK), Karnataka (KA), Kerala (KE), Maharashtra (MH), Madhya Pradesh (MP), Orissa (OR), Punjab (PU), Rajasthan (RA), Tamilnadu (TN), Uttar Pradesh (UP) and West Bengal (WB) over the period 1983-84 to 2007-08. All the relevant data except imports and exports are collected from various issues of "Annual Survey of Industries, Summary Results for the factory sector" published by CSO, Government of India. Data on Export and Import at All India level have been collected from various issues of Foreign Trade Statistics of India, published by the Directorate General of Commercial Intelligence and Statistics.

However state level exports and imports data are not readily available and thus data on export and import have been constructed using CMIE prowess database as follows:

2.3.2 Data on X for the i^{th} state, $X_i = \Sigma x_{ij}$ where x_{ij} is the export figure of the j^{th} firm located in the i^{th} state. Similarly Data on M for the i^{th} state, $M_i = \Sigma m_{ij}$ where m_{ij} is the import figure of the j^{th} firm located in the i^{th} state. It may be noted that if the j^{th} firm is found to be located in say, 3 different states, then the average of the export figure of the j^{th} firm will be taken as the export figure of the j^{th} firm in the 3 states separately. Similar methodology can be found in Goldar & Banga (2007) and Pradhan and Das (2015).

2.3.3 All the variables X, M and Y have been deflated by the appropriate indices i.e. Unit value index of export of Medicinal & pharmaceutical products, Unit value index of import of Medicinal & pharmaceutical products and wholesale price index of drugs and medicines respectively.

3. Results of estimation

3.1 Results of estimation of growth rate of the major states

3.1.1 For finding out the growth rate of output, log of output is taken as dependent variable in the regression equation (as mentioned in section 2.1.2).

c (coefficient of time) represents growth rate for the entire sample period if g (coefficient of DT_t) is not statistically significant. But if g is statistically significant, c represents growth rate for the period before structural break and c+g represents growth rate after the period of structural break. Regarding the choice of the lag value, the figures of the correlogram is used showing that the series is AR(1) type with the autocorrelations dying out and only the first partial correlation coefficient is significant.

3.1.2 Out of 17 states considered, for 9 states like AS, GU, HA, HP, KA, KE, MH, OR and PU, c is statistically significant. It is found that only for 5 states like HP, JK, KA, PU, UP out of 17, g is statistically significant.

Hence three groups of states can be identified:

1) Both c and g are statistically significant: HP, KA and PU. So for these three states, growth rates are different in the period before and after structural break.

2) c is significant but not g: AS, GU, HA, KE, MH and OR. So for these 6 states, c will represent the growth rate for the entire sample period.

3) g is significant but not c: JK and UP. Hence for these 2 states, there exist significant growth rate after break but not before the break. So growth rates are not found to be statistically significant for the entire sample period for these two.

3.1.3 For finding out the determinants of growth of output, only those states have been taken whose growth rates are found to be statistically significant for the entire sample period. The growth rates may be same or may differ for the period before and after structural break. So the two states (JK and UP) have not been considered for further analysis. Thus for determinant analysis, only states belonging to group 1 and group 2 have been taken.

3.1.4 The result of growth rate of these 3 groups of states is presented in Table 1.

3.2 Explaining the variation in Growth of Output

3.2.1 For finding out the determinants of growth of output, only those states have been taken whose growth rates are found to be statistically significant for the entire sample period. The growth rates may be same or may differ for the period before and after structural break. In this way 9 states like AS, GU, HA, KE, MH, OR, HP, KA and PU have been identified. Thus state level panel data comprising of 9 states[2] over the period 1983-84 to 2007-08 have been employed and panel regression analysis has been done under a seemingly unrelated regression (SUR) framework where each regression was adjusted for contemporaneous correlation (across units) and cross section heteroscedasticity is adopted. For the intercept state dummy variables, S_i's defined for each major state, PU, the growth rate for which is found to be minimum over the entire sample period, is taken as the benchmark state.

3.2.2 Four models have been formulated and estimated: Model A-Model without trade related variable, Model B-Model with trade related variable X/Y, Model C-Model with trade related variable M/Y and Model D-Model with trade related variable (X-M)/Y.

3.2.3 The results of the panel regression analysis of Models A, B, C and D are presented in Tables 2, 3, 4 and 5 respectively. High value of Adjusted R^2 shows that the fitted models are reasonably good.

3.2.4 It may be mentioned that the estimated equations of the four models are found to be non-linear. Thus in order to find out the effect of the explanatory variables on the dependent variable, one needs to calculate the marginal effect. The value of marginal effect of all the determinants of the four models has been presented in Table 6. The results suggest that growth of output is positively related to MF, E/L and W whereas it is negatively related to K/L. Thus one may argue that larger firm experiences higher growth of output may be with more accessibility of quality inputs and scale advantage. Also higher wage rate encourages more skilled workers in the production process thereby increasing growth of output. A positive relation between combination of work-force and growth of output indicates that the combination of work force is just right to operate production process efficiently and hence promote growth. The negative effect of degree of mechanization can be explained by the underutilisation of existing capital stock[3]. It may also be possible that Indian pharmaceuticals have installed new plant and machinery recently. Such investment may have been made keeping future opportunities in mind and presently these capitals are not fully utilized (Mazumdar, Rajeev & Ray (2010)).

3.2.5 Along with it, the trade related variables such as X/Y, M/Y and (X-M)/Y are positively related with growth of output. Also it is seen that the inclusion of the trade related variables, X/Y, M/Y and (X-M)/Y respectively in Models B, C and D, has not affected the role of other explanatory variables namely MF, E/L,W and K/L.

3.2.6 Another interesting result found is that the values of the marginal effect of export intensity is higher than that of import intensity (although do not differ much).

[2]The factors influencing the determinants of growth of output remain unaltered if all the 17 states are considered.
[3]Our evidence corroborates the findings of Virmani & Hashim (2009) and Uchikawa (2001, 2002).

3.2.7 It is observed that the coefficient of state dummy S_2 for GU, S_5 for KA and S_7 for MH are positive and significant but the other coefficients of state dummy like S_1 for AS, S_3 for HA, S_4 for HP, S_6 for KE and S_8 for OR are negative and significant. Thus coefficient of state dummy for (i) GU, KA and MH are positive and statistically significant while that of (ii) AS, HA, HP, KE and OR are negative and statistically significant implying a higher (lower) output level for the former (later) group of states compared to PU .

4. Conclusion

4.1 The present paper analyses the growth performance of Indian Pharmaceutical Industry using data on 17 major states employing modern time series technique of Sen (2003) for the period 1983-84 to 2007-08.

4.2 Also, the factors influencing growth of output are taken into account considering the variables like firm size, degree of mechanization, composition of work-force, wage rate and also the trade related variables like export intensity, import intensity and net export intensity. Thus four models, Model A: Model without trade related variable, Model B: Model with trade related variable X/Y, Model C: Model with trade related variable M/Y and Model D: Model with trade related variable (X-M)/Y has been constructed.

4.3 Since growth rate vary across states and since the present paper is not resorted to state specific regressions, for determinant analysis the intercept state dummy for each state is introduced taking PU, the state having minimum growth rate over the sample period, as the benchmark in all the four models. Out of 17 states considered, for 9 states like AS, GU, HA, HP, KA, KE, MH, OR and PU the growth rates are statistically significant for the entire sample period. For HP, KA and PU, both c and g are statistically significant. So for these three states, growth rates are different in the period before and after structural break. For AS, GU, HA, KE, MH and OR, c is significant but not g. So for these states, c will represent the growth rate for the entire sample period.

4.4 For determinant analysis, only 9 states (AS, GU, HA, HP, KA, KE, MH, OR and PU) are considered as for these states the growth rates are found to be statistically significant for the entire sample period (The growth rates may be same or different for the period before and after structural break).

4.5 The estimated equations in the four models are found to be non-linear. It is found that large sized firms, combination of work-force and increase in wage rate will enhance growth but degree of mechanization affects growth unfavourably.

4.6 Thus one may argue that larger firm experiences higher growth of output may be with more accessibility of quality inputs and scale advantage. Also, higher wage rate encourages more skilled workers in the production process, thereby increasing growth of output. A positive relation between combination of work-force and growth of output indicates that the combination of work-force is just right to operate production process efficiently and hence promote growth. The negative effect of degree of mechanization can be explained by the underutilisation of existing capital stock[4]. It may also be possible that Indian pharmaceuticals have installed new plant and machinery recently. Such investment may

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[4] Our evidence corroborates the findings of Virmani & Hashim (2009) and Uchikawa (2001, 2002).

have been made keeping future opportunities in mind and presently these capitals are not fully utilized (Mazumdar, Rajeev & Ray (2010)).

4.7 The trade related variables like export intensity, import intensity and net export intensity all have a positive linkage with growth of output. The value of the marginal effect of export intensity is found to be higher than that of import intensity although they do not differ much.

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Table 1: Growth Rate of the States

State	AS	GU	HA	HP	KA	KE	MH	OR	PU	JK	UP
Growth Rate for the entire sample period	0.065	0.086	0.081	--	--	0.065	0.058	0.124	--	--	--
Growth Rate before break point	--	--	--	0.355	-0.054	--	--	--	-0.519	0.036	0.033
Growth Rate after break point	--	--	--	--	--	--	--	--	--	0.394	0.155

Table 2: Estimated Result of Model A (Without Trade related Variable)

Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	1.256154	3.891625	**S1**	-1.74072	-8.72353
MF	0.004762	6.261689	**S2**	2.632975	10.82402
K/L	-19.8717	-8.3958	**S3**	-0.53947	-4.33446
E/L	5.337703	7.008867	**S4**	-1.25916	-3.05937
W	1.60128	6.948717	**S5**	0.61869	4.738263
			S6	-0.47269	-3.10012
$(MF)^2$	-1.71E-06	-6.18237	**S7**	3.005891	9.759634
$(K/L)^2$	66.25524	8.316875	**S8**	-1.80405	-12.1508
$(E/L)^2$	-3.24475	-5.94125	**Adjusted R-squared**	0.921845	
$(W)^2$	-0.72132	1.60128	**F-statistic**	166.1323	

Table 3: Estimated Result of Model B (With Export Intensity)

Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	1.807387	5.639993	**S1**	-1.82545	-6.75627
MF	0.005203	3.893528	**S2**	2.72442	8.2676
K/L	-18.7861	-9.25342	**S3**	-0.3453	-5.5554
E/L	3.306551	5.1268951	**S4**	-1.128	-3.71585
W	1.058923	6.982532	**S5**	0.75279	4.7177
X/Y	0.32193	6.25386	**S6**	-0.44797	-0.93735
$(MF)^2$	-1.14E-06	-4.78402	**S7**	2.89342	6.427845
$(K/L)^2$	62.54747	8.803341	**S8**	-1.83652	-5.3954
$(E/L)^2$	-1.95234	-5.02489	**Adjusted R-squared**	0.9022201	
$(W)^2$	-0.65697	-6.58797	**F-statistic**	152.2552	
$(X/Y)^2$	-4.04E-05	-11.8088			

Table 4: Estimated Result of Model C (With Import Intensity)

Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	1.82953	2.375401	S1	-1.48823	-5.73722
MF	0.006154	5.160908	S2	2.295789	8.22905
K/L	-25.8365	-11.5956	S3	-0.63805	-4.73457
E/L	3.48653	3.20264	S4	-1.80678	-3.93423
W	1.995218	6.204562	S5	0.933789	4.748203
M/Y	0.2823	4.301204	S6	-0.59764	-3.15859
$(MF)^2$	-2.23E-06	-5.64653	S7	2.277042	6.693502
$(K/L)^2$	56.77819	8.754252	S8	-1.85136	-6.51823
$(E/L)^2$	-2.19653	-6.86321	Adjusted R-squared	0.906917	
$(W)^2$	-0.81773	-6.32538	F-statistic	148.8723	
$(M/Y)^2$	-0.00052	-10.88401			

Table 5: Estimated Result of Model D (With Net export Intensity)

Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
C	1.31323	4.69452	S1	-1.54263	-6.76347
MF	0.008959	3.506348	S2	3.313589	8.75478
K/L	-23.6185	-9.23247	S3	-0.41918	-4.437972
E/L	3.48038	5.658402	S4	-1.99548	-2.98421
W	1.815925	5.633323	S5	0.68312	5.448127
(X-M)/Y	0.41452	6.439942	S6	-0.923124	-3.328782
$(MF)^2$	-6.23E-06	-6.50978	S7	2.969248	7.214702
$(K/L)^2$	52.42456	7.228212	S8	-1.145248	-8.55148
$(E/L)^2$	-2.29482	-4.76823	Adjusted R-squared	0.891616	
W^2	-0.85305	-6.80845	F-statistic	157.8112	
$((X-M)/Y)^2$	-1.89E-03	-10.35458			

Table 6: Marginal effect of the Determinants

Variables	MF	K/L	E/L	W	X/Y	M/Y	(X-M)/Y
Model A	4.43E-03	-15.42453	1.207634	1.600251	--	--	--
Model B	0.004980	-9.009918	0.821522	1.057986	0.319838	--	--
Model C	0.005717	-16.962058	0.690684	1.994052	--	0.276110	--
Model D	0.007739	-15.42453	0.559426	1.814708	--	--	0.301197