P: ISSN NO.: 2394-0344 RNI No.UPBIL/2016/67980 VOL-3* ISSUE-10* January 2019
E: ISSN NO.: 2455-0817 Remarking An Analisation

Technical Efficiency in The Pharmaceutical Industry of Himachal Pradesh
(A Case Study for The Year 2011-12)

Abstract

The study has used the stochastic frontier approach to determine the frontier production function and technical efficiency scores of the firms in the pharmaceutical industry of Himachal Pradesh for the year 2011-12. Technical efficiency for majority of the firms was found to be very low in the pharma industry of Himachal Pradesh in the year 2011-12. It was found that firm size had a negative impact on efficiency for most of the firms. The older the firm, the more the technical efficiency was found to be when the impact of age was captured through total output as a measure of size.

Keywords: Pharmaceutical Industry, Medicines.

Dilasha Anand
Research Scholar,
Deptt. of Economics,
Panjab University,
Chandigarh

Introduction

Pharmaceutical industry is one of the world's most research-intensive industries, generating a continuing stream of new products that save lives and raise the quality of life. Given the significance of pharmaceutical industry every country needs to maintain not only high standards of healthcare and pharmaceutical production but also ensure availability of adequate drugs at affordable prices. Thus, the growth of the pharmaceutical industry is a sine qua non of the overall wellbeing of each and every nation and needs careful study.

The indigenous systems of medicines have existed in India since times immemorial namely; ayurveda, siddha and unani but the allopathic system of medicines was essentially imported by the British (Ramachandran and Rangarao, 1972). The MNCs controlled the reigns of the Indian Pharmaceutical Industry (IPI) under the auspices of Indian Patents and Design Act (1911) and their domination continued till the coming into force of the Indian Patents Act (1970). The long period of foreign stranglehold impeded the growth of local manufacturers. Further, the MNCs majorly relied on the import of bulk drugs to be processed into formulations as a result of which the investment in the domestic pharmaceutical industry was subdued. According to the Report by the Hathi Committee (1975) the total investment (at current prices) in the pharmaceutical sector was just Rs 24 crore in 1952 which rose to Rs 200 crore in 1972, the year the Patent Act of 1970 came into force(Ramachandran and Rangarao, 1972).

The winds of change began to blow when along with the adoption of Indian Patents Act (1970), Foreign Exchange Regulation Act (1973), Indian Drug Policies of 1978 and 1986, Drug Price Control Order and many more such statutory and executive measures affecting the IPI were put in place. The outcome was the increase in the market share of domestic firms in the IPI and the supply of medicines at affordable prices to the masses.

Presently, India ranks fourth in the terms of volume and thirteenth in terms of value in the global pharmaceutical output. The lower rank in terms of value is owing to the relatively low prices of Indian pharmaceutical products (Jha, 2007). IPI is a highly organised sector and is estimated to be worth Rs 18153616 lakhs according to the Annual Survey of Industries Summary Statistics 2011-12. According to the Corporate Catalyst India Pvt. Ltd.'s " A Brief Report on the Pharmaceutical Industry in India", 2014, the IPI is growing at around 8-9% annually and is one of the leaders among third world countries on parameters such as technology, quality, and variety of products manufactured. The pharmaceuticals industry is being called as the 'sunrise industry' as it is the second largest growing industry in India. The last two decades have witnessed a phenomenal expansion of the IPI with currently more than 20,000 registered pharmaceutical manufacturing units which meet 70 % of the domestic demand for bulk drugs, drug intermediates, formulations etc. Although formulations account for a large share of the overall pharmaceutical production in terms of value, since the mid-1990s the share of bulk drugs has been moving on an upward trajectory courtesy a strong chemical industry and reverse engineering (Jha, 2007).

The success of the IPI has been fuelled by the increased sales of generic medicines, captivation of the rural markets, increase in the insurance cover and increased inclination towards hygiene and health. Besides the afore-mentioned reasons, a large chunk of ageing population and strong distribution networks are keeping the growth of IPI lubricated. The pillars of strength for the IPI are a competent workforce, cost effective chemical synthesis, a strong network of financial institutions, sound legal framework, a progressive Information Technology base and a globalized market. Nevertheless, the ascendant pharmaceutical industry of India is fraught with challenges such as patent expiration of major drugs, granting of product patents under TRIPS, low in-house R&D productivity, price controls, infrastructural crunch and conformance to global standards (Corporate Catalyst India Pvt. Ltd., 2014).

In the last decade the pharmaceutical industry of the state of Himachal Pradesh has grown by leaps and bounds. In 2002 Special Category Status was conferred upon the state under which various excise duty, income tax exemptions and capital investment subsidy were granted for the manufacturing establishments to flourish. Industrial areas are now being developed and maintained by the Department of Industries and the Himachal Pradesh State Industrial Development Corporation and the Himachal Urban Development Agency (HIMUDA). Industrial areas located in the adjoining borders of Punjab, Haryana, Chandigarh, Uttaranchal and Jammu and Kashmir have attracted a large number of industrial projects. The state today has a significant presence of the textile and pharmaceutical production capacity of the country and has proven itself as an attractive destination for food processing, engineering, paper, white goods manufacturing and packaging industries along with textile and pharmaceuticals.Himachal Pradesh presently ranks fourth in India in terms of value in the total production of pharmaceutical and medicinal preparations with a share of 11.71%. Within Himachal Pradesh, the basic pharmaceutical products and pharmaceutical preparations, with a share of 26.33 %, have the highest contribution in the Industrial output of the state. Solan and Sirmour districts have attracted considerable investment in various industrial sectors. The small towns in Himachal Pradesh like Baddi and Paonta Sahib are being called as the Pharmaceutical capitals of India due to the increasing concentration of pharmaceutical firms in these areas (India Brand Equity Foundation, 2010).Considering the significance of the pharmaceutical industry in the state of Himachal Pradesh the present study is an attempt to provide an insight into the performance of the pharmaceutical industry of Himachal Pradesh in terms of technical efficiency at the unit level for the year 2011-12.

Review of Literature

A number of studies have been carried out to examine the determinants of technical efficiency in different manufacturing industries in India. Most studies have used the stochastic frontier approach, which is a parametric approach or the data envelopment analysis, a non-parametric approach, in order to assess the performance of firms in terms of efficiency. Further, various determinants of technical efficiency of firms have been listed in the papers such as firm size, skilled labour, location, ownership, R&D, exports, type of organization etc.

Pattnayak and Chadha (2005) attempted to examine the stochastic frontier production function with time varying effects for 76 Indian pharmaceutical firms for the period 1991-2003. For the industry as a whole technical efficiency was found to be increasing, with much more significant improvement for patenting firms. The data obtained from the Centre for Monitoring Indian Economy database Prowess for the years 1991-2003 was grouped into four time periods to analyse a phase wise growth in technical efficiency. It was found that for the phase 1999-2003, when the WTO provisions for patents were enforced the patenting firms reduced their difference from the frontier, while on the average the efficiency of the pharmaceutical industry as a whole remained much lower.

Seethamma Natarajan Rajesh Raj (2007) foregrounded the sources of technical efficiency in the unorganised manufacturing sector in the Indian state of Kerala using thetranslog stochastic frontier production function. Unit level analysis for the sector as a whole and for five industry groups has been carried out with following variables as determinants of technical inefficiency; size, ownership, region and seasonality of operation. Data for unorganised manufacturing sector has been garnered from NSSO survey of unorganised manufacturing enterprises for the period 2000-01. Results showed that, on an average firms were not able to utilise even 50% of their potential output. To assess the impact of firm size on technical efficiency, number of hired workers in an enterprise was taken as a proxy for its size. The regression showed a negative relationship between technical inefficiency and the number of hired workers.

Neogi et al. (2012) have made an effort to identify the factors behind the growth of the Indian Pharmaceutical Industry. They observed that IPI has seen a tremendous surge in the growth since 1991 and an upward trend is again observed after 2005. To analyse the reasons for the same the factors determining the productivity and efficiency in the IPI have been studied. The study covers the period of 2000-2001 to 2005-06 to assess the total factor productivity growth and technical efficiency at the unit level of the Indian Pharmaceutical Industry, the data for which has been garnered from ASI. Stochastic frontier approach has been used to calculate technical efficiency for the industry. It was deduced that firms with low levels of TFP and efficiency either shut down or merge with other firms eventually. Of the various factors affecting the performance of the IPI, managerial skills and wage rates have had a significant positive impact. It was also reasoned out that, areas where pharmaceutical firms have special facilities, the performance of the pharmaceutical firms was better. Technical efficiency has been linked to size, where the fixed capital has been taken to be an indicator of size. The mean efficiency of the large sized firms was found to be greater than medium and small sized firms.

Goldar and Mitra (2013) have exposited the efficiency gaps between organised and the unorganised sector firms across the states for the year 2005-06. The type of sectors is taken to be a proxy for size. The data for the organised sector has been garnered from ASI and for the unorganised sector; the data has been drawn from NSSO data for the unorganised manufacturing enterprises. Technical efficiency has been estimated by applying the constant-returns-to-scale DEA model. It was revealed that while the organised firms were able to better utilise their production capabilities, the unorganised sector while being poor performers showed lesser variance in the performance of firms.

Satpathi et al. (2017) exposit the effect of firm level factors like size, age, import of raw material, advertisement intensity and disembodied technological progress on productivity. The paper uses unit level data for the period 1998-99 to 2012-13 procured from Annual Survey of Industries. The study uses the method of Fully Modified Ordinary Least Squares (FMOLS) method to analyse the impact of firm specific characteristics on productivity and concludes that the main factors affecting productivity are size of the firm, technology, and import of raw material.

Objectives of the Syudy

The study has the following objectives:

1. To determine the frontier production function in the pharmaceutical industry of Himachal Pradesh for the year 2011-12.
2. To identify the factors that affect inter-firm differences in technical efficiency in the pharmaceutical industry of Himachal Pradesh for the year 2011-12

Data Sources and Methodology

Data sources: To assess the performance of the pharmaceutical industry of Himachal Pradesh, technical efficiency at the unit level has been calculated for the year period 2011-12. The present study is exclusively based on secondary data. The unit level data on the pharmaceutical firms in Himachal Pradesh for the year 2011-12 for calculating technical efficiency has been drawn from Annual Survey of Industries, carried out by the Central Statistical Organization. The time period under scrutiny involves analysis of data classified under National Industrial Classification Code; NIC-08 Code 210.Gross Value Added has been used to measure the output. Gross value of plant and machinery has been used as the measure of capital and for measuring labour input, average number of persons employed has been used which includes workers, supervisory and managerial staff and other employees.Total output and fixed capital have been used as a measure of firm size in two different models.

Methodology

In standardmicroeconomicstheory firms are assumed to behave rationally but in analysing efficiency it has been recognised that firms can operate inefficiently. Though a competitive market equilibrium would not allow for such inefficiencies. In order to study technical efficiency of the firms a benchmark production function has to be constructed which is called as the frontier. On frontier lie the technically efficient production unit which indicates the maximum attainable output with the given inputs and technology. All the units producing below the frontier are thus technically inefficient. The two most common approaches of estimating the maximum level of output are data envelopment analysis (DEA) and stochastic frontier analysis (SFA). Data Envelopment Analysis (DEA) is a nonparametric approach that makes no assumptions concerning the form of the production function and is arrived at by empirically observing the relationship between inputs and output.On the other hand SFA is a parametric approach where the form of the production function is assumed to be known or is estimated statistically. The benefits of this approach are that hypotheses can be tested with statistical rigour, and technical relationships between inputs and outputs follow functional forms which are known. SFA can be used to simultaneously arrive at technical efficiency for the firms and a technical inefficiency effects model (Admassie and Matambalya, 2002; Coelli et al., 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007). The paper uses SFA which uses the maximum likelihood method to calculate the frontier model based on the Cobb-Douglas production function for cross-sectional firm level data.A two factor Cobb-Douglas production function utilising cross-sectional data can be written as follows (Coelli, 1996a):

$\ln Y_i = \beta_0 + \beta_1 \ln(K_i) + \beta_2 \ln(L_i) + (V_i - U_i)$ where, $i = 1,.....,N$

Where:

Y_i= Value added of firm i

K_i = the gross value of plant and machinery of firm i

L_i = the average number of persons employed by firm i

V_i = A random variable which is assumed to be an independently and identically distributed normal variable with zero mean and variance, (iidN(0, σ_v^2)), and is assumed to be independently distributed of U_i.

U_i = A non-negative random variable that accounts for technical inefficiency in the production function, and is assumed to be independently and identically distributed as a truncation at zero of a normal distribution, (V_i = iidN(0,σ_v^2))

To examine the determinants of technical inefficiency, U_i is assumed to be a function of explanatory variables. This can be defined as the technical efficiency effects model as follows:

$U_i = \delta^* Z_i + W_i$

Where;

Z_i = vector of explanatory variables

δ^* = efficiency parameters to be estimated

W_i = error term that follows a truncated normal distribution.

Empirical Results

The unit level data on the pharmaceutical industries of Himachal Pradesh was available for 68 firms. In order to estimate the frontier, gross value added was used as the measure of output. Labour and capital have been specified as inputs using gross value of plant and machinery as the proxy for capital and average number of persons employed as the proxy for labour. Besides, in the technical efficiency model firm specific variables such as firm size and age of the firm have been included to explain inter-firm differences in technical efficiency. Two models have been used to find out the factors affecting inter-firm differences in technical efficiency, one including fixed capital as the measure of plant size and the other including total output as the measure of plant size. The descriptive statistics for the sampled firms used in the analysis are presented in the following table:

Table1. Summary Statistics for variables in the Stochastic Frontier Model:

Variable	Obs	Mean	Std. Dev.	Min	Max
GVA (In Cr)	68	66.78	130.09	.045	793.58
GVPM (In Cr)	68	44.51	130.52	.028	817.82
Avg. No. Of persons employed	68	240.83	223.35	14	1060
Total Output (in Cr)	68	143.61	221.21	3.58	1161.53
Fixed Capital (In Cr)	68	49.33	112.45	0.5	807.19

Stochastic Production Function and Technical Efficiency Estimates

The maximum likelihood estimates of the parameters of the model obtained from estimating the stochastic frontier production function and the level of technical efficiencies of the firms are presented and discussed in this section.

Table2. Stochastic Frontier Model and Maximum Likelihood Estimates

• Dependent variable: Log of deflated Gross value added • Observations: 68 • Time Period: 2011-12	Stochastic frontier normal/half-normal model Log-likelihood = -118.20214 Wald-chi2(2) = 55.68			
GVA	**Coefficient**	**Standard error**	**z- statistic**	**p>|z|**
GVPM	0.13	0.11	1.10	0.269
Avg. no. ofpersons engaged	1.02	0.22	4.63	0.00
Constant	12.44	1.59	7.78	0.00

The model estimated by the maximum likelihood method is highly significant asshown by the large likelihood values.Both capital and labour have been found to be having a positive impact on frontier output, but the coefficient of capital (gross value of plant and machinery) is found to be statistically insignificant. This might be because appropriate proxy for capital has not been used and capital has not been calculated with the help of perpetual inventory method. From the above model we can see that elasticity of output with respect to labour is greater than with respect to capital. This also justifies how the coefficient of capital is coming out to be insignificant. After obtaining the frontier by the above method the technical efficiency was calculated for different firms and further technical efficiency scores were assigned to different firms in percentage.

The summary statistics of the same are presented in the following table:

Table3. Summary Statistics for Technical Efficiency Scores

Variable	Observations	Mean	Std. Dev.	Min	Max
te_score	68	27.54	17.1024	6.10	100

From the above table we can see that there is huge divergence between the performances of the firms in the pharmaceutical industry of Himachal Pradesh. The mean level of technical efficiency is 27.54%, which is quite low. Dividing the technical efficiency scores (in percentage) in bands;

Table4. Technical efficiency bands and frequency of firms

te_band	Band value	Freq.	Percent
1	0 – 30	45	66.18
2	30 – 60	21	30.88
3	60 - 100	2	2.94
Total		68	100.00

From the above table we can see that majority of the firms lie in the 0 – 30 % band of technical efficiency.

Sources of Technical Efficiency

The technical efficiency model is applied to find out the factors affecting inter-firm differences in technical efficiency. The firm-specific characteristics included in the efficiency model are firm size and age. There are a number of factors that affect technical efficiency of the firms as evident from the available literature. Other than variables included factors like location of the firm, percentage of skilled labour employed, type of organization, ownership also affect the technical efficiency. But these variables were found to be insignificant and hence the results of the model with those variables have been presented in the appendix.

Model 1

Total Output Has Been Used As A Determinant Of Firm Size.

Table5. Technical Efficiency Model 1

R-squared = 0.2710	Adj. R-squared = 0.2486			
te_score	**Coef.**	**Std. Err.**	**t**	**P>t**
ln_total_output	-6.919275	1.461442	-4.73	0.000
ln_age	9.01875	3.016375	2.99	0.004
constant	153.0935	28.1803	5.43	0.000

In the above model, we can see that though the R-squared is low, but since the coefficients of the independent variables are significant, the model captures the sensitivity of the technical efficiency scores to the changes in firm size and age.

Firm size seems to have a negative impact on technical efficiency of a firm on an average i.e. with one percentage increase in total output; the technical efficiency is expected to fall by 6.91 % points.

Graph1. Relationship between technical efficiency and total output (in Crores)

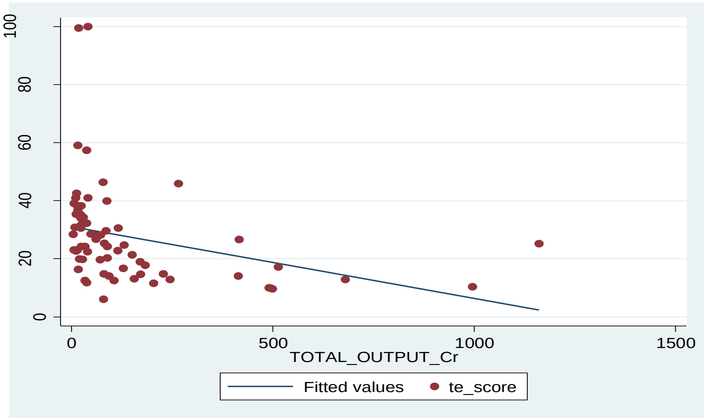
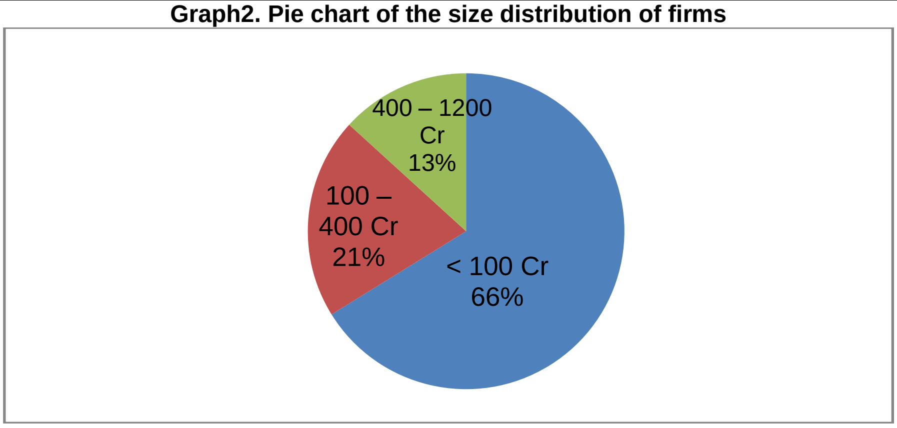


Table6. Distribution of firms according to size of total output

size_band	Total output (in Crores)	Freq.	Percent
1	< 100	45	66.18
2	100 – 400	14	20.59
3	400 – 1200	9	13.24
total		68	100.00

Graph2. Pie chart of the size distribution of firms



The negative relationship between total output (firm size) and technical efficiency is coming out to be negative, this may be because of diseconomies of scale manifesting as output level increases. Diseconomies of scale arise because of following reasons; managerial inefficiencies, problem of coordination and control, marketing diseconomies, financial diseconomies etc.

Age as an independent variable alone doesn't significantly affect technical efficiency, but when modelled with total output is found to be having a positive and significant impact on technical efficiency.This shows that the older firms are able to utilise their resources better such that technical efficiency improves by 9 % (approximately) points with every 1 % increase in age.This model thus captures the impact of age on technical efficiency via the output, showing the benefits reaped in the process of "learning by doing".

Table7. The summary statistics of the age variable of the firms is presented below:

Variable	Obs.	Mean	Std. Dev.	Min	Max
age	68	6.117647	4.845461	1	26

Table8. Correlation matrix between age and total output

Correlation	age	Total output in Crores
Age	1.0000	
Total output in Crores	0.2306	1.0000

Since the correlation between age and total output is low, the model thus will not be inflicted by the problem of multicollinearity.

Model 2

Fixed capital has been used as a determinant of firm size.

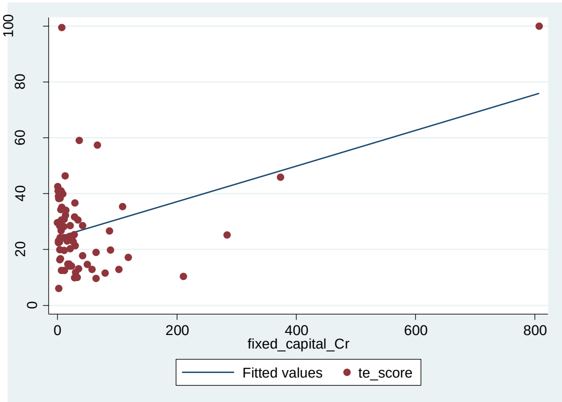
Table9. Technical Efficiency Model 2

R-squared = 0.1843		Adj. R-squared = 0.1592		
te_score	Coef.	Std. Err.	t	P>t
fixed_capital_Cr	.0621734	.0171625	3.62	0.001
ln_age	2.393498	2.983448	0.80	0.425
cons	20.6595	5.102805	4.05	0.000

In this model we can see that impact of fixed capital on firm size is positive and significant where one unit (defined in crores) in fixed capital would lead to 0.06% point increase in technical efficiency.

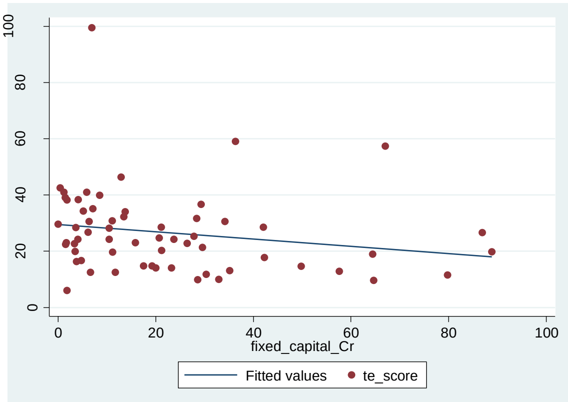
Graph3

Relationship between Technical Efficiency and Fixed Capital (In Crores)



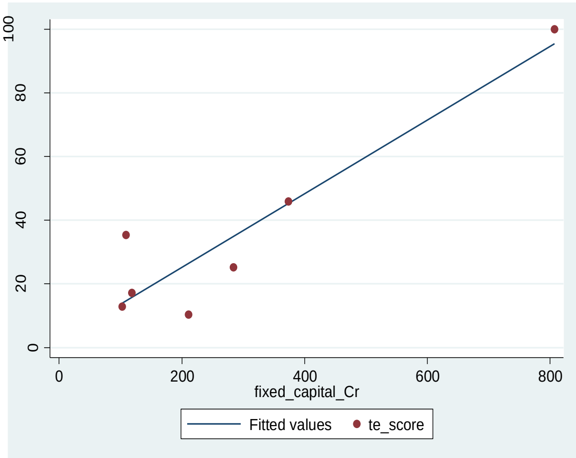
But on closer observation it was found that the positive relationship between fixed capital and technical efficiency does not hold throughout all sizes of fixed capital. It was found that for firms with a fixed capital size of less than 100 crore, there existed a negative relationship between fixed capital and firm size. This can be shown through the graph below:

Graph4. Technical efficiency for firms with fixed capital less than 100 Crore



For a large numberof firms the relationship is negative.For the firms with the fixed capital value greater than Rs 100 Crore, it was found that the relationship turns positive.

Graph5. Technical efficiency for firms with fixed capital greater than 100 Crore



Thus it can be concluded that it was the firms with the large value of fixed capital which were pulling the overall coefficient up.The impact of age in this model was found to be insignificant. Besides, correlation between age and fixed capital was also checked and was found to be low. This negates the existence of multicollinearity in the model.

Table10

Correlation Matrix of Fixed Capital and Age

	Age	**fixed_capital_Cr**
Age	1.00	
fixed_capital_Cr	0.1979	1.0000

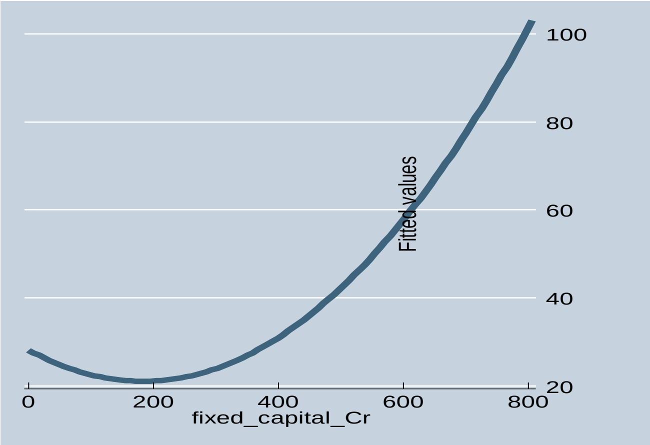
Age alone was found to have no significant impact on technical efficiency. Age was found to be having an insignificant impact on technical efficiency via fixed capital as well. This might be because older firms will have fixed capital of both old and new vintage. The fixed capital of old vintage will pull down the technical efficiency but the fixed capital of new vintage will be instrumental in pulling up technical efficiency. The two effects might be counter-balancing each other and thus the impact of age is coming out to be insignificant.

As was seen that the impact of fixed capital changed with the level of fixed capital employed, therefore a quadratic fit on fixed capital variable was applied and the following results were obtained:

Table11. Technical Efficiency Regressed on Fixed Capital and Squared Fixed Capital

te_score	Coef.	Std. Err.	t	P>t
fixed_capital_Cr	-.0914376	.044019	-2.08	0.042
fix_cap_cr_sq	.0002272	.0000608	3.73	0.000
ln_age	4.2355	2.768725	1.53	0.131
cons	21.91385	4.671856	4.69	0.000

Graph6. Technical Efficiency Regressed on Fixed Capital and Squared Fixed Capital



From table10 we can see that there is a negative relationship between technical efficiency and fixed capital as seen by the negative sign of the coefficient for fixed capital. But the coefficient for the square of fixed capital is positive which shows that the impact of fixed capital on technical efficiency is positive when greater weight is provided to higher levels of fixed capital.Graph6. reveals that there is a threshold limit (close to Rs 200 Crore) beyond which the firm is able to reap the benefits of increasing fixed capital and the impact of fixed capital becomes positive.

Conclusions

The study brings forth mixed evidence in relation to the impact of firm size and age on efficiency. In model 1, total output as a measure of firm size is found to have a negative impact on technical efficiency i.e. as output increases the technical efficiency reduce. This may be because of manifestation of diseconomies of scale. Also age seems to be impacting technical efficiency positively because of the benefits reaped in the process of “learning by doing”.The real life observable situations in Himachal Pradesh support these results. Pharmaceutical firms in Himachal Pradesh are marred with labour and transport union issues which are negatively affecting their performance. But in technical efficiency model 2 it was found that fixed capital (as a measure of firm size) affects technical efficiency positively. But for majority of the firms, firm size measured by fixed capital is negatively related to technical efficiency. Only after reaching a very high threshold fixed capital limit, does the relationship become positive.Age is found to be insignificant in this model probably because for old firms, fixed capital of old vintage and new vintage (added over years) will be pulling technical efficiency in opposite directions such that the resultant impact of age on technical efficiency via fixed capital turns out to be insignificant. But caution needs to be exercised while generalizing these results for the pharmaceutical industry of Himachal Pradesh as a whole and over the years as the observations available were small in number.

Appendix

Regression results when other factors affecting technical efficiency are included-

te_score	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
Ln_output	-6.81	1.19	-5.69	0.000	-9.206564	-4.420645
ln_age	8.46	2.57	3.28	0.002	3.305598	13.61674
Skild_work	-.012	.084	-0.15	0.879	-.1818362	.1560908
R_U_dum	-1.79	5.68	-0.32	0.753	-13.1621	9.56301
firm2_dum	16.15	13.09	1.23	0.222	-10.02793	42.33039
firm1_dum	72.88	12.15	6.00	0.456	48.58082	97.19197
_cons	152.65	24.37	6.26	0.000	103.9109	201.3977

te_score	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
fixed_capital_Cr	-.0619237	.0380203	-1.63	0.109	-.13795	.0141025
ln_age	3.859811	2.945165	1.31	0.195	-2.029411	9.749032
skild_work	-.0458566	.1022886	-0.45	0.656	-.2503953	.158682
R_U_dum	3.007206	6.869599	0.44	0.663	-10.72941	16.74382
firm2_dum	35.385	20.20355	1.75	0.085	-5.014493	75.7845
firm1_dum	122.0935	32.90439	3.71	0.000	56.2971	187.8899
_cons	20.94282	8.975747	2.33	0.023	2.994704	38.89094

Here, skild_work represents the proportion of skilled workers in total workers, R_U_dum represents dummy for location in rural or urban areas. The variables firm2_dum and firm1_dum represent the dummy for the type of organization. There are mainly three types of organizational set up in pharmaceutical industry of Himachal Pradesh; proprietary, partnership and Limited Company. From the above table we can see that none of the above variables has a significant impact on technical efficiency. Hence these variables have not been included in the main model.

References

1. *Chakraborty, C and Arpita Ghose (2013), "Regional Disparity and Convergence of the Growth of Output of Indian Pharmaceutical Industry: Evidence Based on Structural Break Unit Root Test", Journal of Industrial Statistics, Vol. 2 (2), pp 195-207.*
2. *Corporate Catalyst India (2014), "A Brief Report on Pharmaceutical Industry in India March, 2013", available at http://www.cci.in/pdfs/surveys-reports/Pharmaceutical-Industry-in-India.pdf*
3. *Ghose, A and Chandrima Chakraborty (2012), "Total Factor Productivity Growth in Pharmaceutical Industry: A Look Using Modern Time Series Approach with Indian Data", The Journal of Industrial Statistics, Vol. 1 (2), pp 250 – 268.*
4. *Goldar, B& Arup Mitra (2013)"Small versus large manufacturing units: how efficient are they?" , Journal of the Asia Pacific Economy, 18:4, 634-653, DOI: 10.1080/13547860.2013.827416*
5. *India Brand Equity Foundation (2010), "Himachal Pradesh; April 2010", Report by IBEF available at www.ibef.org.*
6. *Majumdar, S.K. (1994), "Assessing Firms' Capabilities: Theory and Measurement. A study of Indian Pharmaceutical Industry", Economic and Political Weekly, Vol. - 29 (22), pp 83-89.*
7. *Neogi, C, Atsuko Kamiike and Takahiro Sato (2012), "Identification of Factors Behind the Performance of Pharmaceutical Industries in India", Discussion Paper Series, RIEB, Kobe University, DP2012-23, pp 1-36.*
8. *Pattnayak, S.S. and Alka Chadha (2005), "Technical Efficiency of Indian Pharmaceutical Firms: A Stochastic Frontier Function Approach", National University of Singapore, Singapore.*
9. *Ray ,S.P. (2011), "Measuring Capacity Utilization and Evaluating the Impact of Liberalization on Capacity Utilization of the Indian Drug and Pharmaceutical Industry", Journal of Emerging Knowledge on Emerging Markets, Vol. 3 (1), pp 207-227.*
10. *Saranga, H and R.D. Banker (2010), "Productivity and Technical Changes in the Indian Pharmaceutical Industry", Journal of Operational Research Society, Vol. 61 (12), pp 1777-1788.*
11. *Satpathi, L.D., Bani Chatterjee and Jitendra Mahakud (2017), "Firm Characteristics and Total FactorProductivity: Evidence from IndianManufacturing Firms", The Journal of Applied Economic Research, Vol. 11 (1), pp 77-98.*