Industrial Performance in West Bengal: Analysis of Technical Efficiency with ASI Data

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Abstract: This paper focuses on the performance of the manufacturing sector of West Bengal, using ASI data. An inter-industry comparison shows us the importance of different industries in the sector. Also, the overall performance of the sector is observed in terms of the growth rates of output and employment. Performance is measured in terms of the presence of technical inefficiency. A stochastic frontier approach is used following the KLEMS-Y Model. The main conclusion of the analysis focuses on the presence of inefficiency in the sector and the importance of an increase in investment, both in physical and social capital, in order to make the production process more efficient.

JEL: C14, C20, O40
Keywords: Stochastic Frontier, Efficiency, Manufacturing

1. Introduction

West Bengal was the second most industrial states in India in terms of value added and was at the top in terms of number of factories and employment even in the mid1960s in spite of its rapid slow-down from the very beginning of independence of the country[1]. Thereafter the state started to lose its industrial primacy with a drastic fall in public investment. The rate of industrial growth in West Bengal not only fell further, but the state had to suffer a process of deindustrialization as well (Bagchi, 1998). The industrial recession in West Bengal was the most severe and long lasting too. While public investment, particularly in steel and engineering in the eastern region from the end of the first Five Year Plan period[2], stimulated some growth in West Bengal, that stimulus was not enough to compensate for the relative sluggishness of private investment (Bagchi, 1998). After the end of the British rule in India, most of the large-scale traditional industries (e.g. Jute) in eastern India owned by the British capitalists were handed over to Gujarati and Marwari entrepreneurs. But they gradually shifted capital to their native states in the western part of the country mostly by utilizing Sick Industrial Companies Act (1985) probably in the hope of more profit.

[1] In the late 1940s more than 600,000 workers engaged in various industries in the organised sector in West Bengal- a figure being equal to that of the present Maharashtra and Gujarat put together.

[2] A number of public sector establishments like the Durgapur Steel Plant, Alloy Steel Plant, Mining & Allied Machinery Corporation, Chittaranjan Locomotive Works, Hindustan Fertilizer Corporation, etc. were established in West Bengal during the 1950s.

In terms of new industrial investment, the western and southern states have gained, and the eastern states are in decline. Gujarat, in the western part, shared 16 per cent of the industrial investment in medium and large-scale industries in the country between 1991 and 2003 and ranked second (next to Maharashtra) among the major states in India. In West Bengal, the eastern region state, on the other hand, the share of new investment in industries was less than 4 per cent during this period[3]. The western region states have continued to dominate the eastern region states in terms of their shares of value added and employment in the factory sector of the country.

Labor militancy has normally been blamed for industrial slowdown in West Bengal. A popular perception is that West Bengal suffers from workers' unrest. But West Bengal has had far many more lockouts than strikes in the period 1991- 2005. In fact, the number of strikes in this period has been less than that in Tamil Nadu, Gujarat, Andhra Pradesh, or Haryana. The number of lockouts, on the other hand, has been significantly greater than for any other state except Andhra Pradesh during this period. In West Bengal, the number of lockouts increased from 108 in 1991 to 172 in 2005. According to the Indian Labor Handbook, West Bengal had only 16 strikes in 1996, the lowest among all the major states, affecting 27,000 workers. But there were 80 lockouts in the state with the highest number of man days lost among the major states during this year. Against this background, this study looks at the performance of registered manufacturing sector of West Bengal from the 1980s to the current period. Overall performance has been analyzed by considering the registered manufacturing sector as a whole for the period 1979-2013. A panel data analysis is done, explicitly taking all the industries of the sector for the period 1998-2013, in ordered to analyze the overall efficiency of production.

The paper is organized in the following way. Section 2 looks at the overall scenario of the registered manufacturing sector of West Bengal for the period 1979-2013 by taking all manufacturing industries in the state. An inter-industry comparison has been done, where we look at the change in the share of different industries under the sector in terms of net value added and total employment. For estimation of overall inefficiency of the sector, we have

[3]As per the data on Industrial Entrepreneurs Memorandums (IEMs) provided by the CMIE: Gujarat (2003), June, total investment in Gujarat is about Rs. 168186 crore and in West Bengal total investment comes to about Rs. 40243 crores over the period 1991 and 2003. Maharashtra is at the top in attracting new industrial investment amounting to Rs. 230043 crores, 22 per cent share of investment under IEMs in India during the same period.

used a stochastic frontier approach following the KLEMS-Y Model, the details of which will be provided in Section 3 that deals with the methodology and definitions used. Section 4 interprets the results obtained through empirical analysis. Section 5 summarizes and concludes. The main conclusion of the analysis focuses on the presence of inefficiency in the sector and the importance of increase in investment, both in physical and social capital, to make the production process more efficient.

2. Performance of the manufacturing sector of West Bengal

Different regions in India have been growing in different rates since independence. According to Kaldor (1975) the regional disparities in growth have been highly associated with unequal incidence of industrial development. Government policies at the national and regional level are one of the most influential factors of manufacturing growth in any region and in any country. During the regulated policy regime West Bengal got a disproportionately smaller share of industrial licenses which further declined rapidly during the period of state control. The industrial policies of the union government formed the pattern of industrialization within a particular state up to 1980. After that, under the guidance of national policies, states in the country got some flexibility in implementing their own economic policies (GOI, 2010). This study focuses on the last period mentioned. Here, we look at the overall performance of the registered manufacturing industrial sector of West Bengal in terms of output, employment, and profitability for the period 1979-2013, though intra sectoral comparisons for the manufacturing sector are done for the period 1998-2013.

2.1 Value Added and Employment: Industrial Scenario of Registered Manufacturing Sector of West Bengal

In terms of net value added for the period 1998-2013, the leading sectors are found to be textiles, chemical and chemical products, and basic metal. However, the pattern of change from period to period are different across the manufacturing sectors. Diving the time period 1998-2013 into three sub periods, as mentioned in Table 1, we can see that the share of textiles has declined substantially over time. Same pattern can be observed in case of chemical and chemical products. However, this pattern is different for basic metals. The share of basic metals in terms of net value added have increased substantially over the years. Though, in the last period considered, we can observe some decline in that share, the basic

metal is found to dominate the manufacturing sector in terms of share of net value added in the period.

In terms of the share of employment, textiles always dominated the manufacturing industries for the period considered. Though, here also, the share of textiles decreased over time. For Basic Metals, however, the share has increased gradually. From the observations, we can conclude that in terms of net value added and employment, the importance of textiles is decreasing, while that of basic metals in increasing over time.

Table 1: Percentage Share of Net Value Added and Employment by Two- Digit Industries in West Bengal

Industry Groups (NIC-2008)	Net Value Added			Employment		
	1998-2003	2004-2008	2009-2013	1998-2003	2004-2008	2009-2013
Food Products & Beverages (10-11)	5.27	6.4	7.75	10.06	12.71	7.94
Tobacco Products (12)	6.13	3.38	2.29	2.46	3.43	2.73
Textiles (13)	19.5	11.84	11.87	34.6	33.31	26.57
Wearing Apparel (14)	0.44	0.49	1.64	0.36	0.65	1.75
Leather and Related Products (15)	1.94	1.89	3.1	2.07	2.22	5.06
Wood (16)	0.44	0.7	1.15	0.95	1.13	1.31
Paper & Paper Products (17)	0.67	0.59	0.92	1.24	1.2	1.28
Printing & Reproduction of Recorded Media (18)	3.35	1.98	1.09	1.53	1.35	1.03
Coke & Refined Petroleum Products (19)	3.78	7.79	2.4	1.23	1.32	1.5
Chemicals & Chemical Products (20)	13.84	11.88	4.06	5.37	4.31	2.7
Rubber & Plastic Products (22)	1.46	1.11	1.84	1.65	1.83	2.12
Other Non-metallic Mineral Products (23)	3.32	4.13	5.23	2.57	2.63	2.73
Basic Metals (24)	16.8	26.91	21.85	14.94	15.5	16.72
Metal products (25)	2.87	2.81	6.13	2.91	3.36	4.57
Machinery & Equipment (28)	4.05	3.06	4.08	5.47	3.3	3.27
Computer, Electronic and Optical Products (26)	0.15	0.43	0.84	0.06	0.26	0.83
Electrical Equipment (27)	5.09	4.58	6.14	3.01	2.54	3.39
Motor Vehicles, Trailers and Semi-trailers (29)	0.74	0.09	0.23	1.68	0.76	0.78
Other Transport Equipment (30)	3.14	3.12	2.63	3.59	3.01	2.54
Furniture (31)	0.36	0.22	0.15	0.42	0.42	0.2
Other Manufacturing (32)	2.89	3.87	7.31	2.59	3.14	3.29

Source: Authors' own calculation using ASI Data

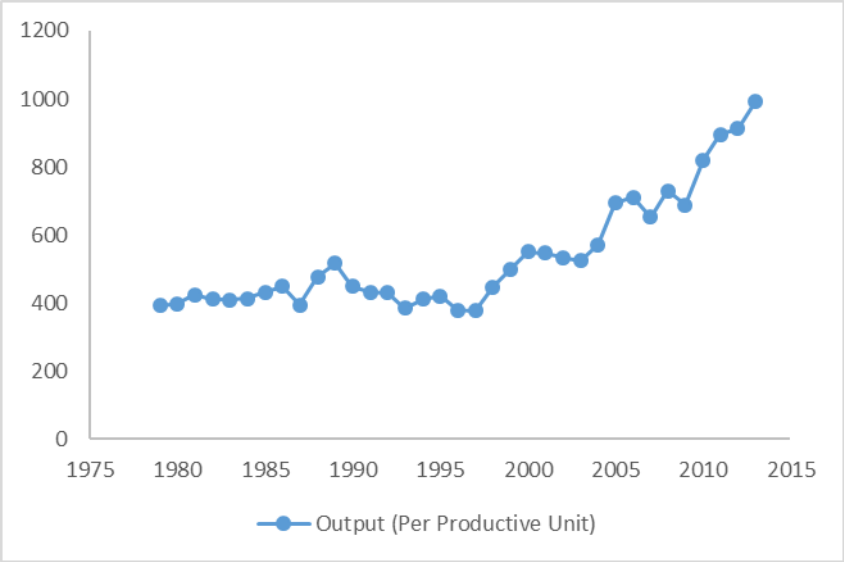
2.2 Output and employment growth in registered manufacturing

Before beginning this analysis, let us first define the concept of output per productive unit used here. Output per productive unit is measured as:

Output per Productive Unit = (Value of Output/ Gross Value Added) X 100

The value of output is divided by gross value added to account for inflationary pressure. The ratio of Value of Output to Gross Value Added is further normalized by multiplication of 100. We should read the above-mentioned definition as Output per 100 unit of productive unit. For our empirical analysis, we need to define Capital /Labor /Energy /Materials /Services per Productive Unit as well, we will do that later. To analyze the output and employment growth in registered manufacturing, let us consider Output per Productive Unit and total employment in the sector considered.

Figure 1: Output (Per Productive Unit) in Registered Manufacturing of West Bengal



Source: Authors' own calculation using ASI Data

Looking at the Output per Productive Unit for the specified period, we can observe an upward trend. However, the trend line suggests that the situation is quite stagnant up to 2000, some improvements are observed after that. As can be observed from Table 2, we can see that the rate of growth is not the same for each period. Dividing the entire period 1979-2013 into three sub-periods (as mentioned in Table 2), we can observe that the growth rate increased a little while moving from the first period to the second, while in the third period it increased quite a lot compared to the former increment.

Table 2: Output (Per Productive Unit) and Employment Growth in the registered manufacturing sector of West Bengal

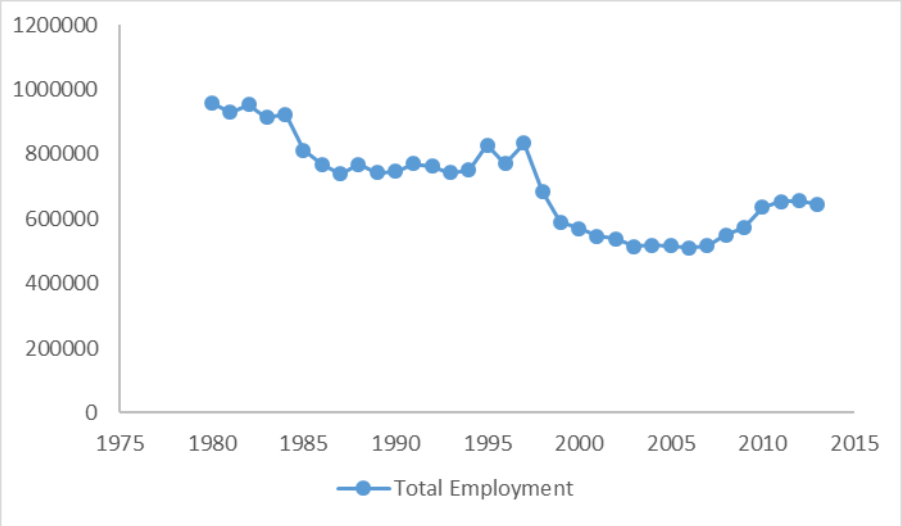
Periods	Growth of Output Per Productive Unit	Growth of Total Employment
1979-1990	1.64	-3.09
1991-2002	2.85	-3.67
2003-2013	5.62	3.02

Source: As in Table 1

Note: Growth rates are estimated by using semi-logarithmic trend equation and are statistically significant at 1 per cent level

As can be seen from Figure 2, total employment decreased over the chosen period. Detailed analysis suggests that the share of different types of employment didn't change much, with the share of workers being around 80% of the total employment. Table 2 suggests that for the first two period's growth rate of employment was negative and decreased from -3.09% to -3.67%. But it became positive in the third period, showing that though for the first two period's employment decreased, it increased in the last period.

Figure 2: Total Employment in Registered Manufacturing of West Bengal



Source: As in Figure 1

Thus, for the period considered, the output per productive unit increased, while total employment decreased, specifically for the period 1979-2002. Which supports the mismatch between output and employment growth in Indian Manufacturing found in 1980s in many studies as mentioned in WBDR (2010), which implies virtually jobless growth.

3. Methodology

Productivity is defined as the ratio of a volume measure of output to a volume measure of inputs. The efficiency in resource use and technical progress accentuates economic growth. Productivity drives the economic growth in terms of output growth by means of input growth. The efficient utilization of resources is referred to as the productivity. "*Productivity growth is generally understood to represent the exogenous shift of a frontier (best practice) production function. The distance from the frontier technology is X-inefficiency*" (Srivastava 1996). Productivity or technological progress gets very little importance in the classical literature though productivity is the most influential factor behind the economic growth. There are different approaches to the measurement of productivity depending upon the purpose of use and availability of data. Broadly the measurement is done in two measures- single factor productivity (SFP) or multi-factor productivity (MFP), both relates to the measurement of output to the combination of inputs. MFP growth is a measure that captures changes in efficiency in addition to pure technical change in the sense of shifts in the production function.

This paper explores the recent performance of manufacturing industry in West Bengal. We have investigated the industrial structure in terms of value added, labour employment, and technology. A realistic representation of the productive performance needs multiple inputs together to estimate what is known as multi factor productivity (MFP). The most widely used MFP model (KLEMS-Y model) relates gross output to capital (K), labor (L), energy (E), materials (M) and services (S). The primary inputs being capital and labor, we will be classifying the intermediate inputs into energy, materials, and services.

KLEMS model addresses the detail industry performance of the indicators for the formulation and evaluation of long-term policies for growth, efficiency, and competitiveness. When the proportion in which the factors of production are combined (e.g., labor and capital) undergoes a change, partial measures of productivity provide a distorted view of the contribution made by these factors in changing the level of production. In a situation where capital-labor ratio follows an increasing trend, productivity of labor is overestimated and that of capital, underestimated. For instance, capital deepening (shifts in technique of production) can lead to a rise in labor productivity and fall in capital productivity over time. In this case, a change in labor productivity is merely a reflection of substituting one factor by another (Majumdar, 2004). Similarly, improvements in labor productivity could also be due to

changes in scale economies (Mahadevan, 2004). In short, the partial measure does not provide overall changes in productive capacity since it is affected by changes in the composition of inputs. KLEMS model whereas, seems to be a useful tool by providing detailed statistical decomposition, more information on the inputs contributing to output growth, and production efficiency. This helps policy makers and economists to identify factors associated with economic growth, such as structural changes in industry's input mix, particularly with regards to the relative contribution from the intermediate inputs. This also facilitates a more disaggregated analysis of the industry origins of aggregate productivity growth, such as changes in the relative importance of input components over time. The classification of intermediate inputs, energy (E), materials (M), and services (S), is beneficial in that they distinct different roles in the production process, and thus it helps in evaluating and understanding the way in which the industries interact. An industry's reliance on primary inputs relative to intermediate inputs may change due to changes in leasing and hiring arrangements rather than the productive process itself. Apart from the input growth, the output growth depends on several other factors like R&D, education, human capital, infrastructure etc. The part of the growth which is not captured by the growth of the inputs, that is the residual component, is explained by the MFP.

There are two approaches in which MFP can be measured: production function approach and growth accounting approach. Our study will be following the latter one because production function approach is associated with various problematic issues like multicollinearity, autocorrelation, and degrees of freedom (Trivedi et al. 2000). Growth accounting approach whereas separates the change in production on account of changes in the quantities of factors of production from residual influences. Multi Factor Productivity (MFP) surrogates these residual influences.

KLEMS-Y model can be expressed in the growth accounting framework by taking natural logarithm as:

$$\ln Y_{it} = \alpha_0 + \alpha_1 lnK_{it} + \alpha_2 lnL_{it} + \alpha_3 lnE_{it} + \alpha_4 lnM_{it} + \alpha_5 lnS_{it} + v_{it} - u_{it} \dots\dots\dots\dots (1)$$

Equation (1) shows the rate of growth of the output in terms of the weighted average of the growth of inputs. α_0 is assuming perfect competition and constant returns to scale. We are assuming *I* industries, indexed by *i*=1…….*I*, through time period *T*, indexed by *t*= 1……..*T*. In the equation v_{it} represents random statistical noise and u_{it}>0 represents

technical inefficiency. Stochastic frontier model provides estimators for two different specifications of u_{it}.

Considering the simplest specification in which u_{it} is a time-invariant truncated-normal random variable. In the time variant model, $u_{it} = u_i, u_i \sim iid\ N^+(\mu, \sigma_u^2), v_{it} \sim iid\ N^+(0, \sigma_v^2)$, and u_{it} and v_{it} are distributed independently of each other and the covariates in the model.
In the time varying decay model, specification is:

$$u_{it} = e^{\{-\eta(t-T_i)\}u_i}$$

Where T_i is the last period in the i_{th} is panel, and η is the decay parameter.
$u_i \sim iid\ N^+(\mu, \sigma_u^2), v_{it} \sim iid\ N^+(0, \sigma_v^2)$, and u_{it} and v_{it} are distributed independently of each other and the covariates in the model.

Considering the time-variant specification we will be applying most appropriate method of estimation for this purpose, which is maximum likelihood estimation method, which imposes no restriction on the pattern of distribution. Measurement of MFP is possible by applying any of the two techniques- frontier and non-frontier approaches, which are further sub divided into parametric and non-parametric method of estimation. Our study is going to follow the method of frontier parametric method of estimation.

Frontier approach aims to find the bounding function, i.e., Production frontier traces the best possible output given the inputs and the technology. The estimation procedure is not the same as estimating the average function by means of ordinary least square technique of regression as a line of best fit through the sample data. Unlike the non-frontier approach which inherently assumes the firms are technically efficient, frontier approach tries to find out the role of technical efficiency in the firms' overall performance. The MFP growth as obtained from frontier approach consist of two components - outward shifts of the production function resulting from technological progress, and technical efficiency related to the movements towards the production frontier. Since in frontier approach, benchmarking is done where a firm's actual performance is compared with its own maximum potential performance, the approach is more suited to describe industry or firm's behavior (Mahadevan, 2003: 373).

Frontier that will be traced can be deterministic or stochastic in nature. We will be considering a stochastic frontier and will be estimating it using parametric method. An explicit functional form is specified for the frontier, which is estimated econometrically by

using sample data for inputs (KLEMS) and outputs(Y). The estimation will be done considering the stochastic frontier model; the deviation of the actual output from the maximum possible output is decomposed into two components, viz., statistical noise and inefficiency.

Here we will be taking all the factors of production and output in their per Productive Unit terms in order to account for inflationary pressure. The Output per Productive Unit is defined earlier. Here, let us define the rest of them.

1. Capital per Productive Unit = (Fixed Capital / Gross Value Added) X 100
2. Labor per Productive Unit = (Total Emoluments / Gross Value Added) X 100
3. Energy per Productive Unit = (Fuels Consumed / Gross Value Added) X 100
4. Materials per Productive Unit = (Materials Consumed / Gross Value Added) X 100
5. Services per Productive Unit = (Services Consumed / Gross Value Added) X 100

Except the data for "Services Consumed", all other variables are explicitly provided in ASI data. "Services Consumed" is derived by subtracting "Fuels Consumed" and "Materials Consumed" from "Total Inputs". The objective of our study is to analyze the overall performance of registered manufacturing industries of West Bengal in terms of technical inefficiency. Thus, we will be doing a pooled estimation under the panel data framework. So, our study is going to account for the technical inefficiency of the manufacturing sector as a whole.

4. Empirical Analysis

This section focuses on the main results of our empirical analysis. All the variables under consideration, namely output, capital, labor, employment, materials consumed, services (all of them defined in per Productive Units, as mentioned in the previous section) are transformed into their natural logarithmic scale. The transformation is performed in order to account for Cobb-Douglas production function. Statistical software package STATA is used for performing the estimation. The results of the estimation are given in Table 3.

Table 3: Stochastic Frontier Estimation for Registered Manufacturing Sector of West Bengal: 1998-2013

Independent Variables	Coefficient	z	P>z
constant	2.62	30.92	0.00
ln_capital_ppu	0.03	2.16	0.03
ln_employment_ppu	-0.03	-1.98	0.05
ln_energy_ppu	0.05	2.76	0.01
ln_materials_ppu	0.56	33.42	0.00
ln_services_ppu	0.25	24.41	0.00
u	0.80	9.16	0.00
eta	0.00	-1.25	0.21
sigma2	0.04	sigma_u2	0.04
gamma	0.87	sigma_v2	0.01
Log likelihood = 327.76438			
Wald chi2(5) = 7784.58			
Prob > chi2 = 0.0000			

Source: As in Table 2.1

In this case the Wald chi2(5) = 7784.58, which is statistically significant. Stochastic frontier model estimation reports that Wald statistic of the null hypothesis that excepting the constant all other coefficients are zero. Hence, we can conclude that the estimated model is overall significant, implying the explanatory variables explains the maximum variations out of total variation in the model.

We have considered a specification where the distribution of the inefficiency component is assumed to be varying over time. The decay parameter η, as mentioned earlier is found to be equal to zero, which implies that the time varying decay model reduces to time invariant model. Thus, the distribution of the inefficiency component remains constant over time.

According to the estimated results of the KLEMS-Y model, we find that output is increasing with respect to all the inputs excepting labor. The estimated coefficient for capital is found to be positive though insignificant. West Bengal being a capital scarce state, increase in Capital per Productive Unit increases Output per Productive Unit. But the investment of capital is found to insufficient in magnitude which gets confirmed by the statistical insignificancy of the variable. However, another major factor of production, labor is found to have a negative impact on the level of output, i.e., increase in labor per productive units decreases output per productive unit. Being a labor abundant state, West Bengal experiences over utilization of existing resources and leads to diminishing productivity. To have a significant effect of labor employment on the growth of the output, which is not observed in

our analysis, calls for the investment on the complementary factors of production. If not done, then the employment will be in the declining phase keeping other factors of production constant and the jobless growth will continue to persist. The intermediate inputs: Energy, Materials, and Services seems to have significant effect on the level of output. All these variables (measured in per Productive Unit) are found to be positively affecting the Output per Productive Unit. Energy being an important component of the social overhead capital is directly increasing the direct productive activities. Materials as defined by the ASI "*represents the total delivered value of all items of raw materials, components, chemicals, packing materials and stores which actually enter into the production process of the factory during the accounting year. It also includes the cost of all materials used for the construction of building etc. for the factory's own use. It, however, excludes all intermediate products consumed during the accounting year. Intermediate products are those products, which are produced by the factory but are subject to further manufacturing".* Our analysis clearly depicts that output is directly proportional to the materials consumed by means of forward and backward linkage. Theoretically it is hypothesized that increase in the proportion of Services which mostly comprises of the outsourcing activities should increase the level of output, and our study confirms it.

The inefficiency parameter in our model specification, *u*, is statistically significant, implies the presence technical inefficiency in the production process. West Bengal is characterized by abundance of labor; proper utilization of this resource requires sufficient supply of capital to work with. The technical efficiency can be increased by increasing capital through more investment. To bring in investment state has a role to play in providing a healthy and sound investment climate by investing more on social overhead capital, and other assistances.

5. Summary and conclusions

The inter industry comparison of registered manufacturing sector of West Bengal in terms of net value-added shows that textiles, and chemical and chemical products industries are in declining phase, on the contrary basic metal industries are increasing rapidly in share. Observing from the perspective of total employment textiles industries continue to dominate the sector, though its share is decreasing over time. The previous studies have shown a mismatch between output and employment growth in Indian manufacturing during 1980s and in our study, we found a similar scenario regarding West Bengal. Estimating the MFP

productivity model in the framework of stochastic frontier approach we observe the presence of inefficiency in the performance of the manufacturing sector of the state.

The inefficiency is accounted because of lack of the optimal amount of investment in terms physical and social overhead capital, given the endowment of labor. West Bengal has never provided a proper investment climate that resulted in huge amounts of lockouts in the previous decades (which our study comprises of). Following this a capital flight has also been observed to other states which provide better incentives to the investors. A role of the state is to be called for to provide a more incentive compatible environment for the investors in order to achieve the optimal allocation of resources.

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