Chapter Five

SUMMARY CONCLUSION AND POLICY SUGGESTIONS

Chapter five is the concluding chapter of this thesis. The first subsection is devoted to the summary of the entire work including objectives, hypotheses, methodology and principal findings. The second subsection is devoted to the policy suggestions of the study. These policy suggestions are based on both descriptive statistical findings and on estimated econometric results. Certain policy suggestions are also given on the basis of information collected at the estate level during the course of the survey but which has not been directly used in any econometric estimation. The final subsection deals with a note on drawbacks of the study and its possible extensions. In conclusion, a note is written on how future research in this area may possibly fill up the drawbacks of the present study.

5.1 Summary of Principal Findings

In the microeconomics of production, efficiency and productivity are possibly the two crucial pillars that are used to evaluate the relative performance of production units. Identification of the precise causes of productivity and efficiency loss is vital from the point of view of policy analysis and intervention. Efficiency promotion is necessary from the stand point of survival of a firm (production units) under a competitive set up but its importance diminishes as the market becomes less competitive. Competition improves the performance of firms by forcing it to enhance its profit raising activities. In empirical microeconomics of production measurements of efficiency and productivity based on observations on inputs and output are essential from the view point of appraisal of relative performance of firms in an industry.

Some firms in an industry may overuse certain factors and some other firms in the same industry may overuse certain other factors. Empirically, the same quantities of inputs are observed to produce different levels of output of firms in an industry under identical technological conditions. This is possible if all producers are not equally efficient. In other words some producers (or firms) can possibly raise output without raising the use of inputs. Producers can save costs by cutting input use but without reducing levels of production. This would generate additional profit for reinvestment. This phenomenon becomes naturally important for developing countries as because they suffer from acute resource scarcity. For developing nations, efficient utilisation of available resources is the key to both long run growth and development.

The present study measures and analyses total factor productivity growth and technical efficiency in the tea processing industry of Assam over the ten year period 2001-10 on the basis of both primary as well as secondary data. Economic importance of this industry is undeniable in Assam and the rest of India. Tea industry is the largest industry as well as the single most important industry of Assam and it contributes almost fifty per cent of India's annual tea output.

Total Factor Productivity Growth (TFPG) provides a measure of performance of production units. TFPG is an index of change in output net of changes in inputs over the same period of time. Alternatively, TFPG is output growth less the sum total of inputs share weighted input growth. A TFPG series can be computed over a period of time by constructing a suitable index that captures the total factor productivity of a production unit. This description of TFPG essentially implies that it is a residual measure – that is, the part of output growth that cannot be accounted for by factor share weighted input growth. This residual actually captures the combined effects of factors (not production inputs) such as change (or improvement) in technology, better capacity utilization, learning by doing, improved input quality, more efficient use of inputs etc.

The concept of the technical efficiency of firms has been pivotal for the development and application of econometric models of frontier functions. Although technical efficiency may be defined in different ways [for example, Fare etal. (1985)], we consider the definition of the technical efficiency of a given firm (at a given time period) as the ratio of its mean production (conditional on its levels of factor inputs and firm effects) to the corresponding mean production if the firm utilized its levels of inputs most efficiently [Battese and Coelli, 1988]. More recent literature shows that efficiency is an important factor for productivity growth as well. In view of the slow growth and increasing instability in tea production in India in recent years, the industry is expected to be benefited to a great extent from the present study on firm level technical efficiency. Estimates of the extent of inefficiencies could help to decide whether the objective of firms should be to improve efficiency or to develop new technology to raise productivity growth.

The present study has used secondary data primarily from two sources. (i) Annual Survey of Industries: *Summary Results for Factory Sector* (various issues)in order to get industry level long run time series data on Tea Manufacturing for the period 1981 – 2009 (NIC – 2001, 5 Digit Classification Code: 22710), and (ii) Annual Balance Sheet information as per CSO (Central Statistical Organisation) format at the estate level, submitted to the Tea Board of India on an annual basis. The study period is 2001- 2010. The analyses on estate level performance, productivity and technical efficiency is based on a sample of 31 tea estates (17 from upper Assam and the remaining from the three districts of Barak Valley) of Assam. The selections of the tea gardens or estates have been done on the basis of convenient sampling. The sample for the present study is thus non-random but covers both the major agro-climatic regions of Assam. Factory sector time series data at the industry level has been used to estimate and analyse TFPG for the state of Assam during the period 1981-2010. ASI data for the tea processing industry at the state level for Assam has been used for this purpose. Appropriate indexes of TFPG under parametric and non- parametric approaches are used. In particular the study has estimated TFPG using the Solow Divisia Index, the Tornqvist Index, and the Kendrick Index among the parametric measures, and has further estimated TFPG by using the well-known non-parametric measure of the Malmquist Index.

Measurements of technical and cost efficiencies are also done. Production and cost frontier based econometric approaches are adopted for the purpose of measuring technical efficiency as well as cost efficiency at the tea estate level. Both time invariant and the time varying models of technical efficiency are estimated by using the well-known technique of the stochastic production frontier model adopting a time varying transcendental logarithmic production function for panel data. The well-known time varying stochastic production frontier model developed by Battese and Coelli (1992) has been adopted in the study as because it allows the statistical tests of a host of parametric restrictions on the error distribution. Different parameter restrictions imposed in the Battese and Coelli (1992) model generate different stochastic frontier models starting with the most rudimentary model of Aigner, Lovell and Scmidt (1977). Whether the given data follows any particular type of error structure (of the inefficiency random variable) can be statistically tested by the use of likelihood ratio test. Efficiency in plantations and agriculture, growth of total factor productivity (TFP) and its decomposition, and the question of how to measure them, is an important subject in developing countries' agriculture (Shah, 1995; Hazarika and Subramanian, 1999).

The tea industry is of considerable economic importance not only in Assam but for the rest of India as well. Producing a fourth of the world's annual tea output the tea industry occupies a place of considerable importance in the Indian economy. Although tea is produced in fourteen

States in India, five of them, namely, Assam and West Bengal in the east, and Tamil Nadu, Kerala and Karnataka in the south account for over 98 per cent of India's tea production. Within that, the two eastern states alone account for around 75 per cent of India's total tea production. Around 85 to 90 per cent is of annual tea output of India is consumed domestically. Although tea industry has played a pivotal role for the economy of Assam and the Indian economy at large, it has faced some severe challenges in recent years. The growth rate of production as well as that of productivity (both in the plantations and factory sectors) has not been satisfactory in recent years. The industry now faces stiff competition from key global players as Sri Lanka, Kenya, Nepal, and China among a few others. The ultimate objective of the present research is to arrive at a set of policy prescriptions that can enhance the performance, productivity and efficiency of the tea industry in Assam.

The descriptive statistics of the variables reported in the data summary include mean, standard deviation, minimum, maximum, coefficient of variation for output, area cultivated or land, wages as a measure of quantity of labour, pesticides and fertilisers, irrigation, and implements. The summary statistics are computed on the basis of ten years data starting 2001. Land has been measured in hectares, wages are deflated by the cost of living index for industrial workers, and pesticides and fertilizers are measured at their cost deflated by the Whole Sale Price Index (WPI of 1993 =100). Similarly, irrigation and implements are valued at their real cost after deflation by WPI. As expected a new WPI series was released by RBI with 2004-05 as base, i.e., with WPI value for 2004-05 as 100. WPIs for all the time points (2001-10) were expressed with reference to 1993-94 as the base year. This was done by splicing which a simple application of the unitary method.

In case of Solow Divisia Index the mean TFPG for all estates (n=31) turns out to be 0.58. The mean TFPG for all estates turns out to be negative at -0.87 and 0.57 for Tornqvist Index and Malmquist index respectively. The standard deviation is more for Tornqvist and Malmquist

Indexes but less for Solow index. Thus greater variability in TFPG is observed in case of Tornqvist and Malmquist Indexes. The simple correlation coefficient between the Solow measure and the Tornqvist measure is computed at 0.65 which positive as well as statistically significant. The same correlation figure computed for Solow and Malmquist measures turn out to be 0.03 which is positive but close to zero and statistically insignificant. The corresponding correlation figure between Tornqvist and Malmquist index turns out to be 0.09. This shows that the two parametric measures are strongly positively associated while the parametric measures are not associated with the non-parametric measure. In case of Upper Assam, the mean TFPG is found is found to be negative for the sample tea estates when measured by both Solow and Tornqvist indexes. However the Malmquist measure shows a positive of mean TFPG. The year wise mean TFPG (Barak valley) is also found to be negative with only one difference. Apart from the Solow and Tornqvist measures, the Malmquist measure also gives a negative mean. There seems to be a turnaround in terms of TFPG at the industry level post 2009. For the Solow measure TFPG is found positive and rising during the last two years and in case of Tornqvist measure TFPG is found to be negative but falling in absolute terms, thereby implying a rise in TFPG. This pattern however is not exhibited by the non-parametric measure. For upper Assam estates, fluctuations in TFPG are observed throughout and with a downturn towards the end years. Even here non-parametric and the two parametric measures show slightly conflicting results and seem to be non-associated. However, it is found that there is no evidence of any association (positive or negative) between TFPG and output growth at the estate level as the simple correlation coefficient between TFPG (as measured by Solow Divisia and Tornqvist Index) and output growth turns out statistically insignificant. Similarly, no pronounced association is observed between area cultivated and TFPG among the sample of tea estates in Assam for the period 2001-10. It has observed that a large number of tea estates (i.e., 54.84 per cent of the total sample estates) have TPFG value between -1.26 and 0.74 which is poor. Roughly 32 per cent of the estates have a TFPG value of 0.74 or more. In fact just three estates have exhibited a TFPG value of 4.74 to 10.74. In other words just around 10 per cent of the estates are found to be performing well in terms of TFPG. The most commonly observed statistical finding is that area under cultivation or land is the most significant factor for the production of green leaf. Although practically labour is perhaps the single most important factor of production in tea plantation, its statistical significance in ordinary regression analysis is very small. This is slightly unexpected.

From the comparison of upper Assam and Barak valley estates it is evident that all measures of TFPG provide higher values for upper Assam. Thus it is perhaps correct to state that upper Assam estates are better performers when it comes to total factor productivity growth.

For the industry level TFPG analysis (using alternative measures), both for the state as well as for the all India level, gross value added is taken as suitable measure of output. Labour, capital and energy are the only three inputs taken to explain gross value added. Three different TFPG measures namely Solow divisia index, Tornqvist divisia index and the Kendrick index, are computed on the basis of ASI data both at the all India level as well as for the all Assam state level during 1981-2010. At the national level, it has observed that during the first phase of weak liberalisation (1981-85) both Solow and Tornqvist divisia indices are found to be negative, while the Kendrick index and the translog rate of technical change are found to be positive. For the second phase of weak liberalisation, observations are very similar to that of the first regime. However in the second phase of weak liberalisation (1986-1990) TFPG is slightly lower compared to regime 1. During the first phase of strong liberalisation (1991-95) TFPG is both positive and high and all the measures give comparable values. It seems that economic reforms, or otherwise what is known as economic liberalisation, seems to have a significantly positive impact on TFPG. During the second half of the 1990s, TFPG fell slightly but still remained positive according to all the alternative measures, Kendrick index showing the highest value.

However, in Assam average TFPG is clearly higher during the post 1991 period compared to the same for pre-1991 years – an observation that is very similar to the all India TFPG results. The similarity in the TFPG patterns for the tea processing industry in Assam (state level) and for the all India level is not surprising. The simple reason is that the share of tea (processed tea) production of Assam in national tea output has been around 50 – 55 per cent so that the productivity behaviour of tea manufacturing in Assam and the all India level is bound to be similar in many ways.

As far as the elasticities of output with respect to factors is concerned, output is found to be most elastic with respect to fixed capital, i.e., machinery followed by energy and labour at the all India level. Interestingly there is not much of a fluctuation in the elasticities of output with respect to inputs across regimes. The scale elasticity of output is consistently above unity. This is indicative of increasing returns to scale in tea processing at the all India level. However, observed output sensitivity with respect to power in tea processing in Assam is lower compared to that at the national level. From the analysis of the decomposition of output growth (gross value added is taken as a proxy for output), it is observed that the performance of the tea processing industry as a whole has not been satisfactory in terms of TFPG. The entire decade before the period of strong liberalization (1982-90) exhibited negative TFPG but there was a sharp recovery during the first five years of strong liberalization. This almost continued during the second five years as well but declined sharply during the period 2001-05. In terms of TFPG this is clearly the worst phase for the tea processing industry in India. However during the last sub-period there was a slight recovery although TFPG was still negative. The first two sub-periods show positive factor contributions but negative contribution of TFPG to growth of gross value added (GVA). The same is true for the second sub-period as well where TFPG fell further along with value added growth. However during the first phase of strong liberalization both the contributions of capital and labour are negative and both TFPG and output growths are positive and satisfactorily high. Share of capital is never negative. So this is possible only if growth of capital stock is negative during this sub-period. The negative contribution of capital continued during the next sub-period although contribution of labour was positive. TFPG fell sharply during 2001-05. This could well be due to the heavy growth of capital over this sub-period. Growth of value added remained stable for the tea processing industry in Assam over the study period all throughout the post 2001 years. TFPG recovered slightly but was still negative during the last sub-period. During the first phase of strong liberalization or regime 3, both capital and labour registered negative growth rates but the growth rate of labour was smaller than that of capital. GVA growth recovered during regime 4, although growth rate of capital stock was still negative and labour grew positively. During regime 5, there was a very sharp growth of capital stock surpassing all other variables. Although there was a recovery in GVA growth during the last regime capital stock growth was the fastest. Broadly, energy growth has never been negative which is expected in the factory sector or the processing sector. Higher degrees of mechanization lead to labour displacement in the factory sector but the process becomes more energy using. Thus it is expected that energy growth would be higher than labour growth on the whole.

The growth rate of all relevant variables per unit of labour reveals that except regime 4, capital stock per unit labour has been growing positively.GVA per labour almost became stagnant during regime 5, but capital stock per unit labour grew at a very brisk pace during this period. Energy per unit labour has always grown positively.

On the whole, GVA per unit labour exhibited highest growth during the first phase of strong liberalization. Y/L can always be taken as a rudimentary measure of labour productivity. The simple correlation coefficient between labour productivity (Y/L) and capital intensity (K/L) turns out to be 0.48 which is significant at 4.16 per cent level. Thus it is not wrong to say that at the industry level a rise in capital intensity is associated with a rise in labour productivity. The overall growth rate of capital stock is around 2 per cent while that of labour force is around 0.33 per cent. Thus fixed capital has grown faster than labour quantity. This is expected with rising automation and mechanization.

At the all India level technical progress in tea processing was biased against labour and energy in regime 1, but the pattern of bias changed in favour of labour and energy and against capital in regime 2. However the bias amounts are very low. During the first phase of strong liberalization capital bias became negative while technical progress was still biased in favour of labour and energy. However during the post 2001 period, technical progress became biased against labour and energy and went in favour of capital. Thus during the last decade or so there is a hint of energy saving type of technical progress. In case of Assam, the observations are more or less similar with low quantity of bias in absolute terms, and exhibiting labour and energy saving type of technical progress towards the end years. In fact technical progress is also found to be of capital using type during the last decade.

Whether the given data follows any particular type of error structure (of the inefficiency random variable) is statistically tested by the use of likelihood ratio test. In the case of the null hypothesis of no technical inefficiency in the data or absence of the inefficiency random variable from the composed error structure (which is further equivalent to an average production function estimation by use of OLS), it is found that the traditional translog production function indicating the absence of the inefficiency effects is statistically an inadequate representation of data on the inputs and output of selected tea estates of Assam over the study period. Hence it can be inferred that there is a technical inefficiency effect in the data and variations in observed output are not due to random shocks alone. The null hypothesis of the time varying Cobb-Douglas frontier model is rejected and a time varying

Cobb-Douglas production frontier model would be an inappropriate representation of the underlying relationship between inputs and output of the selected tea estates of Assam over the study period. The hypothesis of the time invariant Cobb-Douglas stochastic production frontier model is also rejected by the data at 5 per cent level. Thus both the time varying and time invariant versions of the Cobb-Douglas model are inappropriate functional forms and do not represent the technological relationship exhibited by the data on inputs and output of the selected tea estates of Assam over the period 2001-10.The hypothesis tests for the absence of time varying technical inefficiency or for time invariant technical inefficiency under the restriction $\eta=0$, is accepted at 5 per cent level. Accordingly for the selected tea estates of Assam for the study period, technical inefficiency is not significantly rising over time or is insignificantly rising over time (since estimated $\eta>0$). On the whole the selected tea estates of Assam have not been able to raise their levels of technical efficiency over the study period.

Finally the restriction $\eta=\mu=0$ [which boils down the inefficiency specification from the Battese and Coelli (1992) time varying model to the time invariant inefficiency effects model with normal – half normal error structure for panel data due to Pitt and Lee (1981)] is rejected at 5 per cent level and is therefore not supported by the data. Thus the overall results of statistical tests of hypotheses reveals that the translog stochastic production frontier (for panel data) with time invariant inefficiency effects with normal – truncated normal composed error structure may be taken as an appropriate econometric representation of the underlying technological relationship between inputs and output in case of the 31 selected tea estates of Assam over the ten year period 2001-10.

The year wise mean technical efficiency of all the sample tea estates covering upper Assam and Barak valley displays that there is a slight tendency of a rise in technical efficiency over time over the period 2001-10 for the sample of tea estates taken as a whole. Alternatively, there is a hint of a decline in technical inefficiency over time which desirable. The average annual exponential rate of growth of annual mean technical efficiency of all sample estates taken together is estimated at 0.4 per cent. As the growth rate of technical efficiency is below 1 per cent during the 10 year study period, it may be termed as unsatisfactory.

The mean technical efficiency for the entire sample of 31 estates (covering upper Assam and Barak valley) over the study period 2001-10, is estimated at 71.77 per cent. Maximum technical efficiency is estimated at 88.57 per cent while the minimum is 51.67 per cent. This is an indication of substantial variations in the level of estate level technical efficiency. The calculated standard deviation of technical efficiency across estates and over time is found to be 12.55. Further, it is evident that more than 48 per cent of producers have technical efficiency in between 75 per cent and 95 per cent. Around 30 per cent of sample tea estates have mean technical efficiency levels ranging between 45 and 65 per cent. Furthermore around 55 per cent of the tea estates are found to have mean technical efficiency of 65 to 85 per cent. Only a few estates are observed to have mean technical efficiencies below 55 per cent and above 85 per cent respectively. On the whole, the distribution of estate level mean technical efficiency is roughly positively skewed with substantial variations between the technically most efficient and the technically most inefficient.

As far as the cost efficiency is concerned, around 30 per cent of the sample tea estates of upper Assam are found to have cost efficiency between 45 and 65 per cent. Around 53 per cent of sample tea estates in the upper Assam region have cost efficiency levels in between 75 and 95 per cent which is desirable at least from the industry level standpoint. In other words majority of the sample tea estates of upper Assam have cost efficiency levels beyond 75 per cent. Mean cost efficiency of all upper Assam estates taken together is 72.94 per cent. There is a wide observed variation between the minimum and the maximum levels of percentage cost efficiency.

The mean cost efficiency for Barak valley tea estates turns out to be just 63.57 which is far lower than the corresponding figure for upper Assam estates. However the inter-estates variations in cost efficiency are lower for Barak valley estates. Around 36 per cent of sample tea estates have cost efficiency in between 35 and 55 per cent. Interestingly around 36 per cent of tea estates have cost efficiency in between 55 and 75 per cent, whereas just around 28 per cent of the sample estates of Barak valley have cost efficiency between 75 and 95 per cent. In fact no tea estate of this region has a cost efficiency level of 90 per cent or more. Thus the distribution of cost efficiency in this region is more even around a lower mean compared to the same for upper Assam tea estates.

5.2 Policy Suggestions

A set policy suggestions and implications based on the above findings are presented in this sub-section. These suggestions or implications are the offshoots of empirical analysis of the data on the one hand, and peripheral and relevant information of the gardens on the other but which are directly not included in any econometric or descriptive statistical analysis. Any empirical study in the microeconomics of production and productivity is usually conducted with the ultimate objective of arriving at a set of corrective policy suggestions that are aimed to improve the performance of firms or production units (tea estates in the present study).

To start with, it is apparent from the descriptive statistics as well as results of the econometric analysis that both TFPG and technical efficiency are higher for the sample of upper Assam tea estates compared to the Barak valley tea estates. This is possible if upper Assam estates are producing higher output using the same level of inputs or are saving inputs for the same level of output compared to those of Barak valley. Moreover output growth relative to the sum of the factor share weighted input growth is higher on the whole for upper Assam sample of estates. There may be several reasons behind these observations.

Demand for the variety of tea produced by Barak valley tea estates may be lesser compared to upper Assam tea estates. Although latest statistics are not reported here, a'priori information based on the direct interviews of estate managers reveal that final offer price at the auction (both Guwahati and Kolkata) is more on an average for upper Assam tea compared to Barak valley tea. Consequently upper Assam tea estates dominate the auction by both quality and quantity. Higher auction price may induce upper Assam estates to produce more relative to input use. Thus higher offer price at the auction may be an incentive to focus on quality as well as quantity. This is tantamount to more efficient use of resources in upper Assam estates. Rejection of old bushes and more focus on immature cultivation along with R&D may be the key for qualitative improvement of the output of Barak valley estates. For this purpose a long term strategy is required. Unutilized land under the ownership of the estate has to be utilized for fresh plantations at the immature level. Both yield and leaf quality could then be raised in the long run. Another issue in this context is that of plucking. Upper Assam estates focus more on fresh buds during plucking. This is because they try to strike a balance between quality and quantity. Very few well grown and older leaves are plucked in most gardens of upper Assam. However Barak valley estates focus more on quantity and as such plucking is not selective. The ideal kind of plucking in the form of two leaves and a bud is hardly followed by any estate. The interviews with most estate managers revealed that tea quality is primarily determined by the kind of plucking and not factory processing. The fresh buds are basically the source of flavour or aroma or odour. Unfortunately in Barak valley older leaves dominate the total harvest during the season as because tea output maximisation is the primary objective of the estate. All managers have remarked that too much attention to plucking of fresh buds would considerably lower the total harvest of the estate and would raise the per kg cost of tea to such an extent that even if higher offer price is attained in the auction, the total cost of production would just be covered leaving thereby little or no excess profits.

Managers have openly remarked during interview that tea producing is no longer a highly profitable business as it used to be during the 1980s. In their opinion, costs have risen more compared to revenue from sales and herein come the role of fresh investments in tea. Revenue may be limited if offer price per kg is low, or if total quantity produced and sold is low, or due to a combination of both. The new investment by estate owners could be channelized to developing fresh plantations (i.e., more stress on immature cultivation) and for rejection of age old bushes on the one hand, and for installing modern and latest machinery and equipment in the factory sector on the other. Thus fresh plantations along with latest machinery (with low depreciation) may help to raise both quality and quantity of tea.

The empirical findings have shown that cost of mature and immature cultivation in the sample of Barak valley estates is higher per hectare compared to the same for the upper Assam sample. It is possible that certain structural bottlenecks do not allow Barak valley tea estates to cut costs relative to output. The bottlenecks may be in terms of transport and communications with the rest of India along with power supply. Roadway and railway communication of Barak valley with the rest of India, especially the tea auction centres Guwahati and Kolkata, is extremely gruesome even today. From the standpoint of smooth functioning of the tea industry transport and communications is too vital to be ignored.

First, shipping of processed tea is more time consuming and costlier under the present roadway infrastructure. Transportation cost or cost of shipments is a significant cost from the marketing point of view. Upper Assam gardens do not suffer from this bottleneck. Thus the developments of road infrastructure can significantly reduce the costs of transportation of processed tea thereby having a positive impact on the profit of the estate. Second, up-gradation and maintenance of tea processing factories require large shipments of machinery and equipment from the rest of India. Transportation of factory machinery and equipment are is costlier for Barak valley estates compared to estates located in upper Assam. Thus the cost of factory maintenance (depreciation) and installation of additional capacity is higher for Barak valley estates. It apparently seems that Barak valley tea estates are suffering from a locational disadvantage, being situated in a remote area that has limited roadway connectivity with upper Assam. However this additional cost due to the locational disadvantage may be lowered to a considerable extent if Barak valley and upper Assam (the state capital in particular) are connected by four lane highway along with broad-gauge railway. These issues related to transport and communications infrastructures in the north east need to be addressed at the state level by the state leadership rather than by tea research scientists and estate managers or estate owners.

Power shortage and thus frequent and prolonged power cuts in the Barak valley region is yet another impeding factor that may be responsible for lower productivity and efficiency on one hand and higher costs relative to output size on the other. This is expected to hurt the factory sector and not the plantation sector. During the course of the survey meant for collecting garden level (or estate level) data on inputs and output it was revealed that almost all tea processing factories under the ownership of the respective estates use coal as a substitute for electricity for the purpose of heating. Tea processing requires controlled heating in several steps that include drying before fermentation, during fermentation and finally for drying after fermentation. Although a major part of the automated process of tea production is run by electricity, most factories today largely depend on coal as a source of heat.

Most balance sheets at the estate level do not contain any information on coal as a factory input. In all probability the estate management procures coal from illegal and unauthorised surface mines located in Meghalaya at a price below the government declared price. This may account for the absence of cost of coal in annual balance sheets. However according to the management, controlled heating can be done more efficiently with the help of electricity and in such a case the cost may slightly be lower than the cost of coal for the same quantity of processed tea. But without uninterrupted power such controlled heating would not be possible. Thus the provision of uninterrupted or dedicated power to the tea factories can potentially lower the cost structure and may enable smoother running of the tea production process. According to most estate managers the power supply situation of upper Assam is significantly better compared to that of Barak valley. This is one of the reasons why most estate managers believe that use of coal in upper Assam tea processing is much lower compared to Barak valley.

Tea is a plantations based industry. Efficiency and productivity differences between upper Assam estates and those in the Barak valley region (in the plantation sector) may be explained by the differences in efficiency and skill levels of plantation workers as well as that of estate managers. Possibly, upper plantation workers of Assam gardens are more trained and thus more efficient in mature and immature cultivation. In the present study empirical evidence shows that spending on workers welfare and emoluments is higher for upper Assam estates. This is indicative of better health and physical condition of workers and hence higher standards of overall wellbeing, although the same has not been measured at the garden level. Another factor may conceivably explain better overall functioning of upper Assam tea estates. Corporate ownerships of tea estates in Barak valley are very rare. However a group of big corporate houses who are also traditional tea producers own numerous tea estates in upper Assam. For the present sample of upper Assam estates there are six estates under the ownership of large corporate houses. However none of the Barak valley estates in the present sample are corporate owned. Corporate managerial control of certain tea estates might be a significant factor behind the more efficient and productive functioning of upper Assam sample of estates compared to the Barak valley estates. All most all estate managers have remarked during the course of the survey that reinvestment is done primarily for factory and machinery up-gradation and maintenance rather than for upkeep or maintenance of the plantations.

5.3 Drawbacks and Possible extensions

The present research undertaking on productivity and efficiency of the tea industry in Assam is specifically focused on a set of well outlined objectives. This focused or streamlined approach to the study (or else what is otherwise known as vertical integration) is expected in a doctoral research programme. Policy implications of such specific studies may often be narrow in the sense that suggestions based on results and outcomes may be confined or applicable to that sector or industry alone and not to others. Admittedly any econometric study based on firm level empirical data is bound to suffer from certain limitations or drawbacks. These lacunae or gaps may either be theoretical (i.e. conceptual) or empirical (i.e. either statistical/econometric or data related). Identification of the limitations is crucial from the point of view of extensions of the study along with its future modifications.

First, the study considers a limited number of tea estates both for Upper Assam and Barak Valley in relation to the population of tea estates in both the zones. Ideally the study should have been based on a representative sample of 70 tea estates (around 45 tea estates from upper Assam and 25 from Barak valley). However, non-responsiveness of the management staff of around 60 per cent of the tea estates has reduced the sample size for the present study considerably. A larger cross-section would have provided statistically superior estimates of parameters.

Second, a longer time period could have been selected, especially a decade before the onset of economic reforms programme of 1991 could have been considered for statistical robustness as well as for profound economic policy implications. Such a data set could have enabled a comparison of the productivity and efficiency trends between the pre-reform and the post-reform years. In other words impact of reforms on the trends of efficiency and productivity in the tea industry of Assam could have been studied from such a data set covering both pre-reform and post-reform years.

Third, conceptually in case of tea plantations immature cultivation is an input in mature cultivation in lagged sense. It is independently developed by using all the usual inputs employed for mature cultivation. In reality older bushes are replaced by newly matured bushes intertemporally. Nurturing of immature cultivation today is vital for the growth and performance of mature cultivation tomorrow. Thus, although the final output or plucking is done from mature cultivation, it actually is the outcome of immature cultivation. In the jargon of microeconomics of production immature cultivation is purely an intermediate input in tea plantations where the same sets of inputs are applied for both types of cultivation. The single equation approach to production frontier estimation as done in the present research does not capture the role of immature cultivation in final green leaf output at the garden level.

Fourth, the same tea estate produces and sells green leaf as well as processed tea. Thus, a multiple output stochastic production frontier and TFPG should have been adopted.

Fifth, detailed information on input prices could not be collected. Input prices are vital from the point of view of estimating allocative efficiency and hence to estimate a more flexible cost frontier. Simultaneous estimation of technical, allocative and scale efficiencies would have provided a deeper picture of overall economic efficiency at the estate level.

Sixth, quality of manufactured tea as captured by auction price should have been considered as a performance indicator. This variable has not been used anywhere in the analytical part.

Seventh, market share of the tea garden at the industry level should be considered as a relative size of the garden. Relative garden size may have influences on efficiency and productivity.

Eight, casual, semi-permanent and permanent workers should be separately considered as independent inputs as because they are the components of broader input of labour. Typically in tea plantations labour is essentially heterogeneous in nature.

Ninth, the exact type of the plantation in terms of the terrain on which the garden is located is important but has not been incorporated in the study. Some tea gardens are situated on the foot hills of major ranges. These plantations are usually located on undulated plains, mainly on hillocks of varying sizes and rarely on flat plains. However, other types of gardens located on the plains have a few hillocks but are often dominated by flat stretches. The percentage of sloping or undulated land out of total area under cultivation is an important variable that influences both irrigation effort and tea quality. Unfortunately this could not be captured in the present work but can be incorporated in future.

Tenth, the socio-economic status of plantation workers has not been considered at any level. Distress levels of tea garden workers are well identified. Socio-economic studies on tea workers are popular among researchers on poverty and human development. The abominable condition of these people in terms of the human development indicators or overall quality of life needs to incorporated as a modified input that can influence efficiency and productivity in plucking.

If some or all of the above aspects are incorporated in future research works then it would obviously make the study more comprehensive with deeper policy implications.